ENERGY SCIENCE REPORTS

These are ten Energy Science Reports by Dr. Harold Aspden, as published between 1994 and 1997. They were, until June 2003, available for purchase but are no longer in print for that purpose. The full version of the reports, which are listed and referenced (see links below) and described by the abstracts in the bibliographic section of the website http://www.aspden.org are now also of record and may be inspected by using the link included in the relevant abstract.

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ENERGY SCIENCE REPORT NO. 1

POWER FROM MAGNETISM

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POWER FROM MAGNETISM

Introduction

This is the first of a series of reports which are intended to serve as a technical briefing helpful in the evaluation of invention rights by expert opinion more familiar with conventional technology.

It is, of course, not to be expected that technical experts, however, skilled in their own research field, have the necessary in-depth training that applies to discoveries extending beyond what is currently taught in academic institutions. The specialists of the world of 'invention' are really those who are professionally skilled in patent matters, whose approach is not that of 'peer review' in a scientific sense but rather one which embraces, without bias, what an inventor claims to have created and then judges on novelty and merit with attention focused on the prospective practical implementation and the technological significance.

The purpose of these ENERGY SCIENCE REPORTS is to bridge the gap between the disclosure of invention, the province of the patent specification, and a few misconceived but established scientific doctrines that might otherwise make it difficult to understand the new science involved. Without such a briefing, technical advisors called upon to comment on the commercial viability of a 'new science' invention, especially one that is at the 'drawing board' stage, could not undertake a meaningful assessment.

No doubt, this report will be read by individuals who are enthusiastic on the 'free energy' front and are searching for new experimental ideas to take that interest forward. Those readers should, however, understand that the intention here is not to communicate project details aimed at the 'free energy' movement generally. The intention, very simply, is to provide the reader with enough technical and scientific educational insight so that he or she can grasp the significance of what is represented in the patent cover that will later be associated with this report. In short, this report is intended as a marketing aid preliminary to presenting invention rights for prospective exploitation by corporate or entrepreneurial interests. It follows therefore that this report should in no way be deemed to confer any implied right of use in connection with what is disclosed, as all possible proprietary rights are reserved, consistent with this report being made available on a non-confidential but restricted circulation basis.

'Free Energy': Defining the Field of Investigation

The words 'free energy' used in the introduction need explanation. This is an expression which has come into use in an international communication network. It simply means a prospective source of clean energy that is in abundant supply and not subject to territorial or climatic limitations, but one that has yet to emerge on the industrial scene.

In a sense one can imagine that engines running on 'free energy' would be classified as 'perpetual motion' machines, but here one needs to clarify terminology and concept. 'Perpetual motion' may be defined as that which, owing to a cosmic influence communicated via the action quantum named after Planck, results in a sustained energy activity in matter which arises from an equilibrium state as between matter and a 'field' medium in space. Thus, there is perpetual motion in us all. The human body comprises atoms in which electrons move ceaselessly with quantized motion. Even if we die and our bodies are cooled to absolute zero of temperature, to a temperature below the 2.7 K of cosmic space, that motion persists, because those electrons never stop moving. The atoms with their electron motion have perpetual life unless transmuted by the $E = Mc^2$ rule into a pure energy form that then dissipates into space. There is, evenso, a regenerative process in Nature by which forms of matter can be created and the secret of all this activity lies in the understanding of:

(a) the nature of gravitation
(b) the nature of magnetism
(c) the nature of the photon, and
(d) the nature of the aether.

The scientific establishment has not, as yet, provided any accepted explanation for any of these physical phenomena. For example, until there is an accepted and valid derivation of the measured quantity 137.0359, the 'over-unity' version of the fine-structure constant, which is the key to the photon action and the energy quantum already mentioned, those 'experts' cannot deny energy transfer from vacuum to matter via the quantum process. Any such denial would only amount to a declaration that obtaining energy from space to serve a useful end is 'contrary to experience', meaning no more than that the fruits of future invention implicit in this pursuit have not yet come to market.

As to gravitation, all that has been offered by those who claim authority on that subject is that it arises from the distortion of space-time, which is another word for 'aether'. Yet, the aether is the space medium that is alive with energy, and the relativistic philosophy avoids the vision of the aether as an energy source and gives us instead Einstein's four-dimensional space-time as something that is 'distorted' in a way that leaves us completely in the dark on the energy front. $E = Mc^2$ is, by the way, merely a formula derivable from classical pre-Einstein electrodynamics and representing the fact that every individual electric charge comprising a body's mass contributes to the inertial property of that mass by resisting acceleration in just such a way as to preclude loss of its intrinsic electric energy by radiation. In short, every elementary component of the universe resists change of motion in an effort to conserve energy. Einstein did not understand the real nature of gravitation, meaning its essential electrodynamic connection, nor did he ever conquer the mystery of inertia.

The question of primary concern in this Report centres on 'magnetism'. Here, even though you, the reader, might think that scientists understand magnetism, the sad truth is that the phenomenon of magnetic induction which was discovered by Michael Faraday, and which is at the heart of the whole of electrical power engineering, is not understood by the 'experts'.

The simple question of how the energy we feed into a magnetised solenoid is stored by that process has no adequate answer, at least in the standard teaching curriculum of academic establishments. Yet the answer to this question is crucial to the research to be described in this Report.

So, I begin by making a statement about the energy involved in magnetic induction and I challenge any scientist to refute what I say.

When an electric current is supplied to a solenoid the energy stored by induction, which is a mutual action set up between between numerous electric charges in motion, is dissipated into the thermal background of the aether itself. However, the action of that current in the solenoid is to deploy the motion of some of the aether electricity that constitutes that thermal vacuum background in such a way that an opposing magnetic reaction is established inside that solenoid. When the current is switched off it is as if this magnetic system is then a transformer with that reacting vacuum field becoming, in effect, a primary winding and the solenoid itself becoming the secondary winding. Energy is then fed back to the solenoid drawing on the thermodynamic state of the aether, which is left in a cooler condition, until, by a process of thermal equilibrium, energy commensurate with that originally dispersed migrates back through the aether to restore the status quo.

The reader should not think of this as a transformer action depending upon alternating current effects. It is an action that applies also with d.c and, of course, with electromagnets and permanent magnets, where the atomic electron activity that polarises the magnet is that of atomic solenoidal current effects.

There is no question that this is a correct description of the phenomenon of induction. We see here an action by which the aether has the ability to transfer its energy to matter. Magnetism provides the means for tapping into the vast sea of energy that fills space. However, the 'temperature' of that aether is not something we can measure by a thermometer, though one can sense it indirectly by its spectral effect on the radiation background.

The experimental work to be described has been founded on the author's insight into the physics of magnetic induction as outlined in his book MODERN AETHER SCIENCE (see particularly pp. 113-124).

If the reader prefers instead to be guided by orthodox textbook teaching, which is different, then a word of caution is appropriate. There are many excellent textbooks and they will tell you about the laws of Faraday and Lenz. Not all will be 'truthful' in the sense that they will tell you that scientists lack knowledge in this field. The book that stands out in my mind as a very readable text is that entitled 'THE NATURE OF PHYSICS' by Peter J. Brancazio (City University of New York); publisher Macmillan Publishing Co, Inc., New York. On page 328 one reads:

"At the present time there is no real understanding of why charges are set in motion by a changing magnetic field. Thus electromagnetic induction must also be regarded as an unexplained law of nature."

The reader will see that a choice has to be made. On the one hand, there are the sterile teachings that accompany acceptance of Einstein's theory. These eradicate belief in the reality of an electrical energy-active medium in space that transports electromagnetic waves. On the other hand, we have the alternative of an aether that accommodates to our energy needs by storing inductive power in its abundant low temperature heat sink.

If the reader seeks an independent way forward on the question of induction that reader could come to terms with the facts expressed, as recently as December 1993, in the Engineering Science and Education Journal issued by the Institution of Electrical Engineers. The cover of this journal shows (a), as the past, the statue of Michael Faraday in the IEE's headquarter building in London, (b), as the present, two students who face an uncertain energy future and (c), as that future, an illustration of a lightning discharge set alongside one showing a battery 'farm' of wind-power generators. The relevant article of reference is one on pp. 273-280 by John Carpenter entitled 'Understanding Electromagnetism'.

Here are some quotes from Carpenter's article:

"A great many electrical engineers, when challenged on such matters, confess to a considerable unease with their grasp of electromagnetic fundamentals."

"One of the most familiar 'consequences' of a magnetic field is the property of inductance...What do we mean by 'inductance'? We define it by the voltage which is caused by a change in current, and 'explain' the voltage in terms of flux linkage, part of which represents the magnetisation (i.e. the electron spins). It is these spins, acting like the electromagnetic equivalent of little flywheels, which interact with the conduction charges in the wire, and increase inductance. That is, they increase the electromagnetic inertia of the conduction electrons. But, we account for the voltage by some rather mystical quantity, denoted **B**, in empty space, and this is nothing whatever to do with electron spins. We represent **B** by lines on a diagram, provided with arrow-heads, and argue that **B** is the 'cause' of inductance. The type of student who always makes a nuisance of himself (or herself) may ask 'what is meant by **B**?' The student can be told to shut up, but the teacher may have been given pause for thought. Electromagnetic theory might be characterised over the last 100 years, as a progressive retreat from the idea of the aether as some form of 'medium' needed to convey the electromagnetic interactions."

Such, indeed, is the sorry plight of education in electrical science, bearing in mind that that 'aether' is the fountain from which flows all the energy that we see in our universe.

Even though Carpenter discusses the question of inductance in such a critical way, he does, in developing his own thesis about the nature of inductance, avoid bringing to bear that full-bodied aether that is essential to resolving the problem. He too gives way by falling into line with that spirit of retreat from the aether concept. The Carpenter interpretation depends upon current 'interactions' as between currents in matter, disregarding current flow in the aether itself. This is at the very heart of the problem. Does induction energy, the magnetic energy we know is stored when current flows in a coil, reside in the inertial motion of the electrons which carry that current or is it 'stored' in the aether in the sense that it is held captive at the seat of the action?

We are all familiar with storing money in a bank. That money we deposit is not kept in a box waiting for us to come back and withdraw the same money. Once deposited that money dissipates into a sea of action that is pooled and spent, just as energy dissipated as heat spreads itself through space. Banks rely on equilibrium which means a return on investment, an inflow balancing an outflow and compensating for what is spent. We get our money back because the bank has kept a record which 'polarises' the bank's money 'field' in our favour. That record is something left in that bank, that is not the actual money we deposited, but which can be triggered to release money to us from the limited part of the money pool kept by that bank. Inductance is a property by which energy transactions occur in an aether, replicating, in effect, the way in which money transactions occur in a bank. Understanding how the aether 'record' registers an energy transaction is the challenging question and, if we can understand this, with our energy future in mind, we might unlock Nature's energy secret and then be seen to be, as they say, 'laughing all the way to the bank'! Whilst students, therefore, engage in the mysteries of understanding **B** and not then understanding how energy is stored by inductance, the task of harnessing inductance to provide an entry route for tapping energy from that aether is one warranting our attention in this Report.

I must now assume that the reader is ready to accept that magnetic inductance may have some important energy secrets to disclose and now trust that we can move directly to the experimental evidence without the reader feeling that in talking about 'aether' I am leading that person along a blind alley.

'Over-Unity' Power Generation

A brief word is necessary on the theme of 'over-unity'. Readers will have seen this expression used above in connection with the fine-structure constant. This is a fundamental dimensionless physical constant as used by atomic physicists. In that 'over-unity' context it refers to the version of in its reciprocal form 1/, a quantity that is slightly greater than 137. In dealing with atomic situations and spectral analysis, the 'below-unity' form for which is 0.007297 is more familiar to physicists.

This digression does have a connection with aether energy, as the reader may see by referring to this author's contribution entitled 'The First Law of Thermodynamics', which has appeared at pp. 340-342 in the November 1993 issue of the U.K. Institute of Physics Journal 'Physics Education' (See Appendix A to this Report).

The expression 'over-unity' has come into general usage by researchers interested in 'free energy'. For a device to be said to operate 'over-unity' its power input (usually electrical) must be exceeded by the power output, whether the latter is electrical or mechanical or thermal.

This reference to 'thermal' should not be confused with the 'heat pump', by thinking that conventional heat pumps operate with 'over-unity' performance. It may be that one joule of electrical energy can transfer 10 joules of room heat from a lower to a higher temperature, but that is not an 11 to 1 'over-unity' performance since the true input then is 11 joules and the output is also 11 joules. The reverse Carnot efficiency factor of merit or 'coefficient of performance' applies to such a process.

By 'over-unity' in this report what is meant is the output of more useful energy than is supplied as useful energy input. In this context, those 11 joules of heat output are not as 'useful' as that 1 joule of electrical input and so the heat pump is not an 'over-unity' device. If, however, we run a device or a machine and it produces an excess of electrical output or an excess of heat at a temperature so elevated in relation to input heat that the Carnot criteria are surpassed, then we have 'over-unity' performance.

Our energy future is secured once we have the technology for this latter kind of operation. These Reports are being written because that technology is now in sight and there are, indeed, several alternative routes to that objective, all warranting our attention.

There are versions of the motor developed by Robert G. Adams of New Zealand, which have already been demonstrated in 'over-unity' operation, measured strictly in electrical input and electrical output terms. The Nexus magazine published in Australia has pioneered the news on the Adams machine and the Editorial in their January 1994 issue said that in 1993, since the Adams story had appeared:

"Nexus has been contacted by hundreds and hundreds of people from all over the world, and, yes, quite a lot of people have now successfully duplicated the device based on the information we published. In other words, there are now quite a few small-scale free energy machines running successfully out there, in the process of being made into large-scale devices. If you have shares in oil companies - get ready to sell soon!"

The Adams machine will be discussed briefly in a section of this Report and in much greater detail in a later Report in this series. However, at the request of Robert Adams, and in order to deal with a troublesome question that has emerged, I need to comment here on claims of 'over-unity efficiency'. It was said in one early text about the Adams motor that it had a 270% efficiency and 700% was mentioned in a recent magazine report.

The question posed concerns proof of such claims by evidence not relying on calculated interpretation of current and voltage measurements. The crucial and usual question is whether the output from such a machine has been fed back as input so that the machine, once started, runs and delivers output power with no input, at least until some component or connection ruptures or otherwise fails. That would be a 'perpetual motion machine' demonstration.

With such performance it is then absurd to discuss an efficiency measure because the efficiency becomes infinite. Therefore, the expression 'over-unity' has meaning as a classification rather than as a measure and the question is more related to the amount of 'feedback'. It is suggested, therefore, that 'over-unity with 20% feedback' could be one way of saying that 4 units of useful output are generated from one unit of internal feedback. Such a machine or device made available commercially should not be rated by its 'efficiency' but rather by its net power generating capacity, its power rating being its ability to deliver net power continuously.

It is also of relevance here to report that, on present experimental indications, yet to be fully researched, the Adams machines are delivering power which fluctuates with time of day. It is as if whatever is providing that coupling with the aether energy source is dependent upon the orientation of the device in relation to a spin axis characteristic of that aether.

This latter subject is rather special and it too will be covered by a later Report in this series. However, it is noted here that this 'discovery' was, in fact, anticipated by the author, based solely on aether theory, and became the subject of a preliminary patent filing lodged even before the news of the phenomenon was communicated by Robert Adams.

This is an appropriate point at which to interject the statement that, whilst Robert Adams has become the focus of attention, and deservedly so, we owe it to NEXUS magazine for initiating the tidal wave of action that will soon deluge the electrical engineering community. The wave of action will bring with it news of inventions, many of which are already covered by granted patents, but lie unappreciated amongst the dust-gathering information records of our technological age. One very relevant example of this is the U.S. Patent No. 5,227,702 (Inventor: Peter M. Nahirney), dated July 13, 1993, and drawn to my attention by Toby Grotz, the President of the recently formed INSTITUTE FOR NEW ENERGY, the professional society which was created in Colorado in April 1993 when we had, amongst other developments, debated the Nexus article publishing the design details of the Adams motor.

This Report will now deal with experimental results showing how magnetism provides an aether energy access route. In this, our attention turns away from 'free energy' motor developments, as such, and looks at steady-state devices. U.S. Patent No. 4,687,947 (Inventor: Melvin Cobb) is relevant to the theme developed next and warrants the reader's attention after digesting what is now to be described.

The Power Converter

An established technique used in d.c. power supplies involves using electronic switching to chop an input signal into pulses at an audio frequency and feeding those pulses through a ferrite-cored magnetic inductor coupling to transform the voltage before merging the output pulses into a smooth regulated d.c. output. This process is highly efficient and the power systems are compact in construction and offer high power rating in relation to bulk and weight.

The question now addressed is that of exploiting such technology with a view to incorporating the secret that will allow us to tap aether energy so that we get more electrical power output than is supplied as input.

The point to keep in mind is that the above-described technique will be assumed to be of a form which operates with a 'flyback' coupling in that it uses the inductance to store input energy in a time period separated from that in which the inductance releases energy to the output.

Also, what is to be described experimentally is not based on the use of a ferrite core but rather on a laminated sheet steel core, inasmuch as it is only the principle of operation that needs experimental demonstration for the purpose of this Report and it so happens that a convenient non-ferrite core assembly kit was available. We are not therefore, in this Report, going to get into the details of product design and the related costing of materials and specification of a proposed product.

Readers will appreciate that if we can gain some 'free energy' each time we drive a magnetic core through its magnetization cycle, the faster we can do that, the more energy we gain. The ferrite core permits higher frequency operation and, based on use in existing variable voltage regulated power supplies, there is good reason to expect that what is described below, and which works for laminated steel cores, will be eventually implemented in ferrite-cored systems as a preferred product form.

The following disclosure is also more concerned with the structural form of the magnetic core and its function energy-wise rather than the detailed way in which magnetizing coils are wired into an electronic control circuit. There are many variants and design possibilities for the latter, and such design does not pose unusual problems, but the core design depends upon the secret of that energy-tapping function and that does involve us in some new physics. I also remark that there are many who have wondered about the effectiveness and indeed the purpose of using bifilar-wound coils, with currents in the respective portions of the winding that merely cancel each other electromagnetically. The word 'flyback' used above bears upon this question and I leave the reader to ponder on that as a puzzle that I shall answer in a subsequent report.

To proceed, we need first a brief lesson in simple ferromagnetism as it applies to a magnetic core having an air gap.

Ferromagnetism

Ferromagnetism is Nature's way of giving us something for nothing in energy terms. Build a solenoid which has a non-ferromagnetic core and measure the inductance energy which has to be supplied in a.c. current and a.c. voltage terms and then, with the same voltage, see what magnetizing current is needed if the core is replaced by one that is ferromagnetic, say soft iron. For the same voltage, that magnetizing current is proportional to power in reactance terms and so to the energy stored at times of maximum current.

With the ferromagnetic core present we need far less current to secure the same voltage. The reason for this is that the ferromagnetic core itself is making up the energy difference by virtue of the 'perpetual motion' of those atomic electrons in the iron that endow the core with its ferromagnetic state.

Now ask how a power transformer works. We have two coils on an iron core. The object is to put energy into one coil and take energy from the other. By using the iron core we find that we can transfer energy between the two coils using a far smaller magnetizing current than would otherwise be needed. That current flowing in a copper coil means a loss owing to the resistivity of the copper and so, to reduce weight and cost, and assure efficient operation with minimal loss, one really must have a ferromagnetic core linking the two coils to assure minimal magnetizing current.

Now, rather than being satisfied that we know how a power transformer works and so have little to learn from that technology, let us ask how that transformer works if the two coils are separated at a distance along the length of a core or are on different sides of a square core, as depicted in Fig. 1.

We find that, somehow, that iron core has the ability to carry energy from A to B. Without the iron core very little of the energy supplied to A would be recoverable from B.

Now, it is a fact connected with the nature of ferromagnetism that, if one could see inside the iron looking at microscopic sections, the iron would everywhere be seen to be fully magnetized to saturation. Inside each crystal there are what are termed 'magnetic domains' in which the magnetism is directed along one of the three mutually orthogonal crystal axes each of which is an 'easy axis of magnetization'. The intrinsic miniature solenoids that represent the magnetic state of such domains each carry the maximum equivalent current associated with the related atomic electron motion and the normal process of magnetizing the iron macroscopically is one of causing these solenoids to reverse direction.

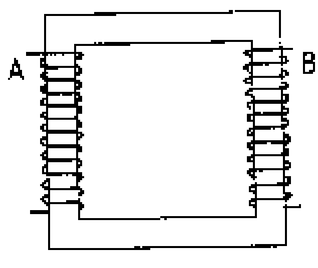

Fig. 1

It needs very little externally applied magnetizing current to promote the reversal of magnetism in a magnetic domain. Essentially such current as is needed is used to overcome the back reaction effects of non-magnetic inclusions in the iron or of the thin boundary wall regions separating domains or any air gaps built into the core as a whole.

These 180^o reversals occur with very little work being done and, as the level of overall magnetization builds up owing to overall domain magnetism becoming predominantly in one general direction, so one approaches the stage where the magnetism exploits the possibility of a 90^o transition between 'easy axes of magnetization'. This needs a stronger magnetizing influence. Thereafter, from about 70% of saturation onwards, any further increase in polarization has to involve a very demanding action where the domain 'solenoids' are literally forced to turn to come closer into line. However, in this process the externally applied current finds itself assisted by the mutual action of the domain solenoidal effects and this is now a stage where the underlying energy which feeds the motion of those electrons is contributing very substantial amounts of energy to bring about that increased state of magnetism. Saturation occurs only when all the solenoidal effects intrinsic to the domains are forced into a common direction and each, like a spring under stress, has a will to revert to a position along one of the 'easy axes of magnetization', but is held in place only by that externally applied current.

Now, when this is summed up, we see that, provided the level of magnetization in an iron core with no air gaps is moderate, there is very little external energy needed to control the magnetic flux which is present in the core. Therefore, a primary coil at A can assert its influence in transferring magnetic action to a secondary coil B without too much of its magnetizing force being used to overcome the back reaction of those non-ferromagnetic inclusions and domain boundary walls. It is better if the primary winding and secondary winding are wound around each other, meaning that A is at B or vice versa. However, 'better' in this sense means better from the viewpoint of avoiding the reaction that goes with harnessing the intrinsic power action of the core. In our 'free energy' pursuit that is not the 'better' course, since it means that we have deliberately avoided the source of that 'free energy'. It is only by making the inductive coupling process difficult so that the intrinsic ferromagnetism of the iron core has to work harder in its 'flyback' role that one can tap into its 'free energy' potential.

To proceed further, we now need to ask how an air gap in a core interferes with the ability of a magnetic core to carry the magnetic flux.

Air Gap Reaction Effects

Suppose (Fig. 2) that a magnetic core has a quite large cross-section in relation to its loop length but a very small width of air gap in the vicinity of B, say 0.1% that of the core length. One would think that all this would mean, as a loss of 0.1% of the iron present, is that the magnetic flux set up by a given current excitation in a coil at A would be reduced by 0.1%.

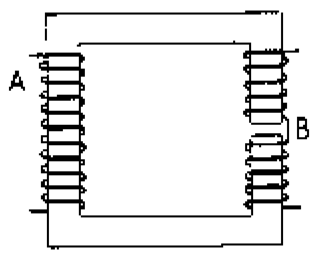

Fig. 2

This is not the case. Indeed, by taking that 0.1% of the iron away, even for iron which is very poor in terms of its magnetic properties, meaning it does not have large crystals and does have impurity inclusions, it can easily be that the magnetic flux is halved in this situation.

It seems obvious, on reflection, that this is not just a question of actions occurring in that iron core. If the magnetism developed by that iron, thanks to a current in coil A, sees nothing to resist it in that air gap, then it should have no difficulty traversing that air gap, especially as it is has still 99.9% of its original strength.

Common sense tells one that the air gap is extremely active in its own right, as if an enormous current is flowing in an imaginary vacuum coil at B directed in opposition to the influence of the coil at A. The vacuum devoid of aether cannot, however, be something in which current can be said to flow, especially a d.c. current - or can it?

The way in which to decide this is to replicate that flow of aether current at B by tests involving a coil placed at B, very close to that air gap, and see what is involved in neutralizing the magnetic reaction effect in the gap.

When this is done, the simple truth is that we discover that there is an asymmetry in the following sense. We establish a state with a given magnet flux traversing that air gap, regarding coil A as primary and see what current is needed in A to set up the flux with no current in identical coil B. Then with coil B as primary acting to set up the same magnetic flux across the air gap in the same direction we find what current is needed for this purpose. It is found that less current is needed in B than was originally needed in A.

Now look at this from the viewpoint of inductance energy storage. To power a coil at A we need more inductance energy input than is needed by one at B to achieve in the air gap the same magnetic condition. What accounts for this discrepancy?

The answer is that for both conditions there is actually a current flow in the aether at the air gap, which current is virtually equal and opposite to that in coil B. Therefore the aether reaction current and the current in coil B complement one another in terms of their role in setting up a store of inductive energy. It needs very little discrepancy between the two currents to stimulate the magnetic polarization in the continuity of the iron core and so, what is represented by this situation is a magnetic flux condition in the air gap with no leakage flux around that gap. Virtually all the energy supplied to coil B is stored in that air gap.

With coil A excitation and no power on coil B, a greater input of energy is demanded by the inductance of the system, because the energy state represented by the air gap proper is supplemented by that of flux leakage, as depicted in Fig. 3.

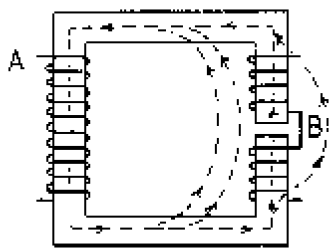

Fig. 3

However, the question at issue here is how the energy gets from coil A to the gap, given that it needs very little action to influence, either create or suppress, the magnetic polarization in the iron. If all the action is by virtue of those 180^o or 90^o domain transitions any reaction field from the gap region would preclude a change in magnetic flux when coil A is energized.

This poses no problem for the coil B excitation because there is nothing around the iron circuit path to resist a change in magnetic flux, but it is a major problem if the coil A excitation has to work against an air gap in a remote section of the core.

The answer lies in the need to set up an internal magnetic field inside the body of the core between A and B and this means that there has to be at least some domain flux rotation, necessitated by the direct action of the coil A current in urging flux rotation by domains which do not have their host crystals with easy axes of magnetization orientated along the coil axis. Once this scenario develops we are entering the realm of 'free energy' and so it is of interest now to report an experiment which involves an accounting of an energy balance sheet. We shall see that we need to bring into account some energy from that mystery source we have called 'the aether'.

Mystery Energy Source: The Energy Balance Sheet

I invite readers to perform the following simple laboratory experiment, one which I feel should be part of a teaching curriculum for anyone who aspires to understand electromagnetism and its energy implications.

All one needs, in addition to a voltmeter or oscilloscope, an ammeter, and a variable voltage 50 Hz or 60 Hz power supply is a standard inexpensive transformer assembly kit, some cardboard and a little wire. A suitable 100 VA transformer kit is one available, as distributed in U.K., from RS Components U.K. (P.O. Box 99, Corby, Northants NN17 9RS). Stock Ref. No. 207-734. There will be a corresponding source of supply available from the local distributers in many other countries. The transformer has an E-shaped core and a bridging yoke as shown in Fig. 4.

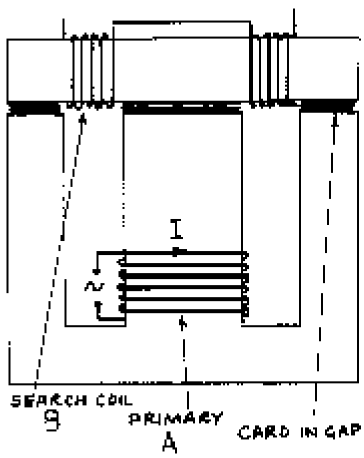

Fig. 4

The experiment involves assembling the kit several times, using a different number of card layers to form an 'air gap' or rather a 'pole gap' of 10 different widths, ranging from 0 to 9 card thicknesses. I used card of 0.25 mm thickness.

The object of the experiment is to compare the reluctance energy or inductance energy stored in the air gap at moments of maximum flux density with the integrated reactive volt-amp measure of energy input to the magnetizing winding over a quarter cycle period.

Standard teaching requires that the input energy represented by that volt-amp-time measure is necessarily greater than the energy stored in that gap. The latter is a measure of the mechanical work potential attributable to the mutual attraction of the magnetic poles, as available if they were allowed to move to close the gap.

The wire is used to wind a search coil or secondary on a part of the transformer core adjacent to the gap where it can provide a measure, given some flux leakage, of the actual magnetic flux traversing the pole gap.

One can, as a physics exercise (see energy balance analysis below), calculate the pole gap energy in terms of the flux density, area and width of the gap. One can also calculate the reactance input energy for the quarter cycle over 1/200 second at 50 Hz or 1/240 second at 60 Hz and compare the two. That is straightforward physics, but the beauty of this experiment is that no such calculations are needed.

For each of the several tests one measures the current supplied to the magnetizing coil, which is the standard primary coil supplied with the kit. The current capacity of the coil is the limiting factor on the flux density so one is obliged with this test apparatus to operate well below the knee of the B-H curve. This current is adjusted by the variable a.c. voltage supply so that the same voltage is induced in the search coil for each test. This means that the gap flux density, and so the force across the gap, is the same for each test. Therefore we have two variables. One is the input current and the other is the number of card thicknesses defining gap width. We plot a graph of current against gap width (Fig. 5) using the data in Table I.

TABLE I

cards	gap mm.	amps
0	0.25	0.038
1	0.50	0.162
2	0.75	0.221
3	1.00	0.279
4	1.25	0.338
5	1.50	0.382
6	1.75	0.421
7	2.00	0.472
8	2.25	0.516
9	2.50	0.538

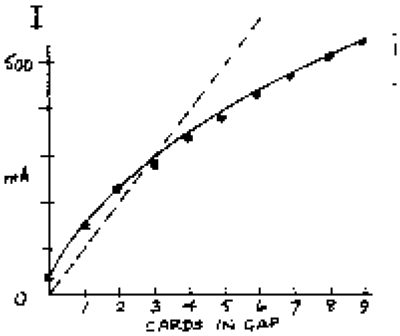

Fig. 5

If we input more energy than is needed to set up the mechanical potential energy of the gap then the plot of current versus that number of card thicknesses will show an upward curve, inasmuch as there will be progressively increasing flux leakage with increasing gap width. However, assuming (a) energy conservation, (b) no loss and (c) no flux leakage, by our standard physics principles, we expect no discrepancy and that means a straight line relationship.

If there is flux leakage, increasing with gap width, but still no energy loss, the inductance energy stored by that leakage will demand more current as input and so the current curve observed will climb away from the ideal linear relationship. That is, unless the 'free energy' source is so overwhelming in its power that it can pull that curve down below the linear norm.

What one finds, in fact, is that, even in spite of leakage effects, the relationship between current and the gap width curves down well below that linear relationship. This means that, with increasing gap width, the reluctance energy in the gap becomes progressively greater, indeed far greater, than the energy supplied as input.

This evidences a clear and direct breach of the law of energy conservation unless we can embrace the concept that the ferromagnetic core has a way of borrowing energy from a source not contemplated by our textbook teachings.

To determine the energy gain and so a measure of the 'free energy' potential, one does need to work out the reluctance energy input. We can then draw the straight line expressing the theoretical reluctance energy as a function of current versus card thickness in Fig. 5.

I calibrated with 3 card thicknesses and found that a primary voltage 76.9 V gave a search coil induced voltage which had an arbitrary amplitude suited to a chosen grid range on the oscilloscope screen. The above current readings were plotted by using the same test amplitude to set the input voltage for all card thicknesses.

The voltage signal sensed in the series-connected coils B, each of 20 turns, shown in Fig. 4, had a peak value of 1.5 V for this test.

Note that the effect of an air gap is to cause the inductance of the primary winding A to become linear in the sense that the non-linear distortion by signal harmonic components often found when the hysteresis of the iron governs the core response is virtually obscured by the dominant air gap reluctance effect. This means that we can reasonably assume a sinusoidal variation of voltage and current. It is also feasible to ignore the phase shift which occurs owing to resistance in the primary winding, at least for the immediate purpose of proving that there is a very substantial 'free energy' anomaly. This can be justified by keeping track of the proportionality of the relationship between primary and search coil turns ratio in relation to voltage induced and voltage supplied. In any event the ohmic resistance effects can be allowed for in the analysis since primary current is measured and the primary resistance is known (17 ohms). Such considerations do not affect the substance of the analysis presented below.

The inductance energy for a current I is expressed as $LI^2/2$ which, becomes LI^2 if I is the root mean square current value and the inductance energy is that at moments of peak current strength. We therefore shall calculate the energy in the air gap for the flux density B_{max} corresponding to a sinusoidal a.c. current I. Note that the root mean square value of the voltage V applied to the magnetizing winding is represented by $L\omega I$ so that the inductance energy supplied to the gap at peak current times is VI/ω, where ω is the angular velocity corresponding to the power frequency.

In the reported test the central core area or total cross-section sensed by the combined search coils was 8 sq. cm. but, owing to the flux return, the total pole face is 16 sq. cm. Each 20-turn search coil embraced a 4 sq. cm. cross-section. The magnetizing winding specification was rated at 240 volts and 3.7 winding turns per volt. The magnetic flux density needed to produce the 76.9 V is, therefore, about one third of the normal operational flux density of the transformer. At 50Hz this corresponds to a maximum flux density of 0.4875 tesla or webers per square meter.

However, this is the flux density in the part of the core at the primary winding location. With that three card thickness air gap of some 0.75 mm there is a substantial leakage of flux not reaching the pole faces and so traversing the gaps. We know this because the central core flux density at its maximum amplitude is that giving a 1.5 V signal in 40 turns embracing half the 8 sq. cm. area of that central core. This, at 50 Hz, is 0.2985 tesla.

Bear in mind that this 0.2985 tesla is the flux density that governs the energy stored between the pole faces across a 16 sq. cm. or 0.0016 sq. m. cross-section and it applies over the full current range shown in Fig. 5. Note further that this flux will be non-uniform across the area of the pole faces, which means that the stress energy we calculate as the mechanical potential of that gap will underestimate substantially the true energy potential should we rely on that 0.2985 tesla as being uniform.

Our energy balance sheet must now take as, energy input, the quantity VI/ω and decide how much of this inductance energy input is stored in the leakage flux zone, where the flux traverses long paths through air, to bridge the legs of the E-shaped core, and how much of this inductance energy goes directly into the small-width gap between the pole faces where it can be 'seen' as part of that 0.2985 tesla field.

Our calculation will be based on unit card thickness of 0.25 mm. The card has a permeability μ which is virtually that of the vacuum, namely $4x10^{-7}$ H/m. B is 0.2985 tesla. The energy density is $B^2/2\mu$ and so the total energy the gap between the pole faces is then 0.0016x0.00025 times this energy density. This works out at 0.01418 J on a per card thickness basis.

If there are N card layers in the test giving the data in Fig. 5 so we have stored inductance energy in the pole gaps given by (0.01418)N joules at instants when the flux density peaks at the level set by the tests. In fact, the energy stored and available for doing mechanical work is much greater than this, because the flux density has to be non-uniform and the root mean square value needed for energy conversion is so much larger than the mean value.

Now, what energy have we supplied? The energy supplied is VI/ω, where I is the primary current and V is that portion of the primary back EMF which can be said to relate to magnetic flux linking the search coil.

The rms primary voltage that corresponds to that 1.5 V maximum is 76.9 V and, for 5O Hz, ω as the angular frequency of the power supply, is 314 rad/s. There is analogy between EMF in a resistive circuit and the effects of primary current in producing magnetomotive force (MMF) in a magnetic circuit. The magnetic flux is analogous to electric current and what we term 'reluctance' substitutes for resistance. By this analogy, our inductance energy input is apportioned to the pole gap region, as if the supply current develops the magnetomotive force which sees a reluctance component that allows a peak flux density of 0.2985 tesla, whereas 76.9 V corresponds to 0.4875 tesla. Therefore, 47.1 V is a measure of V that applies to the primary current in determining reluctance energy fed to the pole gaps.

This energy quantity is (47.1)I/ or, for 50 Hz and ω as 2(50), (0.1499)I J. This applies to a test with three card thicknesses and the energy then known to exist in the pole gaps is (0.01418)N J, where N is 3. Therefore, the corresponding value of I for a perfectly balanced energy account, is I = 3(0.01418)/(0.1499) A or 284 mA.

Table I shows that the current measured was, in fact, 279 mA.

Accordingly, in choosing the pole gap width of 0.75 mm or three card layers, we have fortuitously demonstrated a calculation that applies at the departure threshold where the energy does, in fact, balance.

The point now of relevance is that, in progressing in the Fig. 5 tests to values of N above 3, the pole gap energy component increases linearly, whereas the input energy reduces in relative terms. With N of 9 the primary input has increased to 100 V and the primary current is 538 mA, but the component supplying the pole gap region is still that 47.1 V. In effect, therefore, the input power feeding the pole gaps has doubled but the energy stored in the gap has trebled.

The downward curve in Fig. 5 tells us that, if we cause the magnetic circuit to require more MMF, so the ferromagnetism of the core becomes subject more and more to domain flux rotation and then it sheds energy and makes it available as a form of inductance energy we can tap mechanically by closing the pole gaps.

We do, therefore, have here, in this experiment, the means for probing the 'free energy' resource afforded by ferromagnetism. This account, under the title 'Mystery Energy Source', was offered for publication to "Physics Education". It ended with the following quoted text:

"I therefore see this experiment as a standard experiment which will be used to show future generations that the ferromagnet is a catalyst which gives us access to a new and plentiful source of energy tapping into the vacuum energy source that determines the Planck action quantum. However, that is too taxing a concept for physics teachers to absorb in view of its startling technological implications, so I will end by simply challenging readers to do this experiment and to try to reconcile what they find with what is currently taught about energy conservation principles.

I add that, for those who lack the pioneering spirit and prefer to rely on the authoritative work of others, it is appropriate to refer to Fig. 113 at p. 173 in the 'Principles of Electromagnetism', 3rd Edition, Oxford, Clarendon Press 1959 by Cambridge Professor E.B. Moullin. Such an experiment is there reported and for a 7mm gap in a rectangular core 4 times larger in linear scale than the one I used, and so corresponding to my 7 card thicknesses, the data presented show that the reluctance gap energy is then twice that supplied as inductance energy. However, Moullin kept the **applied** voltage constant and did not use a separate search coil. Professor Moullin was not averse to the 'aether' concept but, in discussing leakage flux effects, he missed the full significance of his experiment. Only a discerning reader, having reason to suspect the intruding hand of something akin to the Maxwell Demon, would have cause to give special weight to Moullin's statement: "We have seen reasons for supposing the leakage flux does not change very much with gap width".

I only became such a 'discerning reader' after nearly 30 years possession of this book, when I heard of 'crank' claims that certain forms of homemade switched reluctance motor, which, when the magnetization was switched on only for a period before pole closure, could deliver more power output than is absorbed as power input. It was no easy task to turn one's formal education around.

I therefore urge readers to pay attention and repeat the experiment I describe. My earlier communications on 'The Law of Perpetual Motion' and 'The First Law of Thermodynamics' were not based on ignorance or philosophy but were intended to pave the way forward to something of major importance now developing on the alternative energy scene. This 'energy from magnetism' theme, as it evolves into technology, need not take those who teach physics by surprise, especially when so simple an experiment can put one's physics education back on track."

Although my comments on the possibility of 'Perpetual Motion' and energy conservation as needing an aether to avoid breach of 'The First Law of Thermodynamics' were accepted and published in the July and November issues of Physics Education, my 'Letter to the Editor' entitled 'Mystery Energy Source' was rejected by the 'peer review' process.

The reasons given in the referee report may interest the reader:

"Aspden presents his results as evidence of a fundamental flaw in the accepted theories of physical phenomena. These have proved so widely and exactly verifiable that something more than a few simple tests is needed to shake one's faith. It is necessary to show that <u>no</u> reasonable theory will account for the observations, and nothing like enough has been done to justify his ambitious conclusions. One needs careful measurements of current and voltage, observations of phase angles, as well as such simple things as remove the yoke altogether, or at least increase the number of cards until the limiting behaviour is clear. Until such tests have been made it would be mischievous to publish his letter."

The implication of this is that I must be wrong and that my measurements are subject to question. I am told that I must show that no reasonable theory will account for the observations, even though I quoted the Oxford, Clarendon Press treatise of Professor Moullin and that text shows that the nearest one can come to explanation by accepted theory is not satisfactory. Moullin did extend his tests to removing the yoke!

My answer, therefore, as a physicist, is that I have made my contribution to the world of learning and have not been heeded and so, my task now is to concentrate as an engineer and develop the technology of this 'free energy' opportunity, leaving the physicist to the comfort of an erroneous and stagnant, but 'acceptable' world.

I believe that the 'free energy' experiment I have described above will eventually become a standard experiment which will be used to show future generations that the ferromagnet is a catalyst which gives us access to a new and plentiful source of energy by tapping into the vacuum energy source that determines the Planck action quantum.

Magnetic Leakage Flux and the Adams Motor

It is not intended that this Report should provide any details about the design of the Adams motor, but some comments are necessary.

Firstly, it was said in connection with the transformer experiment already described that, to get ferromagnetism to supply that 'free energy', we had to weaken the coupling between the primary winding and the part of the core in the vicinity of the pole gap.

Secondly, it was said that our experiment was limited in the flux density that could be generated across the pole gap, because the 100 VA transformer kit only allowed primary magnetizing currents that could sustain 0.3 tesla and this meant operation well down on the B-H curve, where the 'free energy' was not forthcoming in great measure.

Both of these factors are crucial to the successful design of an Adams motor. The latter problem is overcome by using permanent magnets to replace the action of the primary winding and the former feature is built into the Adams prototype machines by an open core soft iron stator design, with control windings mounted on the stator pole members near the pole gap.

The motor operates with 'over-unity' performance, showing that the 'mystery energy source' is contributing to the pole gap energy and much of that energy is then used to provide output power by being prevented from reentry to the ferromagnetism of the permanent magnets.

The underlying concept is to operate the motor in a way which transfers intrinsic ferromagnetic power to the gap between the pole faces, where it is stored by inductance and held for 'flyback' return when output coils are switched into circuit after pole closure, but in advance of pole separation.

The pole gap and leakage flux around that gap are key to the Adams motor operation and it is therefore appropriate to comment on that remark by Professor Moullin: "We have seen reasons for supposing the leakage flux does not change very much with gap width".

A small gap in a magnetic circuit can have an enormous effect on reducing the magnetic flux in that circuit. It should, by accepted theory, not produce any significant amount of flux leakage, in the sense that flux escapes from the circuit. Yet, our experiments suggest otherwise, depending upon the core configuration used.

Consider a simple small-width gap in an elongated section of a ferromagnetic core (Fig. 6). Tha gap adds an enormous capacity for storing inductance energy using a winding on that core and yet the inductance is decreased, not increased. The ferromagnet sets a limit on flux density but the gap allows the core to accept a much greater magnetizing current at that limit of flux density. The $LI^2/2$ energy is related to a flux density proportional to LI and so energy capacity increases linearly with current I, whereas, if L decreases, the energy can increase for the same LI value.

Fig. 6

The energy stored in that gap is represented by a very powerful reacting current flow in the aether in the gap. This current is powered by the aether energy sea. It is a kind of diamagnetic thermodynamic reaction state polarised by the presence of the primary magnetization of the main iron core. This is not a flux leakage phenomenon but one by which the composite magnetic flux, that from the main core and the circulating flux induced locally around the aether current reaction, is effective in appearing as a diversionary agency. The main core flux is partially diverted so as to jump through air external to the main core path whilst the remainder crosses directly between the pole faces.

Now, of course, this reacting aether current flow is what serves in the Adams motor as the means contributing to the weakening of the direct attractive pull between the two core sections, whilst at the same time augmenting the 'flyback' action and serving to deliver energy should the output be taken off electrically rather than mechanically.

The point made here is that Professor Moullin had drawn attention to the curious fact that a small air gap in a ferromagnetic ring core could drastically affect the flux traversing the gap and could cause significant flux leakage around that air gap, but yet by the standard principles of electromagnetism that he knew so well, that should not be. The solution to his problem was unknown to him when he wrote the referenced book in its third edition in 1954, but it was discovered by this author shortly after graduating Ph.D. in that very year for research on ferromagnetic reaction currents, research conducted in Professor Moullin's laboratories. There is what the author terms a 'half-field' reaction effect set up inside metal or in air gaps or in vacuo when magnetic fields are present. This is the way the aether reacts at the equilibrium interface between aether and matter in the energy exchange that we are here discussing.

Physics that does not countenance the 'aether' is physics that has turned its back on the sea of energy in that aether. An electrical engineer of the stature of Professor Moullin had to deal in unsolved mysteries in energy technology because his professorial associates disciplined in physics and mathematics had created a climate of opinion that would not allow aether science to develop.

It was, of course, such frustration that caused this author to write and publish "MODERN AETHER SCIENCE" in 1972. And it is now, following decades of frustration, that technology is ready to take us forward on the track of ferromagnetism to a world which affords access to that energy in the aether.

At this stage, and to underline the importance of the 'half-field' reaction theme, the author could even go further back in years and draw attention to his first printed publication that discloses the way in which the vacuum reacts to store a magnetic field. Chapter 9 of 'THE THEORY OF GRAVITATION' dated 22 November 1959 discusses the gyromagnetic ratio of the aether itself and explains the anomalous factor 2 found in gyromagnetic phenomena. The reaction energy of the magnetic field in vacuo is the thermal kinetic energy stored by the aether.

Some few copies of that printed text are still in the author's possession and are available to those who wish to study the history of these aether developments. This is also mentioned here because, as many readers may know, an initiative launching a 'free energy' company seated in Rapperswil in the vicinity of Zurich in Switzerland in 1993 and offering shares to the public has been based on the aether of a deceased researcher named Oliver Crane. This venture Raum-Quanten-Motoren AG which plans to produce 'free energy' generators in the very near future is associated with the publication of a magazine MAGNETIK which declares itself concerned with electromagnetism and gravitation. In the January 1994 issue there was a 'Focus' (Brennpunkt) editorial entitled: 'Erdmagnetfeld ist Ein Gyromagnetischen Effekt' and mention of Barnett's research and the linking connections with Monstein's experiments and Oliver Crane's 'quantum-space' motor developments. The aether connection between the gyromagnetic ratio and the Earth's magnetic field, and the intermediating quantum-of-action in space were the starting points for this author's theory, as can be seen from the following photocopy of the 'Contents' page of that 1959 'THE THEORY OF GRAVITATION':

CONTENTS

THE ABOVE IS THE TABLE OF CONTENTS OF H. ASPDEN'S 1959 BOOK, 'THE THEORY OF GRAVITATION' (48pp BOOKLET)

For readers who wish to see a more up-to-date disclosure of the 'half-field' gyromagnetic reaction effect, a mathematical analysis analogous to that Chapter 9 in the 1959 work, showing the way the aether vacuum reaction is translated into a reaction inside a metal, has appeared in a very recent patent specification.

APPENDIX B at the end of this report reproduces the mathematical appendix which was at pp. 25-28 of the author's U.K. Patent Specification No. 2,267,995 published on December 22, 1993. That invention is entitled 'Thermoelectric Heat Transfer Apparatus' and it concerns a development relating to the thermoelectric topic below.

Breakthrough on a Thermoelectric Route to 'Free Energy'

This Report is written following publication of an article launching the author's entry into 'free energy' experimentation. In the work "Three Experiments on Free Energy" the author announced that more details would follow in this first ENERGY SCIENCE REPORT. I must honour this commitment.

Having dealt with the first of those experiments, we will now address the second, even though it departs from dependence on aether technology and there is so much yet to disclose on the developments of solid-state magnetic 'free energy' devices on that aether front. The latter will feature in further ENERGY SCIENCE REPORTS which will begin to issue in the near future.

The author has been involved in developing a new technology by which heat and electrical forms of energy are mutually convertible by solid-state methods operating with extremely high efficiency. It has been realised for some time since the first prototype was demonstrated that there had to be some new physical principles at work in this technology, or at least a very special application of existing physical principles that had come about fortuitously and had not been fully understood.

The 'second' experiment which I will now discuss is one performed expressly with the object of a diagnostic testing of a possible principle concerning the physics of that thermoelectric device. In the event it has revealed a regenerative energy process which, when developed and implemented in one of the forms originally contemplated in the granted patents, promises to be one we can classify as 'free energy' and 'over-unity' operation.

Ferromagnetism provides the catalyst for tapping thermodynamic activity in the vacuum medium and generating useful electrical output from the heat input.

In contrast, where we draw heat from a material source, a magnetic field, which need not be enhanced by ferromagnetism, can serve as the catalyst by which that heat is converted into useful electrical power.

The well-known power generating technology involving this latter action is that of magnetohydrodynamics, where a hot ionised gas flows along a channel (x axis) a magnetic d.c. field acts transversely (y axis) and an electric potential supplying current is set up in the mutually orthogonal direction (z axis). The magnetic field deflects the ions one way or the other in the z axis according to electric charge polarity. The heat, as the kinetic energy of the ion motion, is thereby diverted to produce a voltage which supplies current output.

A solid-state implementation of this occurs in a steel lamination to set up a potential between its opposite surfaces (z axis), provided there is a temperature differential in the plane of the lamination (x axis) and the lamination is magnetized in the other planar direction (y axis). The electrons carry heat and in so doing, being ions in motion in a transverse magnetic field, that intrinsic to the internal ferromagnetic state of the steel, they are deflected to set up that voltage potential between the opposite surfaces of the lamination.

When current of an externally-connected circuit is allowed to flow in the z direction, the lamination cools as the EMF so generated delivers power. The advantage of using the steel lamination or nickel, as in the main prototype experiments, is that the strong intrinsic magnetic polarization of the domains in the metal avoids the need to provide externally-powered magnetizing windings. Thus one witnesses a very efficient technique of refrigeration using a solid-state technology, provided, that is, that one can (a) assure that heat flow in the metal and (b) a transverse current flow that does not provide for a concomitant loss of heat in that transverse direction.

As part of the research effort involved in this thermoelectric project, the author has experimented with a magnetic core comprising bimetallic laminations composed of steel and nickel, meaning steel film plated with a layer of nickel on one surface. The principle of the experiment is to induce magnetization loss in the laminations which produces heat. The heat is conducted away by flow confined within the laminations. A transverse current flow exists near both edges of each lamination, being that of the circulating eddy-currents associated with the induction. That z-axis flow at the edges, plus the y-axis effect of the intrinsic domain magnetism on the x-axis heat flow carried by electrons, combine to offer flow paths through domains which serve to set up a forward EMF augmenting that current flow. In effect, one can hope to set up a negative resistance which allows the device to become regenerative as heat input produces electrical power, which, in turn, unless we can tap into it and take some away, will dissipate as ohmic heating in the central portions of the laminations.

The question addressed by this experiment is whether this scenario can be demonstrated experimentally as a basis for onward development. Note that what is being considered is a process for converting heat into electricity with no Carnot limitation, that is, we are contemplating a heat to electricity conversion that potentially is 100% effective. It would operate as an 'over-unity' device because waste heat at ambient temperature could be converted into useful electricity to result in overall cooling.

The breakthrough resides in the fact that the experiment does show the regenerative action.

Where the thermoelectric EMF plays a role we are not here dealing in energy stored by inductance, but rather with energy loss or energy gain by resistive effects causing heat dissipation or negative resistance effects causing heat energy recovery.

Imagine then an electrical transformer core wound with a primary winding and a secondary winding used only to sense induction and consider the eddy-currents induced in the core laminations. It is as if the laminations themselves form the effective secondary winding. A 50 Hz or 60 Hz a.c. current is fed through a resistor connected in series with the magnetizing winding (Fig. 7). The resistor feeds the X plates of an oscilloscope with a signal proportional to its potential drop, giving an oscilloscope trace measure of H. The secondary winding is connected as shown with the Y plates receiving a signal from a 2 μF capacitor in series with the 100,000 ohm resistor. This provides a time integral of the time rate of change of the magnetic core flux density **B** and so the oscilloscope indicates also the B measure.

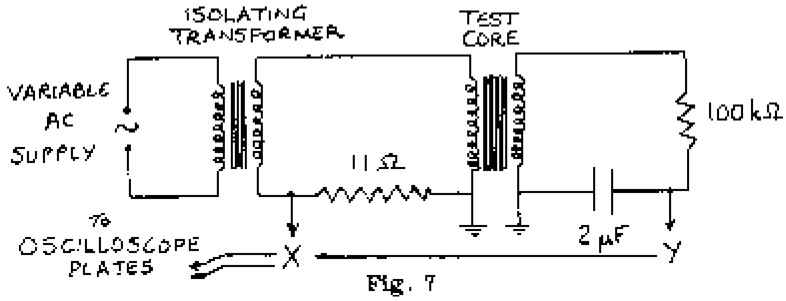

Fig. 7

For normal transformer operation this circuit will provide a normal representation of the B-H hysteresis loop, which develops into an ellipse as the eddy-currents increase (Fig. 8). However, suppose that there is something special about the laminations by which the resistance of the eddy-current path becomes predominantly negative in one section owing to heat being converted into an EMF acting in a forward sense around that eddy-current path.

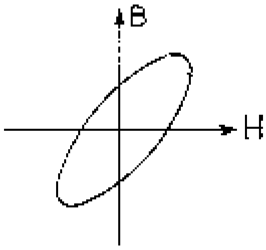

Fig. 8

In this case, provided that action is strong enough, the effective secondary winding provided by that eddy-current path can, conceivably, take over the action and become the primary power input source, energized by input heat. To feed power to the circuit including the resistor used to measure **H**, the induced EMF would need to derive from a **B** flux varying in antiphase with **H**. Accordingly, the B-H loop would convert to one of the form shown in Fig. 9.

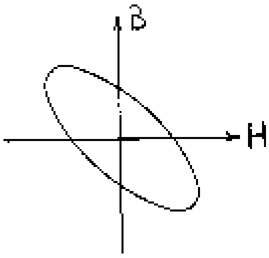

Fig. 9

It follows, therefore, that the regenerative heat-to-electricity conversion potential of the device under test is easily inspected, simply by examining the **B-H** loop as the current in the magnetizing winding is progressively increased.

Now this is exactly what was found to happen in preliminary tests on a transformer assembled with its main limbs comprising steel laminations plated with nickel. This means that there was here sight of a new technology by which bimetallic ferromagnetic laminations can serve to convert heat into electrical power. Before describing what was observed, by adopting the same text as was presented in my article 'Three Experiments on Free Energy', I have to explain that, upon rebuilding the experiment using a more powerful current source aimed at driving the circuit to a higher power level, the staged trigger action of the flip between the Fig. 8 and Fig. 9 B-H loop forms did not occur. Instead, the action was as if there was an enormous activity confined to the Fig. 9 state, characterized by a very wide elliptical form of loop and, on analysis, showing that the power energy action per cycle was extremely high in relation to what could otherwise represent magnetization loss. Note that with the earlier situation and the loop change from Fig. 8 to Fig. 9 as current excitation increased, one knew that there was regeneration.

I now suspect that the test core, which originally exhibited bistable operation, has become conditioned by internal thermal activation, that may have resulted from coupling a capacitor to form a resonant load circuit, so as (this being speculation!) to become locked in its state which precludes Fig. 9 operation.

In my urgency to complete this Report before reworking the apparatus with new laminations, I shall leave this particular issue open for clarification in my next Report on this subject. I am bearing in mind that the power of the B-H loop and phase angle measurements show really enormous magnetization loss per cycle if the device is not acting regeneratively. There are certain other fascinating aspects linking with hitherto unexplained experimental phenomena which will be reported in due course, and which give good reason to interpret the action as regenerative. Special test rigs have now to be built to prove this beyond doubt by extracting that power as output, notwithstanding confinement to the Fig. 8 state, and here we have the leading evidence from the basic experiments on the prototype devices which used films of bimetallic coated polymer. They demonstrated regeneration of electricity from heat convincingly by showing an electric motor running from the thermal effects of ice melting in a room temperature environment. The experiment now under discussion is part of a research programme aimed at improving and simplifying that technology whilst aiming to convert to power delivery accompanied by energy-balancing refrigeration action via a magnetic rather than a capacitative circuit coupling.

The following text comprises paraphrased sections quoted from 'Three Experiments on Free Energy:

"At the mountain retreat where we had a private brainstorming session involving many of the speakers, I mentioned the thermoelectric project in which I was involved and showed a video demonstrating the quite remarkable speed at which ice can form with very little electric power input and how electricity is regenerated with high efficiency drawing on the energy of melting ice.

That Colorado meeting was a landmark event in the history of new energy developments as it marks the beginning of an escalation which will lead to a bonanza on the energy front.

In the intervening period, since we met in Colorado in April, I attended, in August, the 28th Intersociety Energy Conversion Engineering Conference in Atlanta, Georgia. I presented an update on the thermoelectric project, emphasizing its mode of operation as a very powerful solid-state technique of refrigeration avoiding CFC pollution.

That Atlanta conference lacked the excitement of the Denver event, but it has opened doors that can help in onward progress. From a personal viewpoint I felt at a disadvantage in that I have, for the past five and more years, been following the new energy movement from a theoretical standpoint. The 'jewel in the crown' that inspired me from a patent and business motivation viewpoint was my interest as co-inventor in the thermoelectric technology that my associate Scott Strachan was working on in Scotland. His work has been funded and my hope has been to see that venture become the revenue earner that could take the other energy research forward in a business sense.

However, funded only by my pension income and savings, as we older 'free energy' enthusiasts usually are, I did find myself at the meeting in Atlanta, with no update technical input to report from Scott Strachan, and wondering why I was there with no recent personal hands-on experimental facts at my disposal. Indeed, in talking to Patrick Bailey at that Atlanta meeting, I vowed not to attend another such conference unless I could report on my own experimental work.

So, having exercised my professional skills and established a patent position on several energy inventions that I was unable to demonstrate as working devices built by myself, I set to last month and began my experimental program with a very limited funding resource. I say this because I feel that some of your readers will wish to repeat the experiments I report below and I simply wish to stress that very little outlay is involved.

My object is to demonstrate the scientific basis and technical feasibility of three 'free energy' projects. I direct my comments at those who profess to pass on knowledge to future generations. I am not here going to explain how what is described can be implemented in a practical machine. That will follow later when I progress to that stage. I know what I say has a practical end product because my sole objective is to bridge a knowledge gap to cover the true science lying in that zone between orthodox doctrinaire belief and the working 'free energy' machine.

The target objective for the first of my three basic experiments is:

The curious fact that our thermoelectric refrigeration device is built with an inherent functional symmetry and yet it always cools on its exposed test heat sink surface, it being noted that the electrical operating unit is mounted on the same panel that constitutes the second heat sink surface. The latter gets hot as the former cools, but, unless Scott Strachan builds a version that separates the electrical operating unit from the second heat sink we shall have to await the clear experimental evidence that, in truth, both surfaces are cooling as the device delivers electrical power!

The idea that one can build a power transformer which draws in heat and so cools a housing in which it is enclosed and at the same time converts that rejected heat into electricity fed along wires leading from that housing is one that seems beyond belief. It defies the second law of thermodynamics, but that should not deter a pioneer who has in his possession the device mentioned above.

The object of the experiment is to test a suspicion that current circulation within a bimetallic lamination can, under certain circumstances, result in cooling for current flow across the thickness of the lamination. The experiment acknowledges that such cooling would produce an EMF and put electrical power into increasing the current flow in the plane of the lamination, unless deflected from the lamination, transverse to its width. This means extra heating and anomalous loss augmenting the eddy-current loss, but such an anomaly is direct evidence of that underlying cooling and electrical generation.

The prototype devices all used thin film bimetallic layers of aluminium and nickel and involved that transverse 'deflection'. The 'circumstances' stated are that the lamination includes a ferromagnetic layer of thickness less than the 100 micron dimension, the size of a magnetic domain formed within the larger crystals of the material.

In the subject experiment, there was no transverse deflection but the other condition was met. Commercially available steel foil (known in the trade as 'shim steel') of 2 thousandths of an inch in thickness was obtained and an electroplating firm was asked to coat one face with nickel using an electroless plating process. The nickel coating was 0.7 thousandths of an inch in thickness. It was found that this could be cut into small rectangles for assembly in a 100 VA transformer core, supplied in kit form (eg. R.S. Components in U.K.). Thin card placed between the laminations was used to insulate them from each other. The arrangement was as shown in Fig. 10, with legs A and B being formed by the bimetallic pieces. Primary and secondary windings, respectively series-connected in pairs, were formed on each of the legs A and B.

The test involved observing on an oscilloscope the changing shape of the B-H magnetization loop as primary current input increased.

To present the B-H loop on an oscilloscope screen the secondary winding was connected across a 100k resistor in series with a 2 µF capacitor and the Y input to the oscilloscope was taken across the capacitor terminals. The H input was provided by incorporating a series resistor in the primary feed circuit and taking the X input from the potential drop across that resistor.

What I was intending by this experiment was to estimate the eddy-current loss resulting from the bimetallic lamination feature. Having done Ph.D. research studying anomalous eddy-current losses experimentally I was particularly curious as I had never heard of anyone ever before testing a transformer built using bimetallic Fe:Ni laminations. Moreover I knew that I was using laminations that were much thinner, though more conductive, than is customary in transformers.

Added to this, I knew from my Ph.D. research days, during which I measured the loss factors in different elemental sectors of the B-H loop, that there was a particularly high and inexplicable loss in a part of the loop where it was least to be expected.

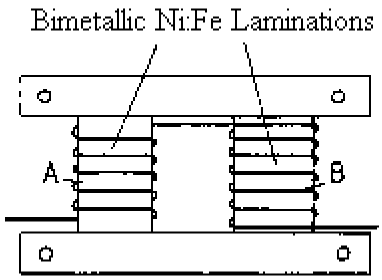

Fig. 10

In the event, what I found was astounding in the light of my experience. I did not have to do any calculations. With such thin laminations magnetized well below saturation at mains power frequency, the B-H picture on the screen at low current was a straight line angled to represent the magnetic permeability. The fact that it was a line meant that there was negligible loss, which is what I expected until a certain threshold was reached.

My reasoning was that the transformer action would introduce heat into the core and that heat would be conducted away. I had planned to arrange for the heat to flow one way so as to set up a temperature difference across the laminations and then my presumption was that a d.c. current would circulate thermo-electrically and affect the form of the loop. Indeed, a d.c. bias would displace the position of the loop on the screen both in the X and Y directions.

Note that a B-H loop with little eddy-current has a rather special shape representing hysteresis effects. An over-dominant eddy-current effect makes the loop elliptical and the width of the loop, in tending to fill more and more of a bounding geometrical parallelogram form, is a measure of the loss portion of the reactive volt-amp input. Remember that magnetic energy is stored as inductance energy and, in oscillating, this energy sheds the loss which is represented by that loop.

Now, what happened was astounding because, upon bringing the current input up to near mid-range, the B-H loop became very wide and quite elliptical. Furthermore, as expected, it shifted laterally by a small but very apparent amount (about 15%). However, the ultimate surprise was that, as the current input increased, the loop began to topple and turn clockwise until, with a greater current, it actually went over so far as to lie in the 'top-left-to-bottom-right' sector of the oscilloscope screen, whereas it began at low current in the conventional 'bottom-left-to-top-right' orientation.

This means that the transformer core having the bimetallic laminations has either become a capacitor, which it is not, or the phase governing the power and magnetomotive force reaction has inverted through 180^{o}. This is an obvious indication that the core wants to act as a generator by which heat sustains a current producing its magnetization and, instead of demanding input current to set up the reaction to the changing magnetic flux, it produces current in a forward direction augmenting that magnetic condition. In the experiment, of course, all that extra current drawn from heat goes into enhancing the eddy-current losses enormously. This is why the loop gets so wide.

So, here was confirmation that there is a process involved in the magnetization of bimetallic laminations that enhances energy transfer productive of anomalous current flow. The source of energy is heat input, but if we dissipate the electricity before taking it off for useful purposes, so we see nothing abnormal in the overall energy action. What we see in this experiment is that toppling B-H loop! There is the clear evidence and here, at last, from this experiment, emerged the confirmation of my suspicion of the secret as to why our thermoelectric device works in its incredibly powerful refrigeration mode. That device has its own a special way of taking off that electricity before it develops those very high eddy-currents. Here, in fact, was a new development, a discovery which had eluded the author's Ph.D research and which could have enabled the author to build a 'free energy' device decades ago, had this insight been apparent in those early years. But who would have thought that a transformer built from laminations of iron and nickel bonded in layers could tell us anything new about electromagnetism?

It must be said, however, that the 'special' way of taking electrical energy from a stack of bimetallic laminations, as used in the prototype devices, involves building those laminations into a parallel plate capacitor. That is not an easy task and to take it from the demonstration prototype to the commercial world needs the support of a major semi-conductor partner. The task is much easier with this new understanding of the physics involved and attention is being given to the possibility of drawing the power off by magnetic induction. It is in this regard that Scott Strachan, the Scotsman who has built the three prototype devices to date, did become preoccupied by a new discovery not yet published by which the thermoelectric action can be controlled with negligible power input, much as a grid in a thermionic valve can control the current between anode and cathode. However, progress on that is extremely slow and, as the need for a new refrigeration technology cannot await Strachan's solitary endeavours, so I am disclosing by this letter my own experimental findings to arouse interest and expedite onward development.

I see the experiment just reported as one that very clearly indicates that heat can be converted into electricity to provide refrigeration technology which, at the same time generates electrical power. The one step essential to the completion of this picture is the verification that if Scott Strachan, or others who now replicate the device, builds a fourth prototype device in which the electrical power circuit is not mounted on the 'hot' heat sink, then that heat sink will also cool.

The above is also my message to those companies now expressing interest in researching this project. This, together with a copy of a specification I can supply to interested parties, points the way forward in a research venture that should provide the best and most effective method of efficient refrigeration and bring, miracle though it might seem, the added bonus of being self-powered electrically."

The Solid-State Energy Probe Experiment

This was the section title under which I introduced the third experiment in my article "Three Experiments on Free Energy". The article was written as an open letter addressed to Don Kelly, Editor of the Space Energy Association's Quarterly Space Energy News, where it was duly published in December 1993. It is also scheduled to be published in Nexus Magazine early in 1994.

It seems appropriate to reproduce first the relevant text from that article:

"The third experiment which tells me that I am on the verge of a breakthrough in penetrating the barrier giving access to 'free energy' in a solid-state device has yielded its own surprises.

Here I built a form of transformer that is intended to serve as an exploratory test rig. I shall, owing to the developing length of this communication, curtail the constructional details and leave something for future reporting.

The test involved setting up a d.c. magnetic bias in the x direction and an a.c. transverse magnetic oscillation in the y direction. Again I used the above-described technique of studying the shape and form of the B-H loop developed by the a.c. flux.

The a.c. excitation was of low magnetic flux density amplitude so that the eddy-current losses should be negligible, as should hysteresis loss. I was operating in the flux rotation zone and above the B-H knee where rotational hysteresis loss diminishes rapidly to zero. I expected the B-H 'loop' to show as a line on my oscilloscope and, indeed, such a line did appear. I had to expand it off the range of the screen by increasing the x deflection sensitivity substantially in order to trace the small capacitive contribution of my circuit for integrating induced EMF to derive the B signal. I could find no trace of a loss. Moreover, the line was not curved; it was very straight, which meant that the incremental permeability effective in the direction transverse to d.c. polarization was virtually constant.

This was as expected from my theoretical reasoning, but there was a surprise in that the transverse permeability was smaller than I expected, by a factor of ten.

Now, if you are wondering what this means, note that my object is to store 'reluctance' energy by that transverse excitation, meaning energy that goes in as inductance energy and is recovered without loss on the down quarter cycle. By making that transverse oscillation stronger and stronger the object is then to deflect the primary polarization so that the intrinsic ferromagnetic power develops flux oscillations in the axis of the primary coil. The aim is to tap energy from that deflected 'reluctance' energy source, most of which is powered by the atomic spins in the ferromagnet, and use that energy on the up quarter cycle.

This process then allows the polarizing bias, which could be that provided by a permanent magnet, to reset as the tranverse current diminishes, but the short-fall in the stored 'reluctance' energy given back to the magnetizing coil in that transverse direction has then to be made up by the magnet.

The experiment I report here goes no further than showing that the transverse excitation is a pure, virtually loss-free, inductive process which involved a characteristic magnetic permeability indicating a 30:1 ratio of ferromagnetic power input compared with external power input. That is the starting point which will, I am sure, lead to the fourth experiment in which that energy is diverted and used without affecting the input magnetization circuit. Then the recovery of energy upon demagnetization of that latter circuit will occur, but as it cannot take used energy back from a load, the polarizing magnetic source simply has to do the work and so leave the quantizing vacuum field in a cooler state.

Rather than wait until I am ready to report such further progress, I thought it appropriate to inform you and via you the readers of your Newsletter at this stage."

I now intend in this Report to extend my disclosure on developments from this experiment but, since this particular project promises the best route to tapping aether energy by solid-state apparatus, and there is much research now needed before the patent cover is secure, I will limit what is said.

My object here is to attract sufficient interest from major corporation research laboratories based on a non-confidential disclosure by pointing the project effort in the right direction, whilst withholding enough to give basis for mutually beneficial negotiation adequate to reward my contribution. This may be an untimely step to take, but there is urgency and 'free energy' development must proceed with all speed, in order that the pollution by our existing energy generation methods can be minimized.

If others who read this Report decide to pursue the R&D also, in their independent ventures, that can but be for the common good, but again it is stressed that this Report should not be taken as granting any rights under what may be proprietory and subject to patent protection. Copyright in this report is also preserved.

As to the principles of the experiment, firstly, the object is to work a ferromagnetic core in such a way that its windings do not cancel the action and so defeat the purpose of allowing the core to contribute some of its intrinsic energy to our output circuit in each successive magnetizing cycle. Secondly, the core has to work hard in this effort and so it must operate at a level of magnetization above the knee of the **B-H** curve or even close to saturation. Thirdly, as much of the core as possible should be involved in this exercise, not just a small portion in a large magnetic circuit. Fourthly, our technique for accessing that energy is to contrive operation so that the input circuit responds as a pure linear inductance whilst the ferromagnetic core acts as a catalyst to feed thermodynamic power to the output circuit electrically.

The drawing in APPENDIX C illustrates a core structure that serves this purpose. The illustration of Fig. 3 should be self explanatory. It is an extract from an early U.K. Patent No. 855,907 dating from April 1956 and of which the author was inventor in his employee capacity with a major U.K. electrical company. However, though there are technical features of that development which the author has called to mind in developing this 'free energy' application, the specific mode of excitation needed to tap that 'free energy' were not disclosed nor, indeed, thought of at the time of that early invention.

A spiral wound steel film coated with insulation has a cylindrical form and is wound around an axially central conductor. A solenoidal winding encompasses the core. Current I in the solenoidal winding produces a magnetic field parallel with the core axis, whereas current I' in the central conductor produces a magnetic field in a circumferential sense. The thin steel film constituting the cylindrical core is everywhere subjected to the cross-field magnetization effects of two fields acting at right angles to each other.

The currents I and I' must, acting together, be sufficient to set up a near saturation condition in the core.

The central conductor winding is d.c. biased and excited with a.c. of smaller amplitude to function as an inductance setting up a circumferential field with energy cycling in and out and subject to very little frequency-dependent loss. There is some I^2R loss in the winding. The intrinsic ferromagnetic energy that corresponds to the near saturation state is represented by a spin state that precesses, in effect, during the cyclic reorientation. In so doing, it induces an EMF in the solenoidal winding and this puts output power into a load connected to that winding during both half cycles of the a.c. oscillations. That output power taps the ferro-magnetic spin energy that the aether supplies by thermodynamic cooling in keeping the ferromagnet its its low minimal energy potential state.

The way in which one should see this is that, looking in any direction of strong magnetization, with the precession moving away from that direction, the **BH** component is reducing without returning all that energy to the aether system. Instead it transfers some to the load circuit. With the precession moving into that direction, the **BH** energy component builds up by input of aether field energy accompanied by thermodynamic aether field cooling and, at the same time, sends some of that energy to the load circuit.

A normal transformer runs solely on the **HB** energy transfers that are conservative in the material system. The 'free energy' future transformers will conserve energy too but will extend the conservation territory to that of the space medium.

The author intends to say no more on this subject until the time comes when a design specification can be disclosed with operational performance data.

On the general issue of 'free energy' from 'aether' reaction in responding to magnetism, there are a few experimental indications now emerging which suggest that the 'free energy' input can be dependent upon orientation of the apparatus in the inertial space frame. Researchers who find performance variations that can change with time of day, as the Earth rotates about its axis, should be alert to this possibility. The underlying scientific reason for such effects and the evidence will be covered by a later Report in this series.

The reader may now find APPENDIX A interesting, as a 'peer-reviewed' November 1993 communication published in the U.K. Institute of Physics journal 'Physics Education'. It has not been presented in its full printed version for copyright reasons. The substantive content of the author's original text only is reproduced and certain sections are presented in bold type, the emphasis being added specially for this Report.

20th February 1994

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APPENDIX A
THE FIRST LAW OF THERMODYNAMICS: PHYSICS EDUCATION 28, 340-342: 1993

Whilst strongly supporting the view expressed by Moore (Physics Education, **28**, pp. 228-237; 1993) that greater emphasis should be given to non-equilibrium processes in teaching thermodynamics, it is submitted that such teaching gets off to the wrong start by the very prescription of the First Law of Thermodynamics as the governing doctrine.

It is the Principle of Conservation of Energy that should be declared as fundamental. The First Law of Thermodynamics, if retained in the physics curriculum under that name only serves as a 'number one' precedent to the 'number two' law.

A thermal system with no heat flow would be at a uniform temperature. A purely thermal system with heat flow can be in equilibrium with heat flow. Non-equilibrium processes imply actions which are not solely concerned with the flow of heat in a system. In presenting his case, Moore begins by reciting that First Law as having a meaning expressed by:

$$E = Q - W$$

where E is the change in energy, Q is heat flow and W is work done.

Note the words 'change', 'flow' and 'done'. The Principle of Energy Conservation requires that a change of energy between its various states, such as heat, electric potential, gravitational potential or kinetic energy sums to zero and I do not see why a student should have to have to learn this as a law of 'thermodynamics'.

At the outset of his argument, Moore defines 'heat' as 'the interaction that occurs between two systems, or between a system and its surroundings by virtue of a temperature difference'. This is not correct, because 'heat' is a form of energy - a scalar quantity, whereas a temperature difference has direction and so is a vector. 'Heat flow' can be said to have the prescribed definition. This shows how careful one needs to be with words in teaching the fundamentals of the subject.

In his following sentence Moore states: 'A temperature difference can be further defined in terms of lack of thermal equilibrium between two systems ...' Later he says 'A new generation of physics textbooks will probably be needed to cope with the fundamentals involved in the teaching of non-equilibrium thermodynamics at a base level'. However, I suggest that the question at issue is whether we are concerned with the physics of temperature difference or whether we are erring in using 'thermodynamics' to relate to something that is not strictly 'thermal'.

Physics today, and science generally, covers such a vast field and there has to be economy in teaching techniques, whilst conserving fundamentals. We need to understand how energy can redeploy and how order can evolve from chaos, but that is not the subject of thermodynamics. Thermodynamics has only become involved because, historically, it has been used to draw an arbitrary line between the possible and the impossible, but this is a line which is not holding steady. The energy that does cross that line in going from chaos to order is not heat, as such. However, it can create heat after making the transition. One has to distinguish between the physics of heat flow that involves a temperature differential and the physics of energy conversion generally.

In stating the fundamental principles underlying that First Law of Thermodynamics, with examples in mind, one really needs to set the stage for the student who may progress and have to face the following two problems.

Firstly, when a ferromagnetic substance cools down through its Curie temperature it releases heat over and above that associated with its normal specific heat. This extra heat happens to equal the sum of the magnetic energy which is thereby established, meaning the energy needed to set up the same field conditions in an air-cored solenoid as exist in the saturation state of the magnetism created in each ferromagnetic domain, and the additional work done in setting up the mechanical strains associated with that magnetism.

Readers will find, on considering this, that, notwithstanding misguided attempts to bring in magnetism as a negative potential, the First Law of Thermodynamics does not hold. We do not have here a situation where the work done requires a loss of heat. The only system we recognize as present is the substance of the ferromagnet. Unless there really are two systems inside one another, one that supplies energy from a source we cannot see or sense in temperature terms, there is no way of keeping an energy balance according to that First Law of Thermodynamics.

So, turning to the Principle of Conservation of Energy, we need to admit that our 'system' comprises an underlying sub-quantum field medium as a coextensive system having its own reserve of 'zero-point energy'. One presumes that there are in that field medium quantum effects at work in priming those spins in atoms that we say establish the ferromagnetic state.

Secondly, although one finds in books on cosmology that one can ask such questions as 'is the vacuum gravitating?' (see section 11, chapter 1 of Novikov's 'Evolution of the Universe', Cambridge University Press; 1983), one does not see the equally important question 'does the vacuum have a temperature?'.

Yet, when we look into the space enveloping body Earth there is evidence of thermal equilibrium manifested by the 2.7 K radiation. For some reason this 'heat energy' is deemed to be a residue of the Big Bang in the scenario of the expanding universe.

What is rather curious is that cosmologists try to apply the principles of energy balance to the assumed gravitational interaction within the vacuum acting on itself, forgetting that if the vacuum does contain something that can gravitate it must contain electric charges in some neutral composition. The pure vacuum, devoid of matter, must have its own quasi-static equilibrium and probably will not exhibit a temperature. Here, the word 'probably' is used because, in common with so much that is theorized about in cosmology, one really does not know the certain answer, but we need to imagine the likely scenario in our effort to solve the riddles of Nature.

However, assuming that, if matter did not exist, the vacuum would have no temperature, what cosmologists then fail to do is to apply the Principle of Energy Conservation or that First law of Thermodynamics to the straightforward question of how matter, that we know exists, interacts gravitationally **and thermally** with that elusive vacuum medium.

Consider the energy balance equation:

$$\varphi m + kT = 0$$

or:

$$\varphi m + mv^2/2 = 0$$

where **m is the mass of a virtual particle deemed by Novikov (in following Zel'dovich) to constitute the vacuum medium, T is the temperature of the particle**, k is Boltzmann's constant, v is speed and φ is a measure of gravitational potential attributable to matter within gravitational range of the particle of mass m.

The equations apply in a physical sense because, by analogy with magnetism in the first problem, gravitational potential is said to be a negative quantity, though really it is a manifestation of an exchange of energy with that hidden field system. Now, much as we think we know all there is to know about gravitation, we really have no adequate reason for believing that gravitation can act over a range exceeding a few hundred light years. Indeed, if gravitation has a limited range of action that could explain why stars form in separate space domains rather than converging into one central core to set up a reversal of the Big Bang scenario. The gravitational coupling across a galaxy can be one that is a chain coupling linking stars that are separated by less than the critical range of action. Note again that the words 'can be' are used deliberately, because students have much to gain by being shown that we are uncertain, which leaves them something to delve into in finding their own way forward in physics!

From a teaching viewpoint, it is then of interest to estimate the gravitational potential at the centre of the sun, based solely on the solar mass. We know φ and so can derive v, the speed imparted to the mass m. When this calculation is performed that speed v is found to be much the same as the translational speed of our solar system through the cosmic background. Therefore, if the formation of the sun meant that gravitational energy was shed, then that could have been taken up as kinetic energy by imparting a translational non-thermal motion to mass seated within the sun.

Should one view the relationship as coincidental or does it have significance cosmologically? The teacher cannot offer the certain answer to this question and so that may be a reason for not telling the student. However, physics education should not just be about what teachers know but should also give students an insight into what teachers do not yet know!

Looking at the equation involving T, one may apply this to the vacuum medium in the near vicinity of Earth. Here the gravitational potential can also be calculated. The effect of the sun dominates that of Earth by a factor of 14, so we need not be too rigorous about specifying an altitude in making this calculation.

The energy kT is used because it is assumed that there are only two degrees of freedom in the **vacuum medium, inasmuch as its action may resemble the properties we associate with antiferromagnetism.** However, the exact numerical coefficient is not too important in making the proposition that the 2.7 K cosmic background radiation temperature is local evidence of the Principle of Conservation of Energy or that First Law of Thermodynamics in the vacuum itself. The known gravitational potential attributable to the solar system in the vicinity of Earth, plus that 2.7 K temperature as measured, lead us, from the energy conservation equation, to derive a 'measured' value of m. **The mass of the virtual particles forming the vacuum medium can, therefore be shown to be approximately 0.04 times the mass of the electron*.**

The main thrust of these remarks is that the Principle of Conservation of Energy is a sufficient statement of whatever is intended by the First Law of Thermodynamics and it does have the merit of embracing actions that are not exclusively thermal or temperature-related. However, in its application we need to be open to energy exchanges involving the vacuum medium and we must then come to terms with the problem that so many physicists think it best to avoid, namely delving into the properties of a real vacuum medium. This is forbidden territory because it is outlawed by the theory of relativity.

In summary, whilst students need to know how internal combustion engines and electric kettles conform with the principles of thermodynamics, the laws of thermodynamics must no longer be presented as barriers which preclude exploration of new energy fields. One governing condition suffices, the Principle of Conservation of Energy, and its application to a physical system embracing the total field environment and if we hypothesise laws of thermodynamics by appeal to 'experience' we should keep in mind that students of the future may yet 'experience' something that past textbook authority did not 'experience'.

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* It is beyond the scope of this commentary to show in detail how one can confirm this value m by an independent test, save to say that the vacuum has the ability to define the value of the fine structure constant in terms of the ratio of the mass m to the mass m_e of the electron:

$$hc/2\pi e^2 = (108\pi)(4m/m_e)^{1/2}$$

A derivation of the above is presented by the author in Lettere al Nuovo Cimento, **40**, 53-57 (1984). See also the derivation as equation (19) on p. 354 of 'Quantum Uncertainties', Nato ASI Series B: Physics Vol. 162 (Plenum Press) 1986.

Footnote for this Energy Science Report: This value of m, the mass of the aether particle, was shown to be 1/25 of the electron mass at page 24 in the author's 1959 work entitled 'The Theory of Gravitation'.

APPENDIX B
ANALYSIS OF THE A-FIELD REACTION

'A-field' signifies the 'aether' diamagnetic reaction field set up in space by gyromagnetic reaction of aether charge in response to the normal B-field. The experimental evidence from classical physics research on gyromagnetism in ferromagnetic rod specimens presents physicists with an experimental anomaly in that the observed change of magnetic moment in relation to angular momentum has twice the value expected. The Dirac abstract 'spin' mathematical route to this factor of 2 is wrong and has led science away from the 'free energy' opportunities. The alternative is to accept the simple explanation as a diamagnetic reaction from free conduction charge in the metal. Then one is confronted with the need to extend the argument to the vacuum medium and accept that the aether contains charge in motion that can set up a reacting magnetic field, even under steady d.c. field conditions. This latter proposition has now been verified by experiment reported earlier in this Report. An insight into the formal theory as applied to reaction in metal is presented below, as it recently appeared in the author's U.K. Patent Specification No. 2,267,995.

To determine the strength of the A-field reaction in a metal conductor one needs to note that each conduction electron moves at a high velocity and is subject an electric potential mainly sourced in the positive residual electric charge of the atoms which have shed those conduction electrons. These atoms are locked into the metal crystal structure and so the free electrons move under the constraint of a local electric force F(r) which has a component constraining the electron to move between collisions in general orbital paths of radius r centred on the atoms.

If a magnetic field of strength B is also present this supplements the electric force by a component force Bev, where e is the electromagnetic charge of the electron and v its speed in circular orbit about an axis aligned with the direction of B.

Note that the force F(r) is a restoring force proportional to displacement of the electron from a notional position of rest, assuming it has no motion. The restoring force factor depends on boundary shape but is the same throughout any metal structure having parallel planar boundaries, regardless of the direction of charge displacement. Its value is halved within a cylindrical metal structure provided the displacement is in a plane at right angles to the cylinder axis. Therefore a displacement through a distance r will involve adding potential energy of F(r)r/2.

The force equation, assuming that B is zero, is simply:

$$F(r) = mv^2/r \text{ .... } (1)$$

If one now sums the effective kinetic energy component attributable to v for all the free electrons in a unit volume of the metal and write that as energy density W, the equation gives:

$$\Sigma F(r)r/2 = \Sigma mv^2/2 = W \text{ .... } (2)$$

Now bring in the action of the B field. This adds the force term in Bev to the left hand side of equation (1) and so changes equation (2) in the following way:

$$\Sigma\, F(r)r/2 + \delta\Sigma F(r)r/2 + B\Sigma evr/2 = W + \delta W \text{ .... } (3)$$

Next, note that the terms in F give rise to a potential energy and it is appropriate to bring the energy terms together on the right-hand side of the equation into a single energy density function that depends upon B. Denoting this energy density function as E, equations (2) and (3) combine to give:

$$B\Sigma evr/2 = \delta E \text{ ....} (4)$$

The expression involving evr/2 is a measure of the reacting magnetic moment of each conduction electron. It develops a back-field or reaction field which is denoted the 'A-field' and which, if scaled by a factor g, has the value:

$$A = 4\pi g\Sigma evr/2 \text{ .... } (5)$$

The B-field acting on each conduction electron is, therefore, a combined field effect produced by a primary field which we write as gB and this is offset by the field of strength A. Note that the same scaling factor has been used to modify the B field as is used to modify the reaction field. Reasons for this will be apparent in what follows, but one needs to keep in mind that a unity value must be assigned to g to comply with orthodox teachings on this subject.

One can now write:

$$B = gB - A \text{ .... } (6)$$

Combining equations (4), (5) and (6):

$$\delta E = (gB - A)(A)/4\pi g \text{ .... } (7)$$

which is a simple relationship representing an energy quantity which tends to maximize because its negative potential energy component tends to a minimum.

The variable in the equation is the value of the A-field. Differentiating equation (7) with respect to A shows that the energy density attributable to the B-field is a maximum when:

$$gB - 2A = 0 \text{ .... } (8)$$

which shows that the strength of the A-field reaction is exactly half of gB and, from equation (6) this means that g is precisely 2. Then, from equation (7) this, in turn, means that:

$$\delta E = B^2/8\pi \text{ .... } (9)$$

which is the conventional magnetic field energy density formula in the units we are using.

The result of this analysis is that when a primary magnetic field acts on the free conduction electrons in a metal there is, inevitably, a half-field reaction, the A-field, which is opposed to that primary field. Since, in the past, one has been able to work with theory which presumes there is no such reaction, then the B-field which is known to be effective in the metal must owe its action to a magnetizing effect twice as strong as the B-field. The half-field reaction has passed unnoticed in experiments because one has failed to double the primary field action before halving it. Therefore, the moment of electric current attributable to the electron, which is represented by a term such as (evr/2), and which would otherwise be deemed to represent the reaction, must also be incremented by that same g-factor. This explains why the g-factor was introduced in equation (6). It makes sense of an otherwise impossible situation.

Note that the half-field reaction is sensed in gyromagnetic reaction measurements, where observation based on reversing the ordered electron activity which is associated with magnetic polarization causes a proportional reversal of angular momentum. The ratio of the electrical current moment to the angular momentum, as measured, is twice that expected from conventional theory based on the known charge/mass ratio of the electron. This gyromagnetic ratio factor of two is the g-factor deduced above. The experiment confirms the theory presented.

Note also that the interpretation of the gyromagnetic reaction in terms of the 'A-field' is indisputably strong, but it does require the concomitant recognition that there is an A-field vacuum reaction involving the charges which account for Maxwell displacement currents. This A-field reaction in the vacuum or aether is the basis on which inductive energy is stored as a magnetic field. Physicists have for most of the 20th century, at least until recent times, sought to avoid referring to the aether or recognizing it as an active energy medium, and this has been to the detriment of innovative energy technology.

APPENDIX C

APPENDIX C

855,907 PROVISIONAL SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*
SHEET 1

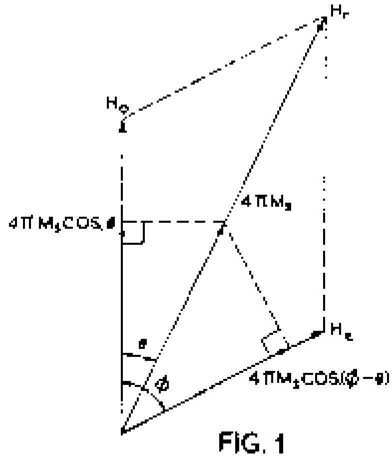

FIG. 1

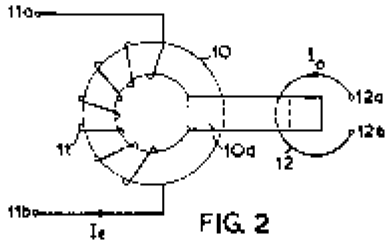

FIG. 2

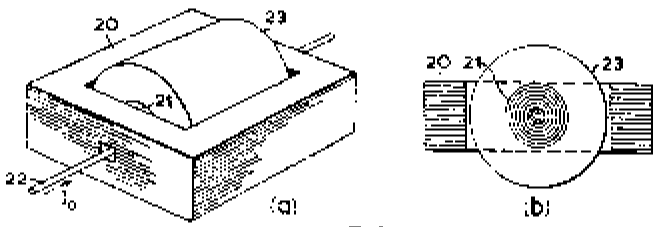

FIG. 3

ENERGY SCIENCE REPORT NO. 2

POWER FROM ICE: THERMOELECTRICS: PART I

by

HAROLD ASPDEN

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ISBN 0 85056 023 3

ENERGY SCIENCE REPORT NO. 2

POWER FROM ICE: THERMOELECTRICS: PART I

Contents

POWER FROM ICE

Introduction

This Energy Science Report summarizes the development status of the Strachan-Aspden thermoelectric energy conversion technology as of May 1994. Onward research from that date is the subject of Energy Science Report No. 3.

The basic invention is the brainchild of its coinventors Dr. Harold Aspden of Southampton, England and John Scott Strachan of Edinburgh, Scotland and it dates from their first meeting in Canada on the occasion of a New Energy Technology Symposium held in 1988 under the auspices of the Planetary Association for Clean Energy.

In its conception, the invention merges the technical disciplines of magnetism (Aspden) and piezoelectricity (Strachan) in a structure which exploits, first and foremost, the thermoelectric properties of metal. In its onward development and promotion, the respective professional skills of the two inventors were brought to bear in laboratory assembly (Strachan) and patenting (Aspden). Geographic separation by 420 miles has precluded a close working relationship in pursuing this project in a normal technological development sense, it being a private venture by two individuals, each having other unrelated technical interests.

In the event, what is an extremely important inventive contribution, that potentially can provide the non-pulluting refrigeration technology of the future, has remained undeveloped, notwithstanding some small external R&D funding that has been of assistance to Strachan.

There are not, of record and suitable for issuance, any detailed experimental tests or results provided by Strachan. Almost all the documentary material that has been made available until now has been generated by this author (Aspden), mainly in a patent attorney or promotional capacity. Much of this latter information is the basis of this Report. One appended item that is new at this time is the account which Strachan prepared in February 1994 describing the polymer PVDF structure and fabrication of the first and third demonstration prototypes which he built. The issuance of this Report at this time follows the recent grant of the relevant U.S. Patent No. 5,288,336 dated February 22, 1994.

The object of this Report, therefore, is to arouse interest in the Strachan-Aspden invention in those corporations having the necessary R&D resources or ability to fund such

R&D in academic establishment laboratories with a view to the disposition of the patents involved.

Concerning the Patent Rights

> **[Note added June 2003 when this Report is made available on the author's websites www.energyscience.co.uk and www.aspden.org . The comments about patent rights which follow no longer apply as the patents involved were not kept alive, owing to lack of interest by prospective developers having the necessary disposition to fund the onward research needed. However, for the record, the text below remains unamended from its initial form as published in 1994.]**

The schedule of patents relating to the Strachan-Aspden technology forms APPENDIX I. The author, in his Attorney capacity representing the proprietor interest in these patents, is empowered to negotiate options or outright assignment. Based on the introductory technical briefing offered by this Energy Science Report, and the information now being incorporated in further reports, the author also makes himself available for some limited consultation on onward development by those parties who enter into the necessary Agreements.

The abstract and title page of the principal U.S. Patent, 5,288,336 is included in APPENDIX I and those interested in the detailed disclosure and claim cover will no doubt wish to acquire and inspect a copy of that published patent specification.

Essentially, the details of the operation and technology underlying the invention can be understood from the descriptive material provided later in this report, but there has been a shift in emphasis as to this author's technical appreciation underlying physical functioning of the invention and this features in certain additional patent applications which have been filed and which, though listed in APPENDIX I, will form the subject of Energy Science Report No. 3.

In order, however, to assist the reader who does inspect the primary U.S. Patent No. 5,288,336 and also U.S. Patent No. 5,065,085 and seeks a simple insight into how this author now views the underlying physics, the diagram in Fig. 1 below may serve.

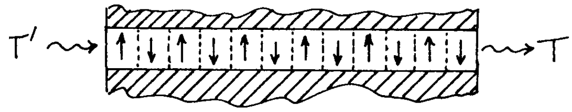


Fig. 1 Nernst EMFs induced in nickel by heat flow

When a temperature differential exists in a thin film of nickel sandwiched between dielectric insulation in a parallel plate capacitor, the heat flow carried by electrons is deflected by the strong polarization fields in the oppositely polarized single magnetic domains that bridge the film thickness. This, by the thermoelectric phenomenon known as the Nernst Effect develops an electric field polarization as shown by the arrows. It is orthogonal with respect to the direction of heat flow and the magnetic polarization. It may then be understood how a lateral oscillation of current flow through the capacitor can choose a flow path on successive half cycles so as always to transfer charge across the metal plate electrodes to draw power from an assisting EMF by avoiding the path obstructed by an opposing EMF. Cooling must then result as that power transfers into the external circuit. The dielectric insulation obliges the heat flow in the nickel to remain orthogonal with the current flow direction and also with the magnetic polarization which is necessarily in-plane in the nickel.

Development Status: May 1994

[The figure references in this section apply to the patent specification drawings included at pages 7 and 8 of this Report]

There were three techniques in the original conception of the invention. The common feature was the idea of using a capacitative coupling to block heat transfer between the hot and cold heat sinks whilst contriving thermoelectric energy conversion. Strachan advised that all three had been tested experimentally and were viable.

The one ready for demonstration (the capacitor stack) was given preference for onward development. The strategy adopted was to file a first patent application showing capacitor use in the heat blocking sense (Figs. 1 to 4 of the 18 November 1988 patent filing - same as those in U.S. Patent No. 5,065,085) and a brief disclosure of the stack (Fig. 4) but not disclose the detailed assembly of the stack. A second U.K. application filed 5 December 1988 added Figs. 5 to 8 and covered that detail and described the prototype version of the stack as I understood it at the time.

In the event the capacitor heat blocking proved not to be of particular merit but we had a basic invention in the disclosure in that the confinement of heat flow to the bimetallic capacitor plates with transverse current oscillations gave remarkable results.

The subjects of Figs. 1 to 3 were not developed further, even though they have merit. I persisted in securing patent cover in U.K. and U.S.A., the latter, as just indicated, being granted as US Patent No. 5,065,085.

The patent cover which followed from the capacitor stack was adjusted and tailored to the diagnostic findings that emerged from the research on the second prototype and the international patent filing including US filing did not replicate the features of Fig. 7 or Fig. 8 or include the acoustic oscillation feature that was incorporated in the first prototype.

The First Prototype: September 1988

This was a capacitative polymer dielectric stack with bimetallic Al:Ni coatings and provision for acoustic oscillation of interleaved premagnetized magnetic recording strips (see Fig. 8).

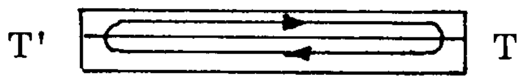
Strachan has, only in February 1994, and in preparation for a visit from overseas by interested corporate project engineers, documented the detailed constructional techniques of that first (and later third) prototype. This forms APPENDIX VI.

Fabrication is very complicated and it is not suggested that the resulting devices did any more than prove that we have discovered an energy conversion principle that has very outstanding merit. The task ahead is to develop on the test findings of the much simplified second prototype.

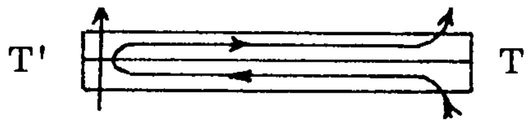
The Basic Principles and the Second Prototype: October 1989

This was the technology on which the multi-national patent filing was based, claiming the priorities of the 18th November and 5th December 1988.

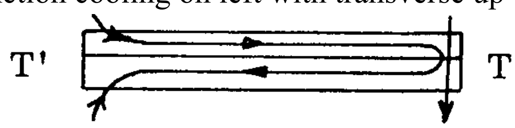
The principle is evident from the following diagram:



(a) Thermoelectric current flow: no transverse excitation



(b) Junction cooling on left with transverse up-current



(c) Junction heating on right with transverse down-current

Note: (1) We are using a.c. with negligible I^2R loss.
(2) The circulating current is that carried by heat flow (Thomson Effect - metals of opposite electrical polarity).
(3) The dynamic a.c. current interruption increases the thermoelectric power enormously (avoids junction cold spot formation).

At that time (October 1989), though the Nernst Effect was in mind and had been mentioned in connection with the disclosure in U.S. Patent No. 5,065,085 and though nickel, a ferromagnetic substance, was one of the two metals in the test device, it was not then realised that the Nernst Effect might also play the key role in the functioning of that second prototype device.

The October 1989 status is evident from the Test Report (APPENDIX IV). APPENDIX V provides a scientific analysis of the cold spot problem).

The questions outstanding from those tests were:

(1) What frequency could we reduce to and still get the high thermoelectric EMF? The cold spot theory implied that we could operate even below 1 kHz, but the capacitor coupling limited the transverse current and that suggested building a direct metal conductor coupling following contours of constant temperature - so as not to divert heat from the junctions.
(2) What thickness of metal film could we increase to whilst not losing efficiency? Note that the Thomson Effect circulation fixed the current that could flow transversely owing to the half-cycle cut-off.
(3) Which metal combination was optimum?
(4) What fabrication technique was best to ease manufacture and assure reliability?
(5) Why was it that we seemed to be getting more transverse current flow than the design capacitance of the stack implied from the voltages we measured?

In the event, early in 1990, Strachan was obliged to abandon all work on the project and the development fell dormant. This was owing to business failure of the sponsors on an independent manufacturing venture but Strachan was then unable to demonstrate a working prototype and we were, in effect, then in a worse position than at our late-1988 start point.

The 1991/1992 Scenario

Not having the resources to set up an experimental programme myself, and especially as I had to sustain the costs of the patents I decided to publish in the hope of attracting interest from corporations. I had nothing to demonstrate.

My effort to publish in the Journal of Applied Physics caused a referee to say 'publish but provided more detail is given as to actual construction of the device', but the Editor felt my amended paper did not go far enough in that respect and so that initiative failed.

By year end 1991 I had an acceptance from a U.K. electronics magazine (the July 1992 article in Electronics and Wireless World) and had a paper scheduled for the 1992 International Energy Conversion Engineering Conference in San Diego.

The publicity in U.K. attracted corporate interest, and Strachan then took the initiative and assembled the third prototype. The showing of that impressed a major U.K. company interested in new energy development and they provided new funding for Strachan for a period of 8 months.

I made sure that the demonstration was recorded on video and this has proved helpful in talks with interested parties. My personal objective concerning onward development has been to see the test device operate without reliance on the capacitor fabrication, either by an alternative conductive coupling between the bimetallic laminations or by magnetic inductive energy transfer, i.e. by intercepting the thermoelectric current by an inductive back EMF.

By year-end 1992, after 4 months of the new funding, Strachan reported on a test whereby, given a temperature differential in the bimetallic lamination, the magnetic flux could be controlled at 20 kHz by an electric grid control. However, that research did not progress to his satisfaction and I have insufficient data for me to make sense of the outcome of the experiment. The funding for Strachan's research ceased at the end of April 1993.

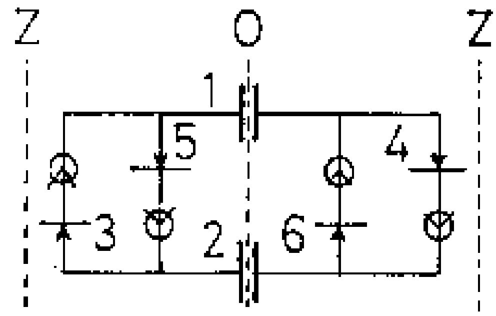


FIG. 1

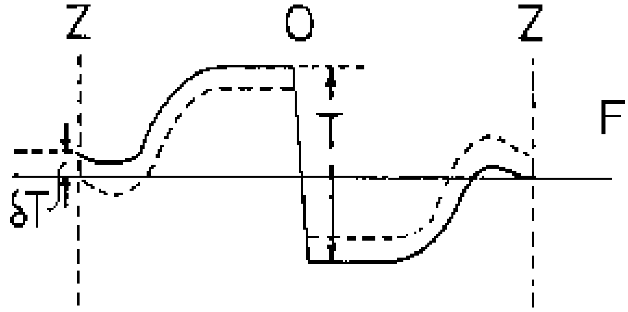


FIG. 2

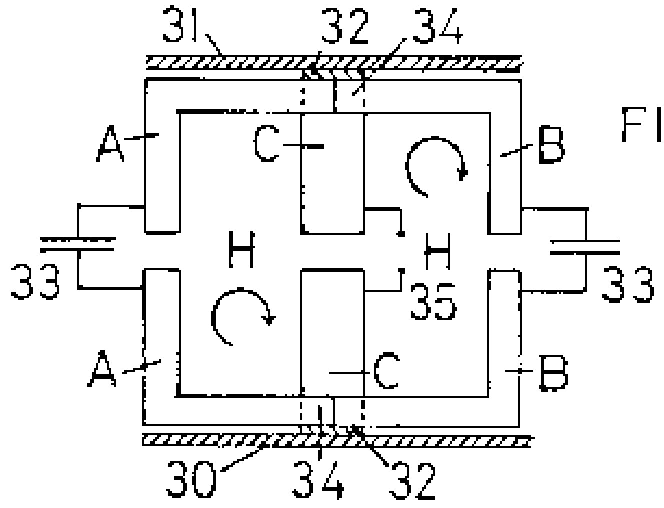


FIG. 3

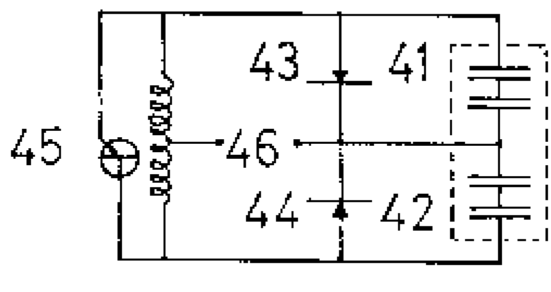


FIG. 4

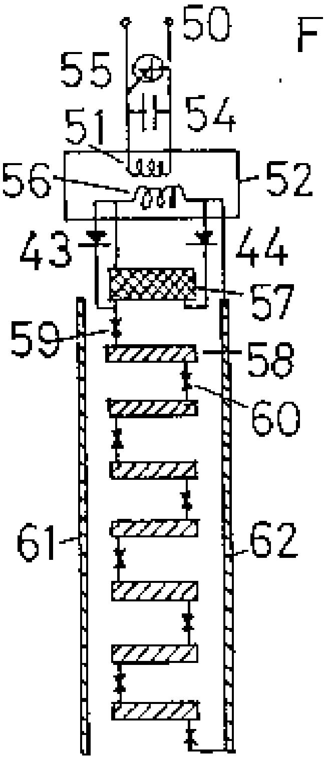


FIG. 5

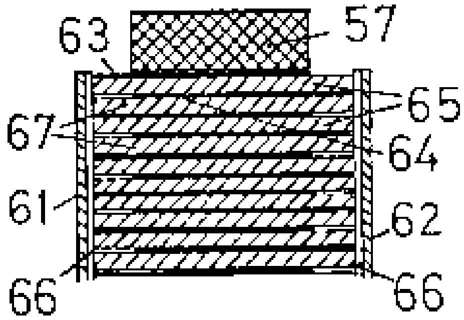


FIG. 6

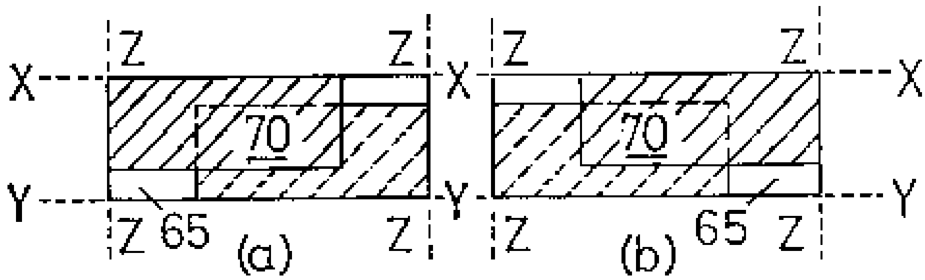


FIG. 7

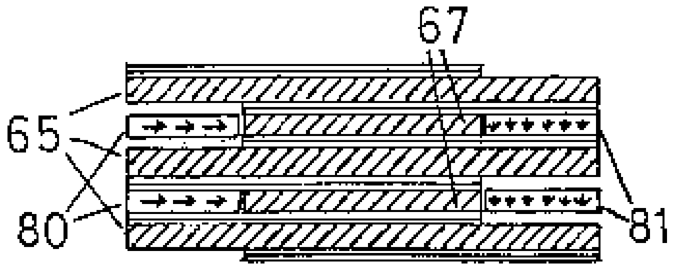


FIG. 8

The Aspden Experiment

In September 1993 I decided to initiate my own small experiments, based on the approach I had been advocating, namely to build a magnetically inductive core system and feed in eddy-current heating to set up a temperature gradient in bimetallic laminations. The idea of this, regardless of application to refrigeration or power generation, was simply to have electrical control throughout the test and determine the relevance of the ferromagnetic property, metal thickness and excitation frequency.

The outcome of the first experiment has been described in Energy Science Report No. 1 and further onward experiments will be described in Energy Science Report No. 3.

However, some interesting problems have been encountered in the latter pursuit and the quest to operate in an all-metal high current mode with no dielectric laminations and capacitor drive, which is aimed mainly at solid-state electric power generation from input of heat at higher temperature than is normal where polymer dielectrics are used, may prove too demanding for this author's private research facilities.

Accordingly, as a guide to readers interested in pursuing the alternative capacitor construction based on that simple Nernst Effect principle as mentioned on page 2, the following analysis is included.

Capacitor Stack: Design Considerations

Consider nickel film to have a thickness δ cm and the form of a 1 cm by 1 cm square. Assume a temperature difference of 1^o C from one edge to the opposite edge and denote the specific thermal conductivity of nickel as K watt-cm^2/^{o}C which implies a throughput heat flow of $K\delta$.

This heat flow is heat input loss if we do not intercept the heat and deploy it into electrical output.

The Nernst Effect has a coefficient for nickel which depends upon whether we use nickel I or nickel II, the latter being larger by a factor of nearly three. On the basis of the data of record from experiments by Zahn reported in Ann. der Phys. **14**, 886 (1904) and **16**, 149 (1905) on nickel we can reasonably assume that a 10 V per cm Nernst EMF is set up at right angles to the heat flow for each degree C temperature drop per cm.

It follows that the heat flow can be intercepted and deployed into output electrical power <u>if</u> we can provide for a transverse flow of current I amps without there being heat flow in that same transverse direction, with I given by the equality of $10I\delta$ and $K\delta$.

We see that the thickness δ makes no contribution to the heat to electricity conversion efficiency. This thickness of the nickel merely has to be small enough to assure the single domain condition, say no greater than 50 to 200 microns depending upon the crystal size in the nickel.

The task is to secure the equality of K and 10I, meaning that with the 1 degree C per cm gradient and K of the order of unity, I has to be 100 mA per sq. cm of capacitor area to get optimum operation. A higher temperature gradient requires a proportionally larger current flow.

The design consideration then centres on the a.c. operating frequency and capacitance of the structure. If the dielectric thickness is of the order of 10 microns and the dielectric constant is 10, both of which are demanding design parameters, then a capacitance of the order of 1 nanofarad applies to the 1 cm. square nickel plate electrodes used and operation at about 16 kHz will give a current of 0.1 mA per volt. It would need 1,000 V across that 10 micron dielectric to give the 100 mA current requirement.

This is voltage stress requirement is too high and, also, there is another problem governing the combination of design parameters. This is that, if the thickness of the nickel is so much greater than the thickness of the dielectric, then the current 'sees' more a flow through the main surface of a ferromagnetic film and less the transfer of distributed charge on the surfaces of a dielectric. This can make the current bunch up by a pinch action in that 'negative' resistance flow path through the metal and, to avoid this, the dielectric has to be thicker than the nickel.

The design therefore proceeds by first deciding the operating limits on the voltage of a resonant capacitor stack using the inductance of the flow through the nickel in combination with the capacitance of the stack to determine that frequency. This sets the thickness of the dielectric. The nickel, if deposited on a substrate dielectric can be quite thin, say 5 microns, and it is this requirement for thin dielectric larger in thickness than the nickel, rather than the domain size factor, that obliges use of even thinner nickel films.

Note that the target of a 100% energy conversion efficiency then will depend primarily upon the scope for increasing the electric breakdown strength of the dielectric used, assuming simple metal parallel plate capacitance. Alternatively, in order then to bring to bear a suitable combination of parameters that allow moderate voltage gradients in a dielectric whilst allowing the current throughput to be adequate at a reasonable frequency, the way forward is to incorporate in the design the technology of electrolytic capacitors.

This, as this author sees the situation, is what Strachan did in building his prototype device using a PVDF polymer dielectric and it follows from this preamble discussion that those best able to develop the subject technology are those corporations who are already manufacturers of electrolytic capacitors.

Given then that the Strachan device did perform as a cooling device and as a heat pump able to convert heat into electricity one sees the prospect of developing a thermal electrolytic capacitor that will convert heat to electricity or serve as a Nernst Effect heat pump with no Carnot limitation on performance.

The reason for this non-Carnot limitation is discussed in Energy Science Report No. 3, but it amounts to the observation that, with heat carried by electrons, the deflection of those electrons by a magnetic field occurs to bring them to thermal rest (effectively zero temperature K) as they transfer energy to the capacitor, followed by their recovery of heat by cooling the substance of their metal host. Carnot efficiency referenced on zero Kelvin is 100% as far as heat/electricity conversion is concerned.

It then needs little imagination for any enterprising research organization to see that such technology, if proven in this particular respect, can provide a complete answer to the world's future energy needs in that, by arranging a conventional Carnot-limited heat pump in back-to-back operation with the Strachan-Aspden non-Carnot-limited heat pump, and deploying atmospheric sources of heat one can generate electricity.

Hitherto the non-Carnot-limited conversion of heat into electricity has been elusive but it is possible in that it already occurs in practice in one half of a thermocouple circuit but there is there the concomitant requirement that the electricity has to close the circuit through the other thermocouple junction which makes the reverse conversion.

All that this Report is suggesting here is that the evidence from the transverse-to-heat-flow current excitation of a heated nickel-electrode capacitor shows how we can intercept the energy and make the non-Carnot-limited conversion without paying the full price of the reverse conversion at ambient temperature. The 'lower' temperature conversion occurs inside the metal as electrons are deprived transiently of their thermal energy. It occurs at positions in the metal where there is only one prevailing temperature. There is no way that Carnot criteria can apply unless there are two temperatures associated with that event and the only temperature that can differ from that prevailing in the metal is the temperature resulting when the electrons give up their thermal energy by being deflected into the charged condition at the interface surface of the nickel and the dielectric. That temperature has to be lower than the ambient temperature of the metal and the electron can only recover equilibrium and carry heat forward if it then takes heat away from the crystal body of the nickel.

Given that the ferromagnetic plate electrode is the seat of the action associated with the Nernst Effect it may seem that there is no need to provide the bimetallic structure of the Strachan-Aspden embodiments. However, it is important to see that there is a two-fold benefit from the use of bimetallic laminations. Firstly, the second metal helps to spread the charge trapped at the interface between the metal and the dielectric and this allows it to participate more fully in the two-way oscillation of current flow. Secondly, the second metal brings to bear the Peltier Effect and this can help to sustain temperature gradients which activate the cooling. Note here that the first and third Strachan-built prototypes had an intrinsic design symmetry and an input current oscillation developed the cooling action with no input temperature gradient.

In other words, the use of bimetallic plate electrodes meant that the back-to-back action described above was at work in those devices.

This Report, therefore, highlights the importance of the Strachan-Aspden invention and hopefully will serve to excite the interest of those corporations having the resources needed for its onward development.

Energy Science Report No. 3 will be issued when this author has completed some further experiments and, in the meantime, some of the findings will be available in confidence to sponsors.

The APPENDIX sequence which follows comprises items written at different times as this project evolved and there are a few published articles and papers that are not included owing to the length of this Report.

It is believed, however, that what is described or identified in this Report will serve as a guide to would-be researchers who wish to become involved in this subject and should suffice as full information about the invention.

The prospective importance of this technology is so great, having regard to the need to avoid the pollution problems of existing refrigeration and energy generation technology, that it is hoped that others will take this project forward on their own initiative. Should any such researcher make progress in this regard, leading to demonstrable devices confirming the viability of the technology, then, so long as this author has control of the patent rights involved there is scope for merging interests in a joint venture.

So far as the availability of rights under the patents is concerned, enquiries from corporations are invited but no licence deals can be entered at this time as the object is to sell the patents outright as a total package, which means that licence dealings will be for the purchaser to determine.

This does not preclude an immediate undertaking in the nature of an option by which some nominal funding will secure a would-be developer, who already commands the necessary research facilities, an interest in the rights whilst evaluating the invention based on prototype building and testing.

Enquiries concerning the patent rights should be directed to me and enquiries concerning availability of Energy Science Reports should be directed to Sabberton Publications (see address below).

18th July 1994

DR. HAROLD ASPDEN
c/o SABBERTON PUBLICATIONS, P.O. BOX 35, SOUTHAMPTON, SO16 7RB, ENGLAND. FAX: Int+44-23-8076-9830. TEL: Int+44-23-8076-9361.

APPENDIX I

Schedule of Patents

Patent applications listed as 1-10 below all have the title:
"Thermoelectric Energy Conversion"
and all were filed naming H. Aspden and J. S. Strachan as co-inventors. Dr. Harold Aspden purchased from Strachan-Aspden Limited all rights in these applications on 12th January 1992. This company, registered in Scotland, was dissolved in July 1992, as it had become more expedient to operate from a company, Thermodynamics Limited, registered in England at Dr. Aspden's address.

1. U.K. Patent Application No.:8,826,952
Date of Filing: 18th November 1988
Grant as U.K. Patent No:2,225,161

2. U.K. Patent Application No.:8,828,307
Date of Filing:5th December 1988
[This served only as an international priority document for listed applications 3-4 & 6-10 below.]

3. U.K. Patent Application No.:8,920,580
Date of Filing:12th September 1989
Grant as U.K. Patent No:2,227,881

4. European Patent Appln. No.:89,311,559.2
Date of Filing:8th November 1989
Published Specification No:0369670
Countries designated: Austria, Belgium, Switzerland, Germany, Spain, France United Kingdom, Italy, Lichtenstein, Luxembourg, Netherlands and Sweden
[Presently pending]

5. U.S. Patent Application No.:07/429608
Date of Filing: 31st October 1989
Grant as U.S. Patent No:5,065,085
Date of Grant:12th November 1991

6. U.S. Patent Application No.:07/439,829
Date of Filing: 20th November 1989
Grant as U.S. Patent No:5,288,336
Date of Grant:22 February 1994

7. Japanese Patent Appln. No.:1-299481
Date of Filing: 17th November 1989
[Presently pending]

8. Canadian Patent Appln. No.:2,003,318-5
Date of Filing: 17th November 1989
[Presently pending]

9. Australian Pat. Appln. No.:44771/89
Date of Filing: 17th November 1989
Grant as Australian Pat. No:622,239

10. Eire Patent Appln. No.: 3677/89
Date of Filing: 17th November 1989
[Presently pending]

****

The following patent rights are currently in process. With the exception of the application identifying Thermodynamics Limited as applicant (sole inventor J. S. Strachan) all these are registered in the name of Dr. Harold Aspden as applicant and sole inventor. Dr. Aspden is empowered to negotiate rights under patents owned by Thermodynamics Limited.

11. U.K. Patent Application No:9,212,818
Date of Filing:17th June 1992
Published Specification No:2,267,995
[Presently pending]

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Strachan et al.

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[54] THERMOELECTRIC ENERGY CONVERSION

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[73] Assignee: Dr. Harold Aspden, Chilworth

[21] Appl. No.: 439,829

[22] Filed: Nov. 20, 1989

[30] Foreign Application Priority Data

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Sep. 12, 1989 [GB] United Kingdom 8920580

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[52] U.S. Cl. 136/200; 136/203; 136/204; 136/205; 136/211; 136/212; 136/224; 136/225; 136/226
[58] Field of Search .... 136/200, 203, 204, 205, 136/206, 208, 211, 212, 224, 225, 226, 227; 322/2 R; 310/306

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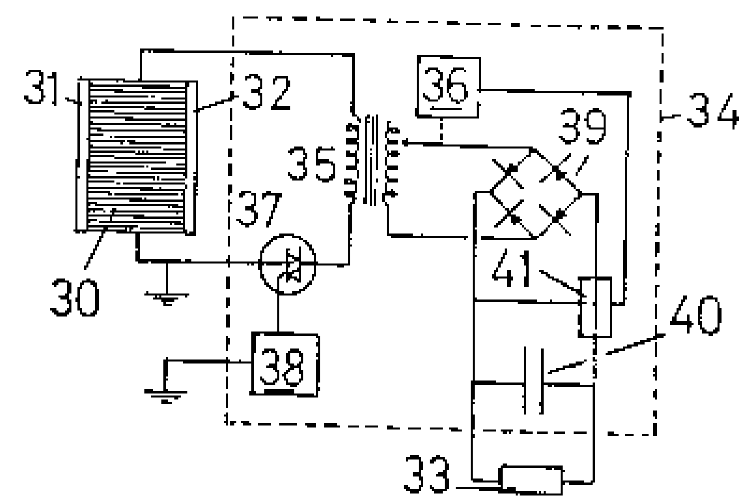
Primary Examiner—Donald P. Walsh
Assistant Examiner—Chrisman D. Carroll
Attorney, Agent, or Firm—Rainer & Prestia

[57] ABSTRACT

A thermopile 30 comprises a stacked assembly of bimetallic layers in which there is full conductor interface contact over the distance separating hot and cold surfaces 31, 32. The assembly may include dielectric layers forming a capacitor stack. A.C. current through the stack is matched in strength to the Seebeck-generated thermoelectric current circulating in each bimetallic layer. The resulting current snakes through the stack to cause Peltier cooling at one heat surface and heating at the other. A.C. operation at a kilocycle frequency enhances the energy conversion efficiency as does heat flow parallel with the junction interface.

12 Claims, 2 Drawing Sheets



United States Patent [19]
Aspden et al.
[11] Patent Number: 5,065,085
[45] Date of Patent: Nov. 12, 1991

[54] **THERMOELECTRIC ENERGY CONVERSION**

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[73] Assignee: Strachan-Aspden Limited, Edinburgh, Scotland

[21] Appl. No.: 429,608

[22] Filed: Oct. 31, 1989

[30] **Foreign Application Priority Data**

Nov. 18, 1988 [GB] United Kingdom 8826952

[51] Int. Cl.5 .... H02N 3/00
[52] U.S. Cl. .... 322/2 R; 310/306; 322/2 A
[58] Field of Search .... 322/2 A, 2 R; 310/306

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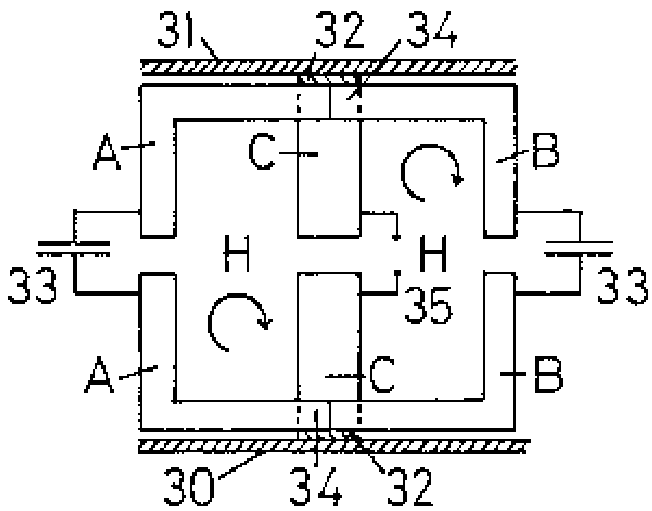
Primary Examiner—R. J. Hickey
Attorney, Agent, or Firm—Ratner & Prestia

[57] **ABSTRACT**

A thermoelectric energy converter incorporates thermocouples in a circuit carrying A. C. current via capacitors which provide electrical coupling but obstruct heat transfer between hot and cold junctions. The cyclic current oscillations through the capacitors are diverted by special circuits so as to be rendered asymmetric as current oscillations through the thermoelectric junctions. One such circuit includes the use of a diode configuration regulating current flow through different thermoelectric junctions spaced apart in the thermal gradient. Another involves the action of a unidirectional magnetic field having a polarizing effect on a three-metal thermoelectric junction.

15 Claims, 3 Drawing Sheet



APPENDIX II

'Solid-State Thermoelectric Refrigeration'

[This is the text of a paper submitted to IECEC by H. Aspden and J. S. Strachan, a summary version of which was presented in person by Dr. H. Aspden at their 28th Intersociety Energy Conversion Engineering Conference held in Atlanta, Georgia, U.S.A., August 8-13, 1993.]

This paper reports progress on the development of a new solid-state refrigeration technique using base metal combinations in a thermopile.

Thermoelectric EMFs of 300 μV per degree C are obtained from metal combinations such as Al:Ni, assembled in a thermopile of novel structure. By providing for thermally driven Thomson Effect current circulation in loop circuit paths parallel with the temperature gradient between two heat sinks and also for superimposed transverse current flow driven through a very low resistance path by Peltier Effect EMF, an extremely efficient refrigeration process results.

With low temperature differentials, one implementation of the device operates at better than 70% of Carnot efficiency. It has the form of a small panel unit which operates in reversible mode, converting ice in a room temperature environment into an electrical power output and, conversely, with electrical input producing ice on one face of the panel while ejecting heat on the other face.

An extremely beneficial feature from a design viewpoint is the fact that the transverse excitation is an A.C. excitation, which suits the high current and low voltage features of the thermopile assembled as a stack within the panel.

A prototype demonstration device shows the extremely rapid speed at which ice forms, even when powered by a small electric battery, and, with the battery disconnected and replaced by an electric motor, how the ice thus formed melts to generate power driving the motor.

The subject is one of the two innovative concepts which were the subject of the paper No. 929474 entitled "Electronic Heat Engine" included in volume 4 of the Proceedings of the 1992 27th IECEC.

The technology to be described is seen as providing the needed answer to the CFC gas problem confronting refrigerator designers. From a conversion efficiency viewpoint this device, which uses a solid-state panel containing no electronic components and a separate solid-state control unit which does contain electronic switch and transformer circuitry, outperforms conventional domestic refrigerators. Since it has no moving parts and contains no fluid, its fabrication and operational reliability promise to make this the dominant refrigeration technology of the future.

However, the scientific research and development of the underlying principles have a compelling interest and pose an immediate challenge inasmuch as recent diagnostic testing has pointed to a feature inherent in the prototype implementation that has even greater promise for future energy conversion technology.

This paper will address the subject in two parts. Firstly, the prototype will be described together with its performance data. Then, the ongoing development arising from the new discovery will be outlined.

General Operating Principle

The research was based on the use of a commercially available dielectric sheet substrate which had a surface layer of aluminium bonded to a PVDF polymer film by an intermediate layer of nickel. This gave basis for the idea of applying a temperature differential edge-to-edge to promote thermoelectric current circulation by differences in the Peltier EMFs at the opposite edges of the film.

However, the nature of this material, which was intended for use in a piezoelectric application and so had a metal surface film on both faces, gave scope for crosswise A.C. excitation, as if it was a parallel plate capacitor. Of interest to our research was the question of how the transverse A.C. flow of current through the bimetallic plates would interact with the thermoelectric current circulation.

Our finding was that the underlying D.C. current circulation which tapped into the heat source thermoelectrically was affected to an astounding degree once the A.C. excitation was applied. Whether we used frequencies of 500 kHz or 10 kHz, the thermoelectric Peltier EMF generated by the Al:Ni thermocouple was of the order of 300 μV/°C, which was 20 times the value normally expected from D.C. current activation.

It may be noted that, with the thermoelectric aspect in mind, the PVDF substrate film used was made to order, being specially coated with layers of nickel and aluminium to thicknesses of the order of 400 and 200 angstroms, respectively. This was intended to provide a better conductance matching for D.C. current flow in opposite directions in the two metals, it being optimum to design the test so that heat flow from the hot to the cold edges of the film would, by virtue of the Thomson Effect in these respectively electropositive and electronegative metals, suffice to convey equal currents in the two closed path sections without necessarily drawing on the tranversely-directed Peltier EMF action.

It was hoped that the latter would contribute to the A.C. power circuit by a push-pull oscillatory current effect whereby heat energy and A.C. electric energy would become mutually convertible.

A full explanation of the commutating effect obtained by combining matched current flow of the transverse A.C. and the in-film circulating D.C. is given elsewhere (Aspden and Strachan, 1990 and, Aspden, 1992). However, Fig. 1 may suffice to represent schematically the functional operation.

Fig. 1(a) shows how bimetallic capacitor plates separated by dielectric substrates are located between hot (T') and cold (T) panel surfaces with electrical connections at the sides of the panel. Some of the plates are floating electrically, being coupled capacitatively in series, whereas the connections linking an external circuit through an SCR oscillator switch circuit form a parallel-connected capacitor
system.

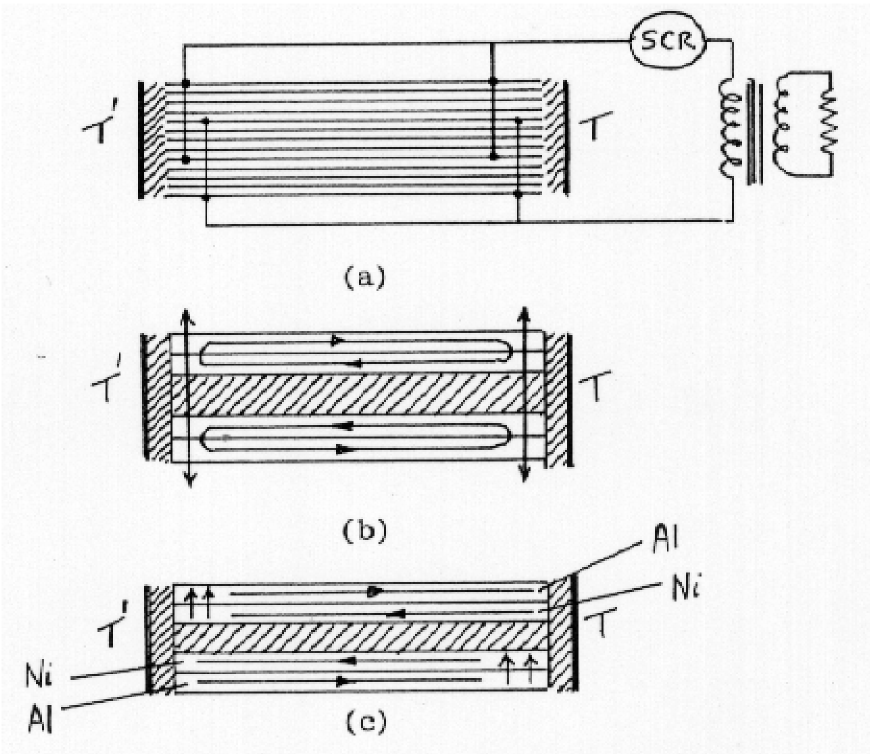


Fig. 1. Thermoelectric Circuit

Fig. 1(b) shows how D.C. current circulates in two bimetallic plates with a matching superimposed transverse A.C. current.

Fig. 1(c) applies when the A.C. current flow is in the upward direction.

The point is that, in alternate half cycles of the A.C., the current flow operates to block the D.C. flow at one or other of the thermocouple junctions whilst segrating the Peltier heating and cooling on their respective sides of the panel.

This has several very interesting consequences.

Firstly, it is found that the Peltier EMF is directed into the A.C. circuit, which being transverse to the thin metal film, is a low resistance circuit with high but virtually loss-free capacitative impedance.

Secondly, by diverting the electric power generated thermo-electrically, the D.C. current flow in the planes of the metal films was virtually exclusively that of heat-driven charge carriers. The current was sustained by the normal heat conduction loss through the metal and so did not detract from thermoelectric conversion efficiency by drawing upon the generated electric power.

Thirdly, and most unexpectedly, it was found that the current interruption precluded the formation of what we termed 'cold spots' at the Peltier cooled junctions. These latter spots arise in any normal thermocouple owing to concentrations of cold by Peltier cooling in a way which escalates so that the junction crossing temperature of a current is very much lower than that of the external heat sink condition. This stifles the thermoelectric power in the D.C. thermocouple and it was our discovery that the cyclic interruption of the flow by the transverse excitation technique accounts for the transition to the very high 300 μV/ºC thermoelectric power. The latter has been observed consistently in all three prototypes built to date and in diagnostic test rigs using the Al:Ni metal combination.

Fourthly, however, the eventual testing of operative devices, though performing overall within Carnot efficiency limitations, awakened special interest because there had to be something most unusual about the temperature profile through the device if the best performance measured was to be bounded by the Carnot condition.

Our research is now casting light upon that latter aspect and may herald a major breakthrough in energy conversion technology generally. However, even without the latter, the technology as developed to date does already justify commercial application in refrigeration systems and that is the primary focus of this paper.

Development History

The project has been slow to progress from its inception. One of us, Edinburgh scientist, J. S. Strachan (formerly with Pennwalt Corporation) assembled the device as a small flat module with 500 layers of bimetallic coated PVDF film. It was formed in a 20 by 25 series-parallel connection array which was a design compromise to enhance the capacitor plate area, whilst matching the A.C. excitation voltage and the current rating to the switching circuitry and dielectric properties of the PVDF.

The device performed remarkably well when first tested, without requiring transitional stage-by-stage development to overcome problems. This had the effect of putting in our hands an invention which worked better than we had a right to expect but left us at the outset not knowing precisely how the different elements of the device were really contributing to the overall function.

More important, however, though the thermoelectric operational section of the device was at the heart of the action, the implementation which used the PVDF dielectric and a capacitative circuit posed problems that were seen as formidable but yet were only peripheral to the real invention. There was also some doubt as to whether the properties of the PVDF had a direct role in the energy conversion. There was difficulty in planning in cost terms the onward scaling-up development, owing to the perceived problems of switching high currents at the necessary voltage level and frequency.

Commercial pressures and the limited resources involved in what became a privately sponsored venture to develop the invention, combined with the barrier posed by the switch versus thermoelectric design conflict, halted R & D and led, sadly, to the project falling into a limbo state. This was until interest was aroused by the publication in the latter part of 1992 of the above-referenced 27th IECEC paper (Aspden, 1992) and by the article in Electronics World (Aspden 1992).

Sponsorship interest in the R & D concerning heat-to-electricity power conversion has now revived, led also by a demonstration made possible by the building of a third prototype which incorporates 1,000 PVDF substrate thermocouple capacitor plates and which provides the following test data.

Refrigeration Performance Data

All three prototype devices built to date exhibited a remarkable energy conversion efficiency. They all operated with different switching techniques and different design frequencies.

The first prototype was dual in operation in that it was bonded to a supporting room-temperature heat sink block and the application of ice to its upper face resulted in the generation of electricity sufficient to spin an electric motor. Conversely, the connection of a low voltage battery supply to the device resulted in water on the upper surface freezing very rapidly.
Had this first prototype been assembled the other way up it would have been easy to use calorimeter techniques and measure heat-electricity conversion in both operational modes. As it was, an attempt to chemically unbond the device from the heat sink resulted in corrosion damage which destroyed the device.

The second prototype was built, not for self-standing dual mode operation, but expressly to test the heat to electricity power generation efficiency with variable frequency. It was not self-oscillating and, as it did not function in refrigeration mode, it offered no test of refrigeration efficiency. It gave up to 73% of Carnot conversion efficiency in electric power generation with room temperature differentials of the order of 20º C.
The recently constructed third prototype is superior in its electronic switching design and works well in both electric power generation and refrigeration modes.

There is, however, a circumstance about its operation which means that, for this particular demonstration prototype, according to its intrinsic magnetic polarization state, it works more efficiently in one or other of its conversion functions. This particular third prototype operated with higher Carnot-related efficiency in the electric power generation mode than in the refrigeration mode. Also, for the same reasons, and an additional factor concerning the power drawn by the electronics and impedance matching internal load circuitry, the overall external efficiencies are very much lower than can be expected in a fully engineered product implementation.

The refrigeration performance data presented below is, therefore, a worst-case situation and will, without question, be improved upon in the months following the date when this text is prepared.

The device included an SCR switching circuit which was self-tuning and ran as an oscillator powered from electricity generated from melting ice in power generation mode or drawing on a battery supply in the refrigeration mode. However, the power taken up by this circuitry was factored into the overall performance, meaning that the thermoelectric core of the device had to be functioning at higher efficiency. Because the electric demands of the circuit were high in relation to the small demonstration thermoelectric core unit to which it was coupled.

The active heat sink area of the device was about 20 sq. cm and a typical test involved a frozen block of 6 ml of water. A test performed after the lower heat sink had settled to a temperature of 25.6º C involved pressing the block of ice in a slightly melting state onto the upper heat sink with a polystyrene foam pad. The output voltage generated was fed to a 3 ohm load. It took 9 minutes for the ice to melt, during which time the measured output was a steady 0.67 V. These data show that a heat throughput of 3.7 watts generates electric power of 0.15 watts with temperatures for which Carnot efficiency is 8.6% This indicates performance overall of 47% of the Carnot value.

It is noted that the 73% value obtained with the second prototype applies to a device which did not incorporate an oscillator demanding power but had simple electronic switching controlled by, and drawing negligible power from, an external function generator.

To test the refrigeration mode, 3 ml of water was poured into a container on the upper surface of the device and a battery supply of 7.2 V fed to the SCR resonator with a limiting resistor now switched into circuit to protect the SCR during its turn-off. This resistor reduced the efficiency further. The circuit drew 6.3 watts and the water froze in 73 seconds.

Since convection was minimal the water closest to the surface froze first and this immediately formed an insulating barrier which would mean operation thereafter at a significant subzero temperature at that heat sink during most of those 73 seconds. However, the overall temperature difference ignoring that temperature drop in the ice was 26^{o} C, associated with a cooling power of 13.7 watts for an electric power input of 6.3 watts. This represents a coefficient of performance of 2.17 or 21% of Carnot efficiency. Cooling action at below minus 40^{o}C has been demonstrated.

Based on such worst-case data, which neverthless applies to a simple solid-state device and compares well with the coefficient of performance data of domestic refrigerators, it can be assumed that the technology is capable of meeting production requirements of non-CFC refrigerators and domestic air conditioning equipment.

Outlook following Breakthrough Discovery

Diagnostic test work has proved that the device operation is independent from the piezoelectric or pyroelectric properties of the PVDF substrate used. Given that the action is truly that of the Peltier Effect, there should be current circulation in the bimetallic thin film productive of magnetic polarization. By detecting such polarization as a function of the applied temperature differential one can verify this situation.

It is to be noted that our early research had shown that the thermoelectric EMF could, under certain circumstances, be greatly affected by the application of a magnetic field to the thermocouple junctions. Accordingly, the tests aimed at sensing thermoelectrically-generated magnetic field effects had a particular significance. Furthermore, we had some interest in the Nernst Effect by which a temperature gradient in a metal in the x direction, with a magnetic polarizing field applied in the y direction can develop electric field action in the mutually orthogonal z direction.

It has become, therefore, a subject of research interest to examine how a bimetallic interface subjected to a transverse magnetic field and a temperature gradient in the interface direction affects the circulation of thermoelectric current between the metals.

What we have discovered that is of great importance to the development of the solid-state thermoelectric refrigerator is that the setting up of a temperature gradient in the bimetallic interface plane between two contiguous metal films will produce a magnetizing field which readily saturates the metal if ferromagnetic. Thus the nickel film in the prototypes tested becomes strongly magnetized in one or other direction according to the direction of the temperature gradient.

When this magnetic field is considered in the context of the Nernst Effect it is seen that it can lead to a transversely directed EMF governed by the product of the temperature gradient and the strength of the magnetic polarizing field. This tranversely directed EMF then contributes a bias active in the individual metal and, being in the same transverse direction, supplements or offsets the Peltier EMF in the prototype implementations.

Remembering then that the heating and cooling actions in the operation of the prototype devices are governed by current flow in metal which is, adjacent the respective heat sinks, in line with or opposed to the action of an EMF, one can see how something new has appeared on the technology scene of thermoelectricity. By using heat to generate current circulation, which in turn generates a magnetic field to provide ferromagnetic polarization, a powerful Nernst EMF set up **in the metal** can act as a catalyst in supplementing the junction Peltier heat transfer action associated with EMF across a metal interface.

This may well be the action which accounts for the very high thermoelectric conversion efficiency we have measured.

In order to quantify this as it may apply to the prototypes we have built, note that a 400 angstrom thickness of well-magnetized nickel subjected to a temperature drop of 20ºC across a metal length of 2.5 mm, implies a Nernst EMF of the order of 6 mV across the 0.04 micron nickel thickness.

Though small, this is significant alongside the Peltier EMF across a junction, but the really important point is that this Nernst EMF **is set up in the metal** and not across a metal junction interface. In that metal, owing to the free-electron diamagnetic reaction currents within the nickel and around its boundary, which offset in some measure the atomic spin-polarization of the ferromagnet, there is then scope for some very unusual thermodynamic feedback effects. Those diamagnetic reaction currents which are themselves powered by the thermal energy of the electrons have a strength related to the magnetic polarization and so exceed, by far, the thermoelectric current flowing across junction interfaces. The heating and cooling processes transfer power between the heat sinks in proportion to current times voltage and the in-metal action within the nickel could therefore generate very significant thermal feedback, thereby greatly enhancing the efficiency well beyond that of the normal thermoelectric bimetallic junctions.

This action only results where one of the metals is ferromagnetic and the configuration of the device is such that an applied temperature gradient promotes internal circulation of thermoelectric current around a closed circuit able to develop a magnetic field in the nickel directed transversely with respect to the temperature gradient.

Conclusions

The exciting prospect for future development of refrigeration techniques centres on the possibility that the feedback process can be greatly enhanced by using thicker metal films. It is hoped, therefore, that the research reported here will soon advance to probe the limits of efficiency that are possible with this new solid-state refrigeration technology.

In this connection the truly exciting prospect arises from the possibility that the efficiency barrier set by the Carnot criterion can be penetrated.

To understand this, note that the Peltier EMF on the hot side of a thermocouple is proportional to the higher temperature T' and that at the cooler side is proportional to the lower temperature T. For a given current circulation the heat energy extracted is proportional to T and the net input of electrical power is proportional to T'-T.

This is the reason why the coefficient of performance has a Carnot limit of T/(T'-T).

Now, if there is a thermal feedback action that is regulated by a Nernst EMF and we can contrive to assure that the forward transfer of heat arises from a uniform temperature gradient in the ferromagnetic metal, then the Nernst EMF is the same on both sides and the amount of heating on the hot side is, in theory, exactly equal to the amount of cooling on the other side.

There is conservation of energy with negligible net energy input but heat transfer from the cold to hot heat sinks and this implies a very high coefficient of performance not temperature-limited according to the Carnot requirement.

This, therefore, is the challenging possibility that looms in sight and is heralded by the rather fortuitous discovery of the surprisingly high performance characteristics of the Strachan-Aspden base metal thermoelectric power converter.

The Strachan-Aspden device uses what the inventors see as conventional physics, albeit with the innovation of combining transverse A.C. excitation with D.C. thermocouple excitation. However, it does seem that in some curious way the device happens to have features which bring some new physics to bear. By producing a thermally-driven current crossing a strong magnetic field in metal the Lorentz forces on that current develop a transverse reaction EMF in that metal. The combination of that transverse Nernst EMF with a circulating current confined within the metal can, it seems, operate to transfer heat thermodynamically, working through the underlying ferromagnetic induction coupling in the metal. This is somewhat analogous to the way heat energy is somehow diverted into electricity in being routed between the hot and cold heat sinks in a conventional Peltier thermocouple circuit. It does, however, introduce new physics to the technology of refrigeration and offers great promise.

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APPENDIX III

The Strachan-Aspden Invention: Operating Principles
[October 1989 Report]

The object of this Report is to merge a review of the status of the project at the time the primary research was abandoned in 1990 with an evaluation of the design options for taking the project forward. Appendix III, together with IV and V, comprise extracts taken from an earlier Report dated 23rd October 1989 and prepared when the project was most active. These provide background information.

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INTRODUCTION

Imagine a panel fitted like a sheet of glass into a window frame but serving as a silent solid-state heat engine which uses electricity to cool the room in summer and heat the room in winter with the high efficiency of a heat pump. Imagine the same panel fitted into a glazed enclosure designed to trap atmospheric radiation to develop a temperature difference across the inner and outer surfaces of the panel and using the trapped heat to produce electricity.

The Strachan-Aspden invention provides the technology needed to fabricate such a panel and brings with it a quite interesting challenge. This challenge is a design problem. The task is that of deciding between a mode of construction that has been tested in prototype form or one that needs some research in advance of development but should prove superior from a commercial viewpoint. The task is to scale down an internal operating voltage and increase internal current flow coupled with conversion to a pulsed d.c. mode of operation rather than having a resonant circuit sustaining a.c. oscillations through the dielectric of a capacitor.

The R & D activity had just begun to address this problem when the Scottish small-business entrepreneurs who undertook initial development deserted the project as their other business ventures failed. This has meant that an invention which could make a major contribution in the effort to free the world from polluting energy technology became virtually dormant.

The merit of the invention can be judged from one simple technical fact. Operating from a room temperature source of heat and melting ice the tested prototype device was able to generate electricity at close to the Carnot efficiency limit by a technology utilizing the thermoelectric power of base metals **at a rating equivalent to 20 kw electrical power output per kg of metal in circuit**. In a non-developed hand-fabricated form, the device performed at 73% of Carnot efficiency. This is not optimum performance and is far from exploiting the full design potential.

The invention opens up a wholly new field of technological opportunity. It arises from a major scientific breakthrough which involves a totally unexpected discovery. In original conception the invention aimed to use the properties of a dielectric film as a barrier to heat loss by thermal conduction and the bimetallic coating on the film as a thermocouple circuit to convert heat into electricity. In reality it was discovered that the transverse oscillatory current excitation of a thermoelectric circuit produced an astounding effect on the thermoelectric power of the base metal combination.

1989 RESEARCH PROGRESS REPORT

[This section is copied from the 23rd October 1989 report]

"The plan during 1989 was for Strachan to engage in detailed research and onward development of the technology involved with a view to consolidating the patent position by year end.

The research phase has not been without its traumas, essentially for two reasons. Firstly, there was a set-back in that to perform certain tests on the prototype device aimed at measuring efficiency at an elevated temperature it had to be detached from its heat base. Secondly, in attempting this using a chemical solvent to separate two parts, the chemical found its way into the main structure which, lacking in foresight on this possibility, had not been sealed against such contamination. This upset its operation; it was a lesson learned, but at that stage a set-back to the development plan. It was not then possible, without rebuilding, to really get the full measure of the performance properties needed to comply with the initial programme. The question at issue was one of controlling temperature differential on a sustained basis with measured heat throughput rather than monitoring a small piece of ice as it melted by sucking heat from the environment, some of which was being intercepted to produce electricity in transit through the device.

Even before this set-back many experiments on components were performed to test operative features in isolation, with the early recognition that something totally unexpected was involved. A very substantial increase in thermoelectric EMF per junction, far in excess of reference data indication, had been achieved thanks to the particular operating technique adopted in the prototype. However, in spite of these progressive steps, the onward development necessitated a firm measure of the minimal operating efficiency of the basic device and, though the eventual products will be far easier to assemble, a small panel was made which closely conformed in design with the original but included certain modifications excluding what by then had come to be regarded as possibly non-essential features. This was a gamble, especially as the construction was very intricate and time-consuming when done by hand, with ongoing circuit tests during assembly to assure proper current distribution and unifomity of response. However, in the event, the device, once completed, did perform with equal or better results than the original version.

Happily, in confirming the new design assumptions made during the first months of 1989, the tests on this second device proved to be a major step forward and justified the filing of a third patent application in September 1989.

The second set-back proved how wise it was to have held back on early publication. The onward research investigations showed that what had been a primary design feature intended to block heat loss and so improve efficiency was not directly effective in that role, at least in the way we intended. Indeed, a fortuitous discovery had been made by proceeding on that assumption and the phenomenon involved had had the same effect, but not for the reason first believed. Instead of physically obstructing heat flow through the device, as had been intended, the operative technique actually converted almost all the heat into electricity before it reached the point of no return and so allowed very little to cross by thermal conduction and so escape as waste.

It was only after this discovery was made and an understanding reached concerning the process involved that it became possible to begin to consider disclosing to the scientific community, not just what had been achieved, but why it works so well.

This disclosure is being made now that the initial applications for foreign patent rights have been registered and the purpose is expressly to attract interest from those who have the resources to help in the development of this new energy technology. It is only by such shared action on an equitable commercial basis that the benefits of the Strachan-Aspden invention can make their full contribution in helping to reduce the world's energy pollution, whilst conserving the chemical qualities of fossil fuel resources for future generations."

The above text, quoted from the 23rd October 1989 report was prepared as a confidential document. The sponsors used the report to try to attract investment in their overall business interests and shortly thereafter ceased to fund R & D on this invention. Apart from initial costs of overseas patent applications, the funding that had been provided had been mainly that needed as salary by Scott Strachan whilst involving him as a consultant on other projects. As yet, therefore, this important energy invention has not had the benefit of serious development funding.

The research effort up to October 1989 had concentrated on simplifying the assembly of a prototype test device using the bimetallic coated film which could also serve as a capacitor dielectric. The immediate objective was to measure the heat-to-electricity energy conversion efficiency and explore the design criteria involved. The inventors were, however, mindful that the principles of operation of the device did not really depend upon capacitative operation and the current limitation which that implied. It was deemed possible to extend the technology to structures which involved an all-metal through-circuit for electrical power and some plans were made for building such all-metal structures for bench testing. Had the research been active in 1990 this alternative would have been thoroughly tested so that a choice could have been made as to the best mode of implementation in a production assembly.

It is noted that no formal product design proposal, with costing that could be used in a business plan, was drawn up in the 1989 period. Strachan was engaged on the preliminary functional testing to assess the performance and determine the optimum techniques and choice of materials. Without this information, one could not price either the market value of a product or its manufacturing cost. Even now, product costing is not really possible until the through-metal-circuit R & D investigations have been completed. The fact that a 20 kw rate of electrical power generation can be delivered by 1 kg of metal, drawing on a temperature differential of 20^{o} C, is the best indicator that it must be possible to build an operational unit that can be costed low enough to justify a very large sales volume. The real question now concerns the best configuration of the metal used and the best choice of metals.

THE STRACHAN-ASPDEN INVENTION

[The section in quotes is copied from the 23rd October 1989 report]

The following is a technical description of the principles underlying the Strachan-Aspden invention written on the assumption that it would form the basis of a lecture by Harold Aspden to an audience who would later witness a demonstration of the operational device by Scott Strachan.

"Before outlining the technical nature of our invention there is one very significant point that I think is worth registering at the outset. The test device on which our company was founded used the thermoelectric properties of contact between two base metals, aluminium and nickel, to produce electrical power from a low grade heat source. A temperature difference of 20 degrees relative to room temperature was sufficient to produce a steady power output of one fifth of a watt per cubic millimeter of metal in the thermocouple circuit. Scaled up, that is 20 kw per kg of metal. It did this with an efficiency that was well above 50% of Carnot efficiency for this temperature range. This is as good as internal combustion engine performance where the fuel burns at more than 2,000 degrees.

This is an invention which should have been made 50 years ago as part of the solution of the electronic age. As to the patentable merits of the invention, it has been said that even a simple invention can be judged highly if 'a long felt want' is satisfied. No one can deny that we need a breakthrough in the pollution-free energy field and what I have to disclose is not quite so simple.

The device is essentially a flat panel that can be fitted like a window or used as a heat exchange interface in an engineered installation to convert heat energy into electricity or to use electricity to cool one face of the panel and heat the other face.

It is simply a panel with an electric supply lead. All that there is between the two faces of the panel is a laminar structure of metal with some insulation, together with a small electrical transformer and an electronic control unit connected to the supply lead via a switch.

What is special, however, and what causes this device to be a revolutionary breakthrough in energy technology, is governed by a combination of two special features. These we have called:

(1) DYNAMIC EXCITATION FEATURE
(2) TRANSVERSE COMMUTATION FEATURE

There is also a third feature which has been used in the prototypes to enhance efficiency even further, but which will only be used in very special products. This is termed:

(3) THIN FILM ENHANCEMENT

Basically, we are talking about a thermoelectric system using either the Seebeck Effect or its converse, the Peltier Effect. By connecting different metals in an electrical circuit and positioning the respective junctions on the hot or cold side of the panel, the passage of D.C. current is related to the thermodynamic effects. Energy can be converted in this way, as is well known, but not, until now, with an efficiency that has such overwhelming implications in the field of energy technology.

The thermocouple working in Seebeck mode operates to extract heat from one junction and inject heat at the other junction. The balance of energy is electrical in the sense that an EMF or voltage is set up at the cooled junction and this can deliver output power in the electrical circuit, provided it is smaller than the back EMF or reverse voltage at the heated junction.

In efficiency terms, the operation is governed by the fact that the heat absorbed or produced at a junction is proportional to the junction temperature measured on the absolute scale, that is referenced on -273 degrees centigrade. Therefore, if one junction is at -3 degrees centigrade (270 K) and the other at 27 degrees centigrade (300 K), we can produce 300 units of electricity from the cooling effect at the hot junction but have to give back 270 units of electricity by heating the cold junction. The net gain is electricity, in theory, could be 30 units of electricity for the price of a 270 unit thoughput or 300 unit input of heat energy for these low temperature conditions. These high numbers of heat energy units should not be regarded as energy waste. They relate to what is called 'enthalpy', which is a measure of heat content referenced on 273 degrees centigrade below zero and even ice has an enormous heat content on this basis of reference.

What has just been described is the so-called Carnot efficiency. It is 10% for the 30 degree temperature differential considered. It works either way, in the sense that if electricity is supplied rather than produced, the input of 30 units of electricity can cause a transfer of 270 units of heat from the outside temperature source at -3 degrees and heat a room to 27 degrees. This is the Peltier mode of operation and it provides a tenfold gain on the use of the electricity in an electric heater, assuming full Carnot efficiency. Operating at 50% of Carnot efficiency, a 10 degree heating can be achieved with only 7% of the power needed by an electric convector or radiator.

The reason we do not see such Peltier heat pumps used on a large scale for domestic heating or power generation purposes is, very simply, that it has not been possible to achieve an adequate level of performance relative to the Carnot limit.

Technically, the obstacle has been the need to find materials which can be used to form thermoelectric junctions having a high Peltier coefficient. This is the factor relating the power conversion at a junction with the amount of current passing through. It is measured in millivolts at room temperature. The dilemma facing this technology is that if base metals such as copper, iron, aluminium etc are used to form junctions, the EMFs involved are very small. However, the electrical conductivity is good and this helps to reduce losses. Unfortunately, in such metals good electrical conductivity goes hand in hand with good thermal conductivity and then we lose heat by leakage through the metal circuit between the hot and cold junctions. For base metals this has been seen as a 'no win' situation, because efficiencies of the order of 1% of Carnot efficiency are representative of practical performance.

For these reasons, the attentions of the last half-century have concentrated on special metals, alloys, and semi-metals or semi-conductors. The price paid for accepting poor electrical conductivity of perhaps one thousandth that of copper has been rewarded by a much reduced thermal conductivity and a very much increased thermoelectric power. The EMF involved is typically in excess of 200 microvolts per degree with a Peltier coefficient of 60 millivolts at room temperature. Such devices are useful for special applications, where small current throughput and low efficiency are of no consequence, but their general use as Peltier heat pumps or electric power generators has been limited.

A typical state-of-the-art power generator using junction materials formed from alloys of bismuth, tellurium, selenium and antimony has a design specification that recognizes a maximum operating efficiency of 22% of Carnot when opeating with a high temperature differential of 300 degrees using a source at 600 K. The electric power produced, assuming perfect accord with the design specification, is of the order of 0.1 kw per kg of metal used to form the thermoelectric junctions.

Practical applications depend upon the energy throughput rate as well as efficiency and what is being offered by the Strachan-Aspden technique is so far ahead of state-of-art technology on both these counts that one must wonder how the technology could have gone so far adrift in missing the real potential of the Seebeck effect.

Some words from the book 'Direct Energy Conversion' by Professor Stanley Angrist bear upon this:

> "At the time of Seebeck's work, the only devices available for producing electric current were extremely weak electrostatic generators. Fifty years passed before steam engines drove electromagnetic generators. It was, undoubtedly, electromagnetism that caused succeeding generations of physicists and engineers to lose interest in the curious effects of thermo-electricity. The only widespread use of the effect was in the measurement of temperatures by means of thermocouples. It is difficult to say how the history of electrical engineering and electronics would have developed had Seebeck's discovery been widely employed."

Those researching this field today seem to have been attracted by the empirical discovery of new materials and have gone astray in not researching the basic question why metal junctions have such low thermoelectric power. This is very curious, bearing in mind that classical thermodynamics theory tells us that the theoretical power of base metal combinations is of the same order as that of these special materials.

I must admit, however, that though, with hindsight, we can bring this problem into focus, we did discover the solution only when we were performing diagnostic tests on our principal prototype. In short, we had built something that worked too well and we were wondering why.

The point rests on the question of whether the metal used increases in electrical conductivity or decreases in conductivity as temperature increases over the operating range. In base metals conductivity decreases with increase in temperature. This means that at the cooled junction the decrease in temperature improves conductivity. Now, if the electric current flowing through the junction is uniformly distributed this will simply mean that the junction has a uniform cooling across its interface. However, if, as occurs in electrical discharges in gases, the flow tends to be in short-lived filamentary surges, there is the real possibility that a current could develop a non-unifom pattern of cooling. A current flow concentrated at one position would form a 'cold spot' in the junction interface. The electrical conductivity there would increase and so the current would favour that path of least resistance and become locked on the cold spot. This could drive the temperature so low that the effective temperature governing Carnot efficiency is not what we see from the external actions.

In other words, owing to the increase in electrical conductivity with drop in temperature, the thermoelectric power falls far below the theoretical potential of the metal junction. There is therefore an enormous loss of efficiency when base metals are used in thermocouples in what has been conventional technology.

Why does this not affect the special materials as well? The answer is tha such materials do not have the same temperature characteristics. The p-type alloy bismuth-telluride (25%) with antimony-telluride (75%), and n-type alloy bismuth-telluride (75%) with bismuth selenide (25%) have, for example, electrical conductivities which reduce the temperature if operated above 300ºC. Such a temperature characteristic means that cold spots cannot form. Therefore, if we want to use base metals, with high energy throughput, the only way we can hope to get high efficiency is by somehow preventing the cold spots from forming in these materials. This is exactly what we achieve by the DYNAMIC EXCITATION FEATURE. Its effect is to increase the thermoelectric power of an aluminium-nickel couple from 17 microvolts per degree to a value well in excess of 300 microvolts per degree. Since this factor operates as a squared effect, because it drives proportionally more current and puts proportionally more voltage behind it, the electric power becomes hundreds of times greater than expected on conventional design criteria. This, therefore, is a major advance because it allows us to use basic metals with high capacity for delivering current, rather than expensive compositions with very limited energy throughput capacity.

What is the DYNAMIC EXCITATION FEATURE? In simple terms, this is a technique by which, instead of causing a steady D.C. current flow through the junctions, we interrupt the flow several thousand times per second in such a way that the current flow through the cooled junction relocates rapidly and before the non-uniform temperature or cold spot condition can develop.

The advantage is that we get the kind of thermoelectric power (i.e. voltage) from aluminium-nickel junctions that is available from bismuth-telluride, but, for comparable dimensions, the higher electrical conductivity of the base metal device allows more than one hundred times as much active power (wattage) to pass through. This takes us well forward technologically, but the TRANSVERSE COMMUTATION FEATURE which will now be described advances performance even further, so far in fact that we can trim back our design objectives on efficiency to simplify the manufacture and so reduce the cost of this technology.

The conventional design of a thermoelectric device involves having two distinct junctions between the two metals, one junction being at a higher temperature than the other. The metal between the junctions merely serves as a conduit for electric current and, unfortunately, provides a channel for heat loss by thermal conduction from the hot to the cold junction. Rather than trying to develop special materials which facilitate flow of electric current but obstruct heat flow, we followed another route. We also had in mind that a really good commercial device could hardly take in heat and produce electricity if the materials were not good conductors of heat. After all, the heat has to get into the device before it can be deployed into electrical form.

Our device uses two metal layers which interface over the whole distance from the hot side to the cold side. We then set up a thermoelectric current which it drives around the closed circuit formed by the interfacing metal layers. We accept the full measure of heat conduction through the metal by allowing it to travel through the full length of the metal layers. However, note that the route taken by the heat is never further away from a junction interface than the thickness of a metal layer. This means that the heat has repeated opportunity to be effective in generating electric power as it progresses along the junction interface. This is a feature vital to success. Unlike the conventional themopile where, once clear of the hot junction, the heat travels to the cold junction to be dissipated, we ensure that it has repeated 'bites of the cherry', as it were, en route to that destination, with the effect that very little even reaches the point midway where the current flow reverses. By 'reversal' is meant flow from metal B to metal A, whereas initially it was flowing from metal A to metal B.

This feature has a remarkable effect on efficiency because virtually all the heat supplied is converted into electricity. The $64,000 question, however, is how we intercept the electrical energy flow around the closed loop circuit formed by the two contacting metal layers and so gain access to that electricity before it is all dumped back into heat over the interface area where the thermoelectric current flow reverses.

This is where the 'transverse' excitation aspect of our invention holds the key to a successful energy converter. As can be seen from Fig. 1, we stack bimetallic layer upon bimetallic layer to build a stack between a hot surface and a cold surface and the external current flow involves a transverse current flow through the whole stack.

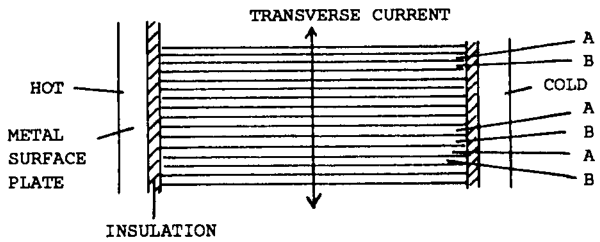

Fig. 1

The point then to keep in mind is that at the interface between the two metals forming each layer there is a thermodynamic effect causing a voltage to act from metal A towards metal B and this voltage varies across the layer according to the local temperature. It is greater, the higher the temperature. Because of this there is an imbalance of voltage from point to point in the heat flow direction across the contact interface in each layer when a temperature differential exists between the side faces of the stack. This imbalance causes current circulation in the sense shown in Fig. 2, where one layer is presented in enlarged form.

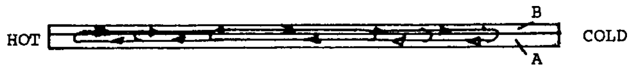

Fig. 2

All this does is to cool one side and heat the other, with the result that the metal conducts heat from the hot side to the cold side.

However, now suppose that we provide a channel for transverse current flow up or down the stack. This means current flows transverse to heat flow but, in this layered arrangement, it augments or opposes the thermoelectric current as it traverses a junction, depending upon the direction of flow of the transverse current. The channel for this transverse current is assured if there is good interface contact between all metal layers in a stack formed by metals A, B, A, B, A, B etc in sequence. Owing to the symmetry of the system a current travelling right in metal B will have to overcome the same potential barrier or back EMF at the cold junction whether it goes up or down the stack. However, we cannot have some contributing to tranverse current flow by going up the stack in one part and elsewhere having some going down the stack. Either the current all goes up or all goes down or there is no transverse current flow at all and the thermoelectric current flow is everywhere confined to its own bimetallic layer.

The current will take the path of least resistance, or will it? If there is an external resistive load connected in the transverse current flow path, then the easier route for current will be the closed circuital track shown in Fig. 2. Some small amount of current should flow either up or down the stack, because the external circuit offers a supplementary route for current. However, this will not give us scope for causing cyclic interruption of the primary junction current, nor will it give access to any real power output. Indeed, without the dynamic excitation, the voltage driving the circuital current in Fig. 2 is very low. Nevertheless, the circuit is a bistable system and how it behaves when relying solely on the thermoelectric voltage produced by the heat input is not the same as its response when a voltage surge up or down the stack governs the action.

Given a trigger effect which causes a transverse current surge up or down the stack, the junction current can be interrupted by a fast cycling switch in the external circuit and, once this happens, the full high powered thermoelectric action comes into effect, but this is a condition only effective if the transverse current is strong enough to exceed the normal steady state junction current. Given some intrinsic inductance or capacitance to sustain transverse voltages which carry the action through the zero current transient states, the device can become locked into the dynamic excitation mode to deliver an electrical current powered by the full thermoelectric action. In this mode the current flow is represented by the snaking flow shown in Fig. 3.

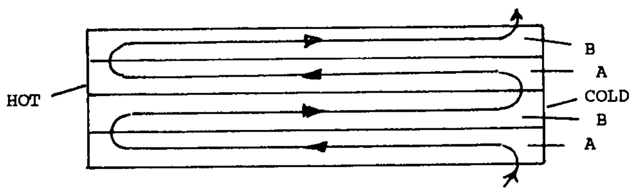

Fig. 3

The device actually works and exhibits extremely high efficiency in converting heat energy into electrical power output. Indeed, the capacitative versions of the device which have been constructed use bimetallic layers less than 0.1 micron in thickness (one micron is a millionth of a meter) and 300 such layers of one square cm area interleaved with 28 micron thick dielectric could generate 300 milliwatts of electrical power using just over one calorie per second of heat input at 40 degrees Centigrade and output at 20 degrees.

This is quite remarkable, bearing in mind that even these temperatures and their differentials are so low. It is even more remarkable when one realises that the power generated is at a rate in excess of 20 kilowatts per kilogram of metal used to form the thermoelectric circuits. This capacitative device does, however, make use of the enhanced electrical conductivity of thin films, which accounts for the very high efficiency obtained.

To bring the design parameters into perspective it is useful to consider a formula for the figure of merit Z normally applied to thermoelectric systems. This is presented in Fig. 4.

$$Z = \beta\alpha^2\sigma\gamma/K$$

FIGURE OF MERIT Z TRANSVERSE COMMUTATION FACTOR β
THERMOELECTRIC POWER (VOLTS/DEGREE) α SPECIFIC ELECTRICAL CONDUCTIVITY (MHO-CM) σ
THIN FILM ENHANCEMENT FACTOR γ THERMAL CONDUCTIVITY (WATT-CM) K

Fig. 4

This formula, when multiplied by the operating temperature, in absolute degrees Kelvin (say, 300 at room temperature) is a measure of the potential electric power generated as a ratio of the heat conducted from the hot junction to the cold junction and so wasted. This assumes operation with a low temperature differential and allowance has to be made for the duality of the metal paths, which are in parallel for heat flow and in series for electrical current flow. This tends to reduce the ratio by a factor of 4. Also, the potential electric power output depends upon the load resistance as related to the intenal resistance of the device.

All in all, therefore, to build a viable thermoelectric power converter the Seebeck coefficient α has to be as high as possible. The Strachan-Aspden devices tested so far are offering α values in excess of 300 microvolts per degree centigrade using base metals for which the bulk specific electrical conductivity σ is in excess of 100,000 mho-cm and the specific thermal conductivity about 2 watt-cm. On these figures, at the temperature of 300K, the formula gives near unity ratio of electrical power to thermal power lost.

However, the Strachan-Aspden technique earns its qualities by virtue of the factor β and also the factor γ. These are the coefficients representing the effects of the transverse commutation feature and the thin film feature, respectively. Each of these factors is a unit of magnitude giving ten-fold benefit.

The electrical conductivity of a thin film of a few hundredths of a micron thickness can be more than 10 times greater than the bulk value. Such film was used in the main prototypes tested. We did not measure the factor γ, because the bimetallic thin film material was available commercially with a rated electrical resistivity of 0.1 ohm per square. It comprised thin film layers of aluminium of 0.02 micron thickness and nickel of 0.04 micron thickness. Knowing the bulk values of σ as given by reference books, the value of γ was estimated as being about 10 from these data.

Concerning the factor β, this represents the repeated 'bites at the cherry' effect as heat gets repeated opportunity to convert into electricity as it is conducted into the device. For conventional thermocouples where the temperature drop between junctions is linear, β is unity. However, we had a system in which the temperature was changing much as depicted in Fig. 5.

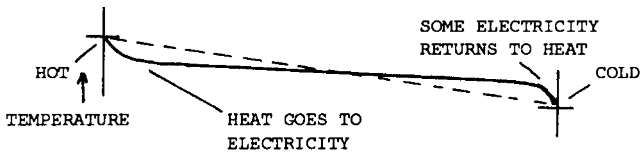

Fig. 5

The dotted line represents the linear temperature profile and the curve the profile we are exploiting. β is a measure of the conventional temperature gradient of the dotted line as a ratio to the minimal temperature gradient midway between the junctions. The latter is a measure of the heat energy going to waste and the much larger gradient of the full curve at the hot junction is a measure of the heat energy entering the device before conversion into electricity. Because the midway gradient is much lower than the linear case, we have a high β factor and because it is very much lower than the input temperature gradient we have a very efficient device capable of taking in far more heat than a conventional device.

I believe that I have said enough to outline why the Strachan-Aspden thermoelectric power converter works so well. The ongoing research relates to how far we can compromise on the thin film factor γ with a view to using thick metal layers and relying exclusively on the β factor of the transverse commutation feature. Unquestionably, our primary products will use the dynamic excitation feature to get the advantages of power from base metals, but we foresee also the use of special metals as well, coupled with designs based on the β factor.

I should like to end by describing how, even before we filed our first patent application or got involved commercially, we got a measure of the β factor applicable to our first demonstration device. Very simply, we had built a small panel having metal faces and layers of thin metal film rnning from face to face but embedded in an insulating dielectric. Looked at in the direction of heat flow, the metal and dielectric were side-by-side, with the metal presenting a cross-section amounting to about one five hundredth of that of the insulator. Such a device, therefore, was not, in thermal conductivity terms, a through-metal conductor.

To get a measure of its properties, we put an ice cube of standard size on the upper metal face and attached the lower face to a commercial heat sink base at room temperature. The ice melted, partly by heat absorbed by air convection from above, partly by heat loss by thermal conduction through the intervening insulation and partly by heat conduction through the metal. It took in excess of 20 minutes to melt completely. This was with the output leads from the device unconnected, that is, on open circuit. I knew from a test at home that such an ice cube on a metal work surface took about 5 minutes to melt and took 30 minutes on a Formica-topped kitchen table. The point of interest then was that when the same sized ice cube was used on the device with the output leads connected to an electric motor or a resistor load, the time of melting reduced to between 3 and 5 minutes. The motor stopped running, of course, soon after the ice had completely melted, but the message from these very simple measurements was clear testimony of a very high internal efficiency in the generation of electricity from heat. There being no independent electrical power supplied to the device and the ice being the only perturbing influence, the connection of the electrical load had diverted more than 80% of the heat energy around the wired load circuit and this was via a capacitance. That 80% and more of power was electrical power and most of the other 20% of heat conduction was seemingly unnecessary loss because much of it was due to extraneous convection or heat conduction through what was unnecessarily thick dielectric insulation.

It was from such a very simple test that we knew the β factor had to be 10 or more, but we were carried along by that empirical performance and, may I say, that was so high that, for a time until we could make more precise measurements, mainly of temperature, we thought we had achieved the impossible, by going above 100% of Carnot efficiency.

As it is today, in our best performing thin film prototypes we still have difficulty measuring just how close we are to the ultimate Carnot efficiency.

Concerning thick film designs, which do not have the high thin film conductivity feature, our research is progressing in sustaining the themoelectric voltages achieved by the DYNAMIC EXCITATION FEATURE and exploiting the β gain by the use of the TRANSVERSE COMMUTATION FEATURE."

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Concerning the latter comment about thick films, this was a theme which this author (H. Aspden) urged at the time (October 1989), but this was shortly before the R & D funding ceased and the test facilities closed when the other business interests of the sponsors failed.

This author did, independently, seek to experiment with a small test unit in which thin nickel plates plated on both sides with copper were bonded into an integral assembly for resistance testing. It did not function as hoped when subjected to a small temperature differential.

However, this was a first attempt at a time when thoughts were on the collapsing sponsorship and it later became evident that the test external circuit facility used lacked the necessary current capacity to cope with current oscillations at the requisite frequency and strength.

The test apparatus used was also unable to sustain a significant temperature gradient in the metal owing to metal thickness being too large and it had, at the time not occurred to this author that it would have been better to drive a moderate current oscillation through the structure and look for a cooling effect attributable to the Nernst action.

Evenso, in this latter regard, the nickel sheet material used in these experiments would, with its copper plating, have posed the same problem that has now (1994) been encountered in a much larger test device, namely the fact that a multiple bimetallic interface in a series circuit can, without an initial temperature gradient to prime the action, avoid the Thomson Effect current diversion and thereby generate junction heating that is not segregated from the Peltier cooling.

The author's current research which will be described in Energy Science Report No. 3 is now directed along a track which aims to overcome these particular problems in an effort to avoid transverse current excitation through a dielectric medium whilst constraining heat flow to be transverse to the current and EMF attributable to the Nernst Effect.

APPENDIX IV

The Strachan-Aspden Invention: Test Results
[October 1989 Report]

This report is a copy of the TEST REPORT presenting the status of the Strachan-Aspden Energy Converter project on 19th October 1989, as included in the 23rd October 1989 document.

Introduction

The device tested was built expressly to verify design criteria, essentially to check that we were right in eliminating certain design features present in the first demonstration device. The tests confirm our theoretical assumptions.

In order not to alter too much in this stage of development, the same commercial bimetallic coated dielectric was used and the same physical dimensions of the thermocouple junction interfaces. These are not optimum, particularly concerning thickness of metal layers and possibly concerning choice of the actual metal combination as well as the length dimension between the thermal surfaces.

However, whereas the operating frequency was 500 kHz with the first device, the present device runs at 18 - 25 kHz, depending upon load and voltage output rating. Such frequencies impose design constraints, which will not be a problem if we can build a non-capacitative device now predicted as a possibility using the verified design principles.

The primary objective of the tests reported here is not to see whether the efficiency of the device assures its commercial viability as it stands, because we can certainly design to achieve a far better power rating and a simplified technique of fabrication. The objective is to measure the efficiency of the device for operation over a moderate range of ambient temperature, with atmospheric, geothermal and waste heat in mind as energy sources.

The measure of efficiency and study of factors affecting efficiency are vital to projecting commercial applications and designing products for manufacture, especially concerning the Peltier mode for refrigeration and cooling and also for conjecturing products which store electrical energy as heat and regenerate electricity. The use of plastic film as a substrate for the bimetallic layers has limited the temperature range of the particular device tested. Also, owing to the specific form of the electronic switch system built for the device, tests in the refrigeration (Peltier) mode did not prove viable for reasons in no way related to the device structure and measurements of efficiency of Peltier mode operation have been deferred.

An overall performance figure, allowing for all circuit losses and output voltage transformation, which can be relied upon for conversion of heat to electricity with temperature differentials as low as 10 to 30 degrees Centigrade is 70% of Carnot efficiency.

The Structure of the Test Device

The device is constructed from 300 layers of 28 micron thick high dielectric constant plastic film as a substrate for sputtered junctions of two layers of metal, nickel and aluminium. Each layer had a width of 3 cm and a length of 0.25 cm, the width dimension and edge forming the surface interfacing with the heat exchange surfaces. The aluminium film was 0.02 micron thick and the nickel film 0.04 micron thick.

These 300 layers therefore defined 300 junctions each having exposure to a hot and a cold face of the panel form of the assembled device. These were divided into 20 groups of 15, each group comprising 3 sub-groups of 5 layers. Each such sub-group is bounded by a layer of copper as an electrode for wiring the device into the chosen series/parallel configuration. Thus, in effect, there were 15 layers stacked to form a series capacitor unit and 20 such units were wired together to form a parallel connection of the capacitor units, ultimately having connection to an external circuit by two supply wires.

The copper electrodes were narrower than the junction length to reduce their thermal conduction contribution to the heat path. The entire stack of 300 junction layers was bonded on to a ceramic powder composition base to give good heat coupling but to ensure electrical insulation from the heat sink base an upper aluminium sheet was bonded by an electrical insulating heat sink compound to the upper surface of the stack to form the other external heat surface.

When a temperature differential is set up between these external heat surfaces there is a thermoelectric charging of each junction which contributes to the energy storage in the capacitor stack. Indeed, as a function of the temperature differential, the capacitor so formed has a greater effective capacitance than would be expected purely from calculation based on the dielectric constant and dimensions of the assembly. Typically, the capacitance can be of the order of 1.5 microfarad for this very compact assembly.

The thermoelectric current acts to sustain the recharging of the stack as it is systematically charged and discharged by a fast operating switch unit. For the test to be described this unit comprised five electronically controlled switches operating in parallel expressly to ensure that there is a minimal loss of electric potential, inasmuch as the EMF of a mere 15 junctions was being switched. The control of this switch bank involved a frequency generator input of negligible power. Note that it was a specific feature of the first prototype test device that it included a self-activated oscillator for switch control powered by the electric signal generated by the device.

The action involved, therefore, can be seen as one involving deploying thermoelectric power into the charging of the capacitor stack and then, as fast as possible having regard to the recharging speed, transferring the stored energy to an output circuit by a cyclic switching operation. Subject to the capacitative delays and charge storage aspects, the action can also be seen as one involving circulating thermoelectric currents in the bimetallic layers with a superimposed transverse current flow through the capacitor.

A high Q transformer winding is intermittently connected to the stack via the switches. This presents a low impedance into which the capacitor stack drops its thermoelectrically acquired charge. The secondary winding of the transformer then transforms the resulting voltage to a value which matches well with the load, both to give suitable measurement voltages and also to ensure that the load seen by the stack has a sufficiently low impedance to draw out the charge quickly. Note that the device has its own internal resistance and the load resistance has to draw most of the power.

Measurement Criteria

The device tested is a flat square metal-faced unit which has a pair of electrical input/output leads. Given a temperature differential across its metal faces an electrical power output is available. In terms of the heat input, this electrical output depends (a) upon the internal design structure of the device (which cannot be varied as part of the test) and (b) upon the manner in which the load circuit is electronically controlled. The latter control, though as just described working successively to charge and discharge the capacitor form of the device, also implements what we term 'dynamic current excitation' and this greatly enhances the power output. The A.C. power supplied is converted to D.C. and smoothed for measurement. The performance depends upon matching the load with the device to secure optimum output.

Basically the test to be reported is very simple. By feeding in a sustained amount of heat, controlled by electrically powering a small resistor in a liquid heat bath, the task is to reconvert some of that heat back into electricity as D.C. in an output load at a steady voltage and current. This will give basis for precision tests on power in and power out, but to assess the result obtained it is important to have a very good measure of the temperatures of the two metal faces. The temperature measurement poses problems, because, firstly, we must beware of any non-uniformity of temperature across the operative surfaces and, secondly, we must know the extent, if any, of any interference caused by the measuring device or probe.

Earlier test results had been clouded by the problem that the bounding 1 mm thick aluminium plate was not able to buffer the heat distribution to assure a uniform temperature, given a concentrated heat source (electrically energized carbon resistors) on the external face.

For this reason the initial measurements on the device described, which were unreliable in ranging from 50% to 100% of Carnot efficiency, according to test conditions, have been repeated using a stainless steel can containing water heated internally by a chain of four 10 ohm resistors. This can was specially built with a flat lower surface able to interface well with the heat surface of the device and was mounted thereon using heat conducting paste. Also, the whole structure was housed in a close fitting heat insulating container.

The temperature measurements involved calibrated platinum resistance probes registered by a digital voltmeter and were from time to time confirmed with an alcohol thermometer.

Peripheral Test Information

It was not part of the test reported here to repeat certain experiments that were made in the earlier development stages. Nor could we measure directly the thermoelectric EMFs in the sections of the stack built into the device. During construction it was part of the discipline of the assembly procedure to test each part-assembly of five junction layers to verify insulation and be sure that it was performing with the power of 2 millivolts per degree Centigrade when subjected to dynamic excitation. Any that did not match the uniformity requirements were rejected. However, as will be seen, the test data do tell us that this thermoelectric EMF is at work in the operating device because the output EMF from a stack is measured and the voltage at the output terminals is roughly equal to the internally produced thermoelectric EMF times the measured efficiency relative to the Carnot limit. This also means that the current output as a measure of junction current relates by this total thermal power to the potentials active at the junctions and so gives a measure of the thermoelectric power in the device.

This thermoelectric power is the crucial factor in our onward design of any products. It was 400 microvolts per degree Centigrade per junction pair in the above device and this applied to the thin film (0.02 micron aluminium on 0.04 micron nickel) assembly. The two metals had no intervening metal; they were vapour deposited. In contrast, earlier tests had shown that a stack of metal plates of iron and nickel of sub-millimeter thickness with

<u>soldered</u> junctions gave a thermoelectric power per junction of 118 microvolts per degree centigrade with dynamic current excitation. Given that we can reasonably expect iron and aluminium to present similar thermoelectric action when forming junctions with nickel, the question we need to resolve is whether that gap between 118 microvolts and 400 microvolts is due to the thin film aspect in the vapour deposited case or the adverse effect of the intermediate solder in the thick film test case.

The most important test data of interest, therefore, at this time and before products are designed and manufacture evaluated, are
(a) the actual efficiency for limited ambient temperature use of the device already constructed, and
(b) the thermoelectric power of a thick metal junction assembly with no solder connections.

This report addresses the first of these issues and the next report will deal with our findings on the other question.

The onward test programme must relate to the factors such as optimum film thickness and dielectric thickness in the vapour-deposited/capacitor system or thickness of a thick film version, optimum electronic design and excitation frequency as well as waveform profiles, choice of metals, structural dimensions (panel thickness) and electrical insulation/heat conducting spacing material at the interface of the external metal surfaces and the junction assembly.

The Test Data

These tests were performed independently by Scott Strachan and Harold Aspden during different periods in October 1989.

The Strachan tests were performed between 10th October and 12th October. The test results obtained by Aspden on 17th and 18th are those listed in Tables II and IV.

The test apparatus is as shown in Fig. 1.

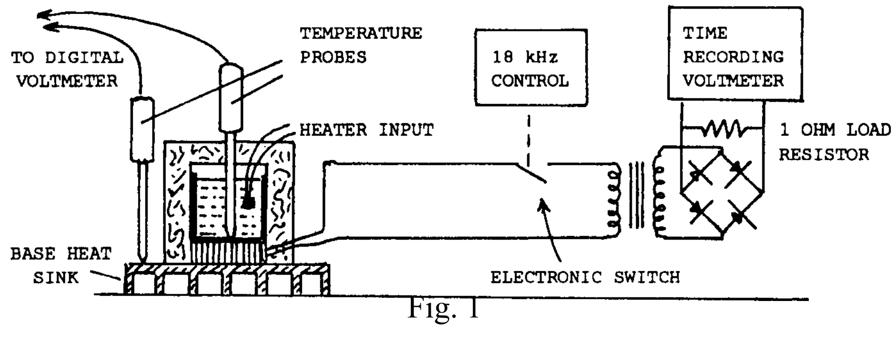

Fig. 1

Application of heat energy is via the medium of heated (or cooled) water in a container on the upper heat exchange surface and use of a commercial heat sink base at room temperature replicated conditions which would apply to production devices. The cold underside can be considered to be at an even temperature because it is mounted on a massive heat sink with a recognized high heat dissipation capacity.

The water heat sink provided a uniform temperature interface and this temperature was measured by a commercial platinum resistance temperature probe calibrated to give a measure of temperature via a digital voltmeter. A similar and separate heat probe was used to measure the temperature on the surface of the base heat sink.

Owing to heat transfer through the device, albeit mainly via the electrical conversion route, as Peltier cooling occurs at one face and Peltier heating at the other, it is inevitable that the actual temperatures at the working interfaces of the device will be slightly lower than the hot temperature measured and slightly hotter than the cold temperature measured. This means that the true efficiency relative to Carnot will be just a little greater than that calculated using the measured temperatures. No allowance is made for this in the test data, because the temperature drops involved would be present in an engineered installation and so the test results give an overall measure of effective efficiency which can be regarded as representative of commercial conditions.

Preliminary Tests

The following tests were conducted under steady-state conditions, that is, the rate of heat input was pre-set and temperature readings as well as electrical power output readings were made only after the system had stabilized.

TABLE I

TEST	HEAT INPUT			OUTPUT TO 1 OHM		TEMPERATURE		EFF.
No.	Volts	Amps	Watts	Volts	Watts	T'	T	%
1	6.64	0.179	1.19	0.125	0.016	33.8	20.0	30
2	9.16	0.244	2.23	0.280	0.079	40.4	20.6	56
3	11.22	0.298	3.34	0.450	0.202	47.5	20.8	73
4	12.60	0.337	4.25	0.520	0.270	53.4	21.0	64
5	19.00	0.530	10.07	0.720	0.518	62.2	23.0	44

****

The above readings were the first set of readings to be made on the device under proper laboratory test conditions using electronic test circuitry that was designed to operate essentially with power output voltage above 0.3 volts, which is a nominal threshold for effective operation of the germanium diodes used to rectify an A.C. output. For this reason, attention centres on tests No. 3 and 4. Concerning test No. 5, this fell short in measuring true efficiency for reasons to be discussed below, owing to a heat dissipation problem which set in above 55 degrees Centigrade and upset the measurement on the input side.

Immediately, however, one can verify the design assumptions by considering the ideal 100% of Carnot condition if applied to test No. 3. This would require all the heat energy input at the hot side to convert to electric power given by $N\pi i$, Where N is the number of junctions (300), π is the Peltier coefficient $\alpha\theta$ and θ is the temperature of the hot junction in Kelvin (320). With α as 400 microvolts per degree, this gives an input power of (38.4)i watts. Now, i is the junction current and we regard this also as external current, subject to allowance for the series/parallel junction combination and the transformer ratio. In effect, therefore, the 100% of Carnot situation can only occur if the heat power supplied at 320K is precisely such that it is 3.34 watts, which corresponds to a junction current of 87 milliamps. This flows in each of 20 parallel circuits to suggest a total current of 1.74 amps would suffice to carry all the heat input through as electricity.

This checks with the measured current of 0.450 amps if allowance is made for the 5:1 transformer ratio. In fact, this measure is 2.25 amps compared with 1.74 amps needed for 100% efficiency and this is 77% agreement (cf. the 73% of Carnot efficiency measured). This is very good agreement, also bearing in mind that the 400 μV/K thermoelectric power can be effectively diminished by parasitic current flow owing to the 20 parallel-connected circuits in the device and may need some offset for the partial action of the component added by the Thomson effect. The latter does not contribute to the Peltier heating and cooling at the junction proper, but does drive current as part of the thermoelectric power.

The measurements of current output in relation to heat input fit remarkably well and confirm the high thermoelectric power, α of 400 μV/K, that had been measured on a test basis as each five-junction part-assembly was built into the device.

It had been foreseen from theory that about 260 μV/K would be true thermoelectric power and about 170 μV/K could be due to Thomson effect. Therefore, a 60-70% effciency factor might imply a measured output voltage of the order of 250 μV/K. In test No. 3 the 0.450 volts came from a 26.7 degree differential and 15 junctions in series with a 5:1 transformer ratio. This works out as a junction EMF of 225 μV/K.

Concerning the drop of efficiency as more heat is fed into the device (test No. 5) it is found that the apparatus begins to lose heat from evaporation as bubbles form around the heater. This loss of heat is such that the apparent performance drops appreciably with increasing temperature. However, this is an artefact of the way in which the heat input is measured by the electrical heating of water. Evaporation on the input side of the device cannot be a fair factor in the test, which is only viable provided bubbles are not formed in the test heat input source or the latent heat carried away by those bubbles is somehow accounted for.

Load resistance versus internal resistance

The value of the load resistance, given a variable heat input rate, is an important consideration. The heat input determines the operating temperature and this, in its turn, determines the output EMF. The load resistor and this EMF determine the current output, but for optimum operation it is necessary for this current output to be the full junction current. It is possible for some junction current to be internally diverted by closed loop circulation between the metals forming a bimetallic layer. Such circulation would transfer energy from the hot to the cold junctions without the Carnot component being diverted for use in the external load circuit. However, the test bears out an assumption which emerged in the development of the 'cold spot' theory of the device. The expectation from this was that, at least when operating in the Seebeck mode under test, the dynamic current excitation developing the enhanced thermoelectric power would drive the junction current exclusively through the external circuit. On this basis, the only load matching consideration is how the internal resistance of the device relates to the load resistance in contributing to ohmic losses.

For the 1 ohm load condition of test No. 3 we can interpret the output of 0.450 volts as a measure of 0.090 volts on the input side of the 5:1 transformer. This is the output of 15 junction pairs and, for the temperature differential of 26.7 degrees, it implies that a thermoelectric power of 225 μV/K has reached the load circuit. Bearing in mind that a 400 μV/K thermoelectric power is known to be potentially active and that the 1 ohm load is a 0.04 ohm load on the input side of the transformer (owing to the squared effect of the 5:1 transformer ratio), this suggests that the internal load resistance is 0.03 ohms if there is no loss of potential. A value of 0.02 ohms is calculated from knowledge of the resistance of the commercial material used to build the device (see comment on this which follows) and this is probably the true value. Such resistance applies if virtually all the external current is flowing by snaking action through the thermoelectric junctions with very little internal closed loop flow detracting from that performance. These considerations tend to confirm the design assumptions used.

The internal ohmic heat loss is then estimated from the measured external current 0.450 amps, which scales to 2.25 amps for the input side of the transformer and this current in 0.02 ohms implies an ohmic heat loss of 0.10 watts.

This can be reconciled with the 0.202 watt output with an estimated 70% of Carnot efficiency, much as is deduced for test No. 3, especially as some of the ohmic heating at 0.10 watts is available for regeneration of electricity.

This discussion really aims to assess the scope for increasing efficiency further by future design which reduces internal resistance, it being important to understand the factors affecting performance in the design under test.

It now remains to reconcile the relatively low efficiency of test No. 1, for example, with that of test No. 3. This is easily explained simply because the germanium diodes used in the bridge rectifier connected to the transformer output absorb energy, becoming good conductors only as the forward voltage across them rises above 0.3 volts. This will present no problem in production thermo-electric devices because many more junctions than 15 will be connected in series and this will result in high performance relative to the Carnot limit, even with the low temperature differentials represented by test No. 1.

However, in the verifying tests to be reported below, this will be checked in view of the importance of applications working with quite low temperature differentials.

Calculation of internal resistance

The efficiency necessarily depends upon the internal resistance of the device. This may be calculated approximately using the fact that the 0.1 ohm per square specification of the bimetallic layer arises from parallel flow through 0.2 ohm per square of nickel and 0.2 ohm per square of aluminium. The device involves series flow through 300 bimetallic layers of width 3 cm and length 0.25 cm, but the current will not follow the longest route. This is somewhat less than 0.03 ohms per layer. The layers were connected 15 in series and 20 in parallel and this implies a total internal resistance somewhat less than 0.75 times 0.03 ohms or, say, 0.02 ohms. This is the value estimated from the measurement data reported above.

Verification Tests

These tests were performed by H. Aspden on 17th and 18th October. The first set of tests reported in Table II concentrated on the peak range of efficiency indicated by Table I. It was found that even a small change of heat input rate meant waiting for between 20 and 30 minutes to secure temperature equilibrium. The latter is vital to proper measurement of temperature. The temperature readings are believed to be correct to within 0.05 degrees Centigrade and, as far as can be judged, any error from making measurement at a surface point slightly offset from the actual operative thermal interfaces would mean that the efficency values obtained are 'worst case'. It is, therefore, felt that the efficiencies now registered are reliable in indicating what can be achieved in a commercial installation.

TABLE II

TEST	HEAT INPUT			OUTPUT TO 1 OHM		TEMPERATURE		EFF.
No.	Volts	Amps	Watts	Volts	Watts	T'	T	%

6	9.50	0.253	2.40	0.300	0.090	41.9	18.6	51
7	10.00	0.266	2.66	0.340	0.116	42.8	18.8	57
8	10.50	0.279	2.93	0.375	0.141	45.1	19.3	59
9	12.00	0.318	3.82	0.490	0.240	49.4	20.2	69
10	13.00	0.345	4.48	0.545	0.297	54.0	20.6	65
11	14.00	0.371	5.19	0.565	0.320	55.0	20.9	59

These tests reported in Tables I and II are characterized by the use of electrically heated water as the thermal input source, as opposed to an electrically heated metal interface. The object was to get more uniformity of temperature and so a precise indication of the true temperature. However, above 55 degrees Centigrade the water loses heat rapidly owing to vaporization and then the measure of heat input rate fails to indicate true efficiency.

The tests certainly reveal that efficiency of heat to electricity conversion of 70% of the Carnot level is a reasonable expectation with temperature differentials in the 30-40 degree range close to ambient conditions, but this is further supported by the tests in Table IV.

Based on test No. 10 a check was made of the effect of changing the dynamic excitation frequency. The operating frequency for the data in Tables I and II was 18 kHz. This had been chosen for optimum tuning of the circuits. As might be expected, there was a drop off in efficiency with reduction of frequency. The data given in Table III apply.

TABLE III

TEST No.	FREQ. kHz	THERMAL INPUT Watts	POWER OUTPUT Volts	Watts	TEMPERATURES T'	T	EFF. %
10	18	4.48	0.545	0.297	54.0	20.6	65
11	14	4.48	0.530	0.281	54.0	20.6	61
12	10	4.48	0.495	0.245	54.0	20.6	53

****

This test does not mean that the frequency has to be of the order of 18 kHz to obtain the highest efficiencies from the dynamic excitation. It is just that the capacitor structure of the particular test device with its transformer inductance and self-inductance has an optimum switching frequency. A problem ahead is to assess the best frequency for dynamic excitation giving the highest thermoelectric EMFs and then design the device so that the capacitance and inductance match this operating frequency.

The next set of experiments involved a change in the transformer from the one used in the above tests which had a 5:1 ratio to a new one with an 8.5:1 ratio. This required a 25 kHz excitation frequency for best response, owing to the change in inductance on the primary side.

The object of this change was to explore the loss of output power for very low temperature differentials, which loss resulted from a threshold cut-off in the germanium diode bridge rectifier circuit used to produce smoothed D.C. from the transformer output. The problem faced was due to the A.C. output waveform being of the form shown in Fig. 2. As the signal amplitude increases, more and more of the signal rises above the operating threshold of the diodes and, to get a realistic efficiency measure, substantially all of the signal has to lie above the threshold.

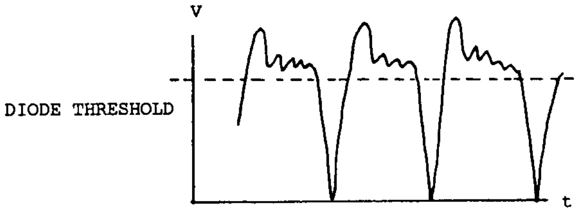

Fig. 2

The sole purpose of the following tests in Table IV was to check to be 100% sure that we still have an efficient converter using the temperature differentials of Test No. 1. This test has given 30% of Carnot efficiency with a 13.8 degree differential but the output voltage was below the diode threshold for a significant part of the dynamic excitation cycle. By stepping

TABLE IV

TEST	HEAT INPUT			OUTPUT TO 2 OHM		TEMPERATURE		EFF.
No.	Volts	Amps	Watts	Volts	Watts	T'	T	%
13	8.48	0.226	1.92	0.400	0.080	38.3	18.8	66
14	6.20	0.168	1.04	0.255	0.032	32.8	18.8	67

****

the voltage output up by the greater transformer ratio, a greater portion of the signal becomes effective in overcoming the bias in the diodes.

These data clearly show that the comparable results for tests Nos. 1 and 2 suffer from the diode cut-off, that the problem has been easily overcome by output circuit redesign and that efficiencies of 66% plus relative to the Carnot level are to be expected as the operating norm of the Strachan-Aspden converter, even when the temperature differential is only a few degrees.

Tests using iced water

It was possible to cool the heat sink base by immersion in a tray of iced water and hold the upper heat surface of the device at ambient temperature. The results (power output for a given temperature differential) were fully in accord with the performance just reported for similar small temperature differentials. The ice test of the first prototype device holds up in that electricity can be produced by melting ice. Such tests, however, do not give a measure of efficiency because the rate at which the ice is melting is difficult to measure. However, the efficiency must be as indicated in the tests of this report, because the device and its circuit only 'see' temperatures at the working heat surfaces.

Conclusions

The tests reported above are definitive tests on a Strachan-Aspden device using thin film thermoelectric techniques with dynamic excitation and transverse commutation in a capacitative assembly.

The tests aimed at determining efficiency. The efficiency results were typically 65-70% of Carnot level for differentials of temperature in the ambient range. The power rating measured in heat throughput rate was 2 kilowatts per square meter for a 20 degree temperature differential. The corresponding electric power generation with this very low temperature differential is 80 watts per square meter. However, efficiency, rather than throughput power, was the purpose of these tests and it is important to remember that the working metal involved in the test device is interfacing over only one part in 1000 of the total area of the heat input surface. As we adjust the metal film thickness relative to the dielectric and conceivably eliminate the dielectric, the full design potential can be exploited. It is such that the technology of the device can cope with any practical level of heat input per unit area that available heat sources (or heat transfer materials) can supply at the operating temperatures specified.

Concerning tests in Peltier mode, meaning input of electricity to cause heat transfer between the heat surfaces, this was not possible with the specific design of excitation control circuitry of the device just tested. The first prototype incorporated a self-tuning circuit which could adjust to give the best dynamic switching rate.

Such tests will be performed but until they have been performed either on the subject device or other implementations we cannot pronounce on the efficiency for Peltier mode operation. Our feeling is that it will be high, but perhaps not as high as for electrical power generation in Seebeck mode. However, high efficiency is more important for electrical power generation applications and an outlook of 70% of Carnot with more expected from production designs is very good indeed.

Footnote

Much of the research effort between February 1989 and July 1989 involved efforts to fully understand the relative roles of the factors which contributed to the working of the first prototype. It was a set back that an attempt at partial reassembly of that device to test efficiency had caused its destruction by internal shorting owing to chemical penetration. However, the new device, built in July-August 1989 period and modified according to the results of that research, now verify the design assumptions and have yielded the efficiency data. Thick-metal-film test converters are now under construction and once the tests on these are complete we will be in a position to project how best to proceed to a product stage.

Our patent position has been brought into line with these recent findings so that our main international cover will relate directly to design variations centred on the structure incorporated in the test device discussed in this report. Such cover also caters for what is expected to be a successful outcome on the thick-film embodiments.

H. Aspden: 22nd October 1989

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The above test report describes the status of a research test at a time when the interest centred on measurement of efficiency. In the diagnostic research phase which followed it was realised that there was a gain in performance that came from the Thomson effect driving current along the thin film by heat action. One did not need to generate electricity to sustain the full measure of current flowing and thereby eat into some of the useful power generated.

The problem, however, with the capacitative device was that the transverse current carried through the capacitor stack which was powered directly by the Peltier EMF was no doubt a distributed current across the section of the stack. In this case the capacitor implementation must involve joule heating owing to some current flow in the thin section of the metal film, as allowed for in the above analysis.

However, then the current traversing the junctions in the transverse direction is not concentrated at the edges of the bimetallic layers, as it could be in a modified non-capacitative implementation. The actual efficiency of the capacitor device found under these circumstances is quite remarkable and is at the limit of the what is conceivable from Peltier action owing to the temperature profile across the junction interface. Bear in mind that the temperature governing the Peltier action is not exclusively that at the

edges. This suggests that there is some other action involved in the device which contributes to enhancing the efficiency.

Research into this question points to a thermal feedback effect connected either with the Nernst Effect or with free electron diamagnetism, meaning a thermodynamically powered gyromagnetic reaction set up in conduction electrons in metals in opposition to the magnetizing effect arising from the Thomson effect circulating currents in the metal films.

The updating of this research report will therefore need to examine the theoretical factors involved and the very different design considerations which apply if one makes connection between the bimetallic films by metal conductive edge contact only, without the circuit path being through charge oscillations in a capacitor dielectric. Such a report update also may need to include an examination of the research implications if one designs the converter to over-excite the thermal feedback action, assuming that such an action is really adding to that efficiency. In principle these later developments point to a very much greater performance potential, having regard to the fact that we are exploiting temperature gradients in metal with transverse current excitation and not a power current flow through metal directly between junctions at different temperatures.

APPENDIX V

The Stachan-Aspden Invention: Thermodynamic Power Anomaly
[October 1989 Report]

D.C. THERMOELECTRIC POWER ANOMALY

The Strachan-Aspden invention shows that thermoelectric EMFs far greater than are expected from conventional textbook data are effective with A.C. operation. The reason for this needs to be understood in order to give one a measure of confidence in advancing the R & D effort needed to exploit this newly-discovered phenomenon.

The following scientific paper, which has not been published elsewhere, deals with this question.

ABSTRACT

The discrepancy between the theoretical and measured thermoelectric power of bimetallic thermocouples is explained on the assumption that current flow across the junction occurs in filamentary surges which concentrate the heating and cooling effects and so distort the effective temperature differential. The basic theory used conforms with that of more classical treatments, inasmuch as modern theory has adapted to cope with semiconductor materials which exhibit temperature effects quite different from those found in base metals.

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The theoretical thermodynamic value of the Peltier coefficient is shown by Ehrenberg [1] to be:

$$(\frac{kT}{e})\log(\frac{n'}{n}) \qquad \textbf{(2)}$$

where k is Boltzmann's constant, T is the junction temperature, e is the electron charge and n', n are the population densities of the free electrons in the two metals forming the junction.

The thermoelectric power of an individual junction is the same expression without the T term, being an EMF per degree of temperature.

In Table III of this Ehrenberg text [1] a tabulation shows the measured values of the thermoelectric power for various base metals referenced on the metal sodium. The data show that the discrepancy between the caluculated and measured values is a factor of 15 for Ag and Au, a factor of 21 for Cu, 51 for Al and 6 for Ni. Ehrenberg also deduces theoretical values for the Thomson coefficient, which makes an additional contribution to the thermoelectric effect and is a function of the rate of change of free electron density with temperature. Ehrenberg does not compare theory and experiment in this case.

In view of the potential benefits of efficient thermocouple devices in refrigeration avoiding the use of polluting CFC chemicals, there is now a pressing need to understand the fundamental reason for this discrepancy. The following investigation is part of an ongoing commercial research study into this problem, which has already revealed techniques by which to close the gap between the calculated and measured thermoelectric power, particularly for an Al-Ni thermocouple.

Equation (4) is derived on the thermodynamic assumption of a thermal pressure balance as between electrons in both metals. If, as with certain semiconductor thermocouple junctions, there are positive (p) and negative (n) charge carriers in the different conductors, the Peltier coefficient need not depend upon the ratio of carrier densities. If p-n annihilation occurs at one junction and p-n creation at the other, the current-related thermodynamic energy exchange is more consistent with a thermoelectric power corresponding to a Peltier coefficient of 3kT/e. Upon annihilation, for example, two carriers merge, each transferring its individual thermal energy 3kT/2 into electrical power, and so developing a net EMF E related to an energy Ee equated to 3kT.

For the Al-Ni combination, using equation (4), Ehrenberg [1] assumed a carrier density ratio of 21, which gives a logarithmic factor of 3.04. This implied a thermoelectric power of 265 microvolts per degree centigrade. Since then, however, carrier polarity data for the Hall effect, as revised, suggests that the Al-Ni thermocouple may have a thermoelectric power related to the p-n condition, which coincidentally gives virtually the same value. Thus, the very substantial discrepancies between observation and theory noted by Ehrenberg still apply, even for this Al-Ni metal combination.

It is possible that, though a predominant free electron population exists in a metal conductor, the electrical conduction properties are not, at every instant, related to the shared action of all the electrons. Imagine, for example, that the charges carrying current tend to concentrate their ordered motion collectively into a transiently relocating filamentary in-line flow through the conductor. This filament, which may comprise short and transiently discontinuous current elements, corresponding to charge concentrations, breaks up to be replaced by another such filament elsewhere so that, on average over a period of time, the flow appears uniformly distributed across the section of the conductor. In a sense, this physical picture is easy to justify because the electrons following at speed in the same direction along a common line, one behind the other, are less likely to be scattered by collisions.

Of course, such speculation has little value unless supported by tangible evidence. Force-free vortex filaments which appear on a nanosecond time scale feature in plasma research [2] and have led to analysis of the density and velocity distribution profiles of electrons and positrons in filaments [3]. However, so far as solid conductors are concerned, this filamentary action is not something that can easily be established. It may emerge from research into the properties of 'warm' superconductors or from research on the thermoelectric anomalies under discussion.

Firstly, with the plasma aspect in mind, it is known that the arc discharge in mercury arc rectifiers develops discrete cathode spots on the surface of the mercury pool. This means that the current divides into separate flows. These spots meander around but there is some mechanism by which the discharge breaks into discrete filaments of the order of 15-20 A in strength, as if this represents some critical current factor defining a single current filament.

Secondly, extensive researches by Hildebrandt [4,5] have shown that current as high as 30-40 A will divide between two separate anode-cathode discharge paths, with anti-phase modulation at a period of 15 ns, and that this effect is not caused by resonant circuit properties but is an inherent property of the conductive medium. Thus, in a plasma at least, this is consistent with a preferred filamentary current state in which the carrier flow is involved in what may be termed an 'inverse avalanche effect' as the conduction action concentrates into fewer carriers in a filament with a 15-20 A critical maximum current for continuous in-line flow.

It is now noted, without particular elaboration, that if a train of electrons form in line at equal spacing and move together to convey current along that line, then, if each one steps forward to the position of the electron ahead at the Compton electron frequency, the current carried is 19.79 A. This is simply ec/λ_c, where e is electron charge in coulombs, c is the speed of light and λ_c is the Compton wavelength.

This is such a basic physical quantity that we must indeed by very attentive to any scientific phenomenon which happens to point to a 20 A current threshold. It suggests a limiting value for the amount of current which can flow in a single filament. It suggests that current may be conveyed even through metal conductors in a burst mode in which it involves short filamentary current elements having a 20 A intensity over lengths reduced as necessary in proportion to the average current flowing through the metal.

More important, however, is the fact that such a current with electrons really in line at spacings as close as their classical diameters would imply a velocity of electron motion in the current direction of the order of the Fermi velocity of an electron gas. We assume this is possible, notwithstanding the classical Coulomb repulsion effects, embracing to some extent the idea that what is involved is electron displacement from electrically-neutral sites, as if electrons alternate with positive holes or as if electrons and positrons moving in opposite direction somehow carry the current. This proposition then suggests that a Fermi velocity, which is not a function of temperature, in some way powers the action. For a given metal this means that the electron speed along a filament is constant and that filaments of lower current strength than 20 A either comprise electrons or holes at proportionally greater spacing or what are, effectively, short discontinuous filamentary components. Possibly, filamentary vortex loops of circuital current may form, occasionally opening up to carry current forward through the conductor before reforming as closed loops.

Conceivably, therefore, even in a metal containing a high free electron density, the current flow might, at any instant, be carried by but a few of these electrons and even, given a relatively few mobile carriers, allow the positive 'holes' to make a current contribution by favouring a flow route which causes some ordering and displacement of the holes to set up current filaments nucleated by positive charge carriers.

Now consider such a current filament as traversing a bimetallic junction interface in a thermocouple. The Peltier heating or cooling will be concentrated in an extremely small spot defined by the zone taken up by the filament. Thus the temperature of that spot, which determines the Peltier coefficient cannot be the mean temperature we measure for the junction interface as a whole. Depending upon the relaxation time needed to cause the filament to relocate, the effective temperature active in determining thermoelectric power can be very different from that assumed.

A concentrated cooling effect at a spot in a junction interface must increase the electrical conductivity in the region of the spot and this alone could develop a crossing point of least resistance, which would tend to keep the current trapped in that position. An exception to this can be expected in certain semiconductors and alloys over temperature ranges for which resistivity may decrease with increase in temperature. Indeed, such materials tend to be those used in advanced thermocouple research, which itself implies that here lies the weakness of normal metals from the viewpoint of their application to thermocouples.

The Peltier coefficient is measured by supplying a controlled amount of heat to a junction cooled by the Peltier effect, based on a technique developed by Calendar [6]. For Peltier cooling the governing equation is easily formulated as:

$$\frac{\delta\theta}{\delta x} = \frac{\alpha\theta' i}{4\pi K x^2} \qquad \textbf{(3)}$$

This merely represents the gradient of temperature θ with spherical symmetry with respect to distance x from the point of action, given that K is the heat conductivity (assumed the same for both metals). α is the thermoelectric power (volts/ºC), θ' is the absolute temperature and i is the mean current.

When solved this gives:

$$\theta = \theta_o - \alpha\theta' i/4\pi K x \qquad \textbf{(4)}$$

The minus sign would be replaced by a plus sign if the current direction corresponded to Peltier heating.

We define a mean least value of x as x_o and, for ease of rough calculation, estimate this as the distance from the centre to the side of a square area of a cross section of filament. Thus, assuming N electrons per unit length of filament with n as the electron density:

$$n = N/(2x_o)^2 \qquad \textbf{(5)}$$

We further equate the energy of self inductance of the filament with the kinetic energy of the electrons, so that:

$$\frac{1}{2}Li^2 = (N)(\frac{1}{2}mv^2) \qquad \textbf{(6)}$$

where L is the standard calculable inductance 0.5×10^{-7} henries per metre, m is electron mass 9.1×10^{-31} kg and v is electron speed. From (7) and (8):

$$i/x_o = v\sqrt{(2nm/L)} \qquad \textbf{(7)}$$

The temperature difference between the mean junction temperature θ_o and the temperature θ' is then $\alpha\theta' i/4\pi Kx_o$ and, putting this in (5) gives:

$$\delta\theta/\delta x = (x_o/x^2)(\theta_o - \theta') \qquad \textbf{(8)}$$

The actual temperature effective at the junction, and the mean junction temperature, change and so scale in proportion. indeed, from (6):

$$\theta'(1 + \alpha i/4\pi K x_o) = \theta_o \qquad \textbf{(9)}$$

From (9) this becomes:

$$\theta_o/\theta' = 1 + \alpha(v/4\pi K)\sqrt{2nm/L} \qquad \textbf{(10)}$$

This means that this expression represents the factor by which the measured thermoelectric power or Peltier coefficient will underestimate the true value which really governs the thermodynamic action.

It is believed that v is independent of temperature, as already stated, and that it is also independent of current strength, inasmuch as N is the variable corresponding to effective current. We may use Fermi-Dirac statistics to estimate v, but the result is much the same if we appeal intuitively to the threshold current condition $I = ec/\lambda_c$ and estimate v as given by equation (8) when N is 2.66 10^{14} per metre. This corresponds to a line of electrons spaced by their classical diameter, as calculated using the formula of J. J. Thomson, a saturation condition that is relevant because the diameter was calculated by J. J. Thomson by equating kinetic energy with electromagnetic energy in the magnetic field.

It is found from this that v is 284 km/s. To estimate the factor (6) insert typical values for copper, eg. $n = 1.3\ 10^{29}/\text{m}^3$ and K = 400 watts-m/°C to find that the factor becomes:

$$1 + 0.12\alpha \qquad \textbf{(11)}$$

if α is expressed in microvolts per degree C.

Writing now the measured thermoelectric power as ε, we know that the factor just deduced is α/ε, so that if α is 144, as calculated by Ehrenberg for copper at 17° C, the measured value of ε which we 'think' is a measured value of α does, from (13), work out at 7.9. Somewhat similar results apply to Ag and Au, which have smaller n value and so a similar theoretical α value, but much the same K value. Note that equation (13) based on n being 60% that of copper and α being 100, say, gives ε as 9.7.

Ehrenberg gives, for Ag, Cu and Au, experimental values of ε that range from 6.9 to 7.2 microvolts per degree C, whereas the theoretical values range from 99 to 144 per degree C. This, therefore, is fairly well in line with the interpretation offered here.

Considering aluminium, for which α referenced on sodium, in theory, is 183, n is greater than for copper by the factor 1.6, K is measured as 210, and ε as measured is 3.6 in the same units. The same argument leads, via equation (12)) to an equation (10) factor 1 + 0.29α or a theoretical ε value of 3.4.

Thus, even for aluminium, for which the thermoelectric power discrepancy between textbook theory and experiment is a factor of 51, we see that the interpretation provided here reduces the discrepancy to a point where theory and experiment are virtually in full accord.

It is submitted that the filamentary current proposition discussed is highly relevant to thermoelectric action. As intimated above, commercial research aimed at reducing and, indeed, virtually eliminating the discrepancy in practical thermocouple circuits is proving successful. The secret is to use a.c. to prevent cold spots from forming and so choking off the thermoelectric power, this being a d.c. current symptom peculiar to metal thermocouples as opposed to semiconductors.

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APPENDIX VI

THERMOELECTRIC EXPERIMENTAL DEVICE CONSTRUCTION

The following is a copy of a text written by John Scott Strachan dated February 9, 1994 transmitted to U.S. researchers and project engineers as briefing material for non-confidential discussions held in Edinburgh, Scotland later that month.

It contains details concerning Strachan's fabricaton of the original test device of which this author had no prior knowledge and it is evident from this information that there is no easy and immediate route to developing this technology using the methods adopted by Strachan. This will therefore explain why Strachan has switched his attentions to other projects, leaving this author to pursue this thermoelectric research along lines closer to his own original perceptions of the invention which avoid use of PVDF substrate film.

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Strachan's account dated February 9, 1994:

The original device discovery happened accidentally and was the result of the construction of an ultrasonic lithotriptor. At the time Dr. Aspden and I were discussing the concepts of thermoelectricity and were trying to conceive methods of reducing the thermal wastage in such devices. I had constructed a few experimental samples but with little success. At the same time I was working on an idea for a sonic 'laser', a device to progressively amplify a travelling wavefront in a transducer with a view to creating a high intensity ultrasonic pulse from a low acoustic impedance.

The goal was to produce an intense compression pulse from a low acoustic impedance source for the delivery of a focused shatter pulse in kidney stones. The resultant 'sonic laser' units were to be placed in an array which would allow phase steering of the wavefront and the changing intensity in three dimensions to produce a versatile triptic pattern. This would allow the destruction of stones down to 1 mm in size with very little heating of the surrounding tissue. The further advantage of the low impedance of the source would be the ability of the array to 'listen' to the shattering of the stones and intelligently follow the crack growth with the peak intensity of the wave. Had the project been successful it would have reduced the treatment time for gall and kidney stones by a factor of ten or more and the lithotriptor itself would have had a market value of more that $100,000.

The device consisted of several stacks of high k PVF2 in a column, with an electronic circuit set to trigger a compressive pulse in phase with a pulse travelling through the stack, in order to synchronise the circuit and cope with the variations in acoustic impedance of the adhesives. I interleaved the PVDF layers with layers of recording tape. Thus, as the compressive wave passed through the stack, the motion of the recording tape could be detected in the next layer as a fluctuating voltage. As such, it could be used to trigger the next pulse in perfect phase, since the speed of the electromagnetic signal allowed advanced warning to the trigger circuit of the approaching acoustic wave.

It was a really neat idea and I was very proud of it!

The device worked well for brief instants but kept blowing the drive circuit. This seemed to occur when the stack was touched on one side. Since I had been thinking about thermoelectric devices and the stack resembled vaguely some of the ideas I had of trying to create a capacitatively-coupled thermopile (later it was proved that such a thing is inherently impossible)*, I wondered if there might be a thermoelectric explanation for the stack's strange behaviour.

The construction of the stack was as follows.

Materials:

(a) 28 µM PVF2, (D_{33} = 27, k = 18) having bimetallic coating of Ni and Al (Ni = 2200 angstrom, Al = 800 angstrom) and a resistivity less than 0.1 ohm per square.

(b) BASF metal recording tape poled manually in line with the long axis.

(c) ZAP ethyl cyanoacrylate adhesive (formula unknown).

(d) One strip 2.5 mm x 2.5 mm x thickness resonance 2MHz PZT 5a lead zirconate ceramic with silver electrodes.

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* This statement with its brackets is made in the February 9 1994 account by Strachan but the 'impossibility' relates to a thermopile involving only the Peltier Effect because the 'proof' amounts to saying that as much electric charge flows in one direction as in the other and so must cause at least as much heating at either junction as cooling. This has now to be viewed in a different context because the Thomson Effect introduces bias as between the junctions of each thermocouple pair and once the Nernst-Ettinghausen Effect becomes operative, particularly where one or both metals are ferromagnetic. [This footnote by H. Aspden].

(e) 10 layers of super-hard acrylic machined to a thickness such that the acoustic delay is equal to a half wavelength at the resonant frequency of the ceramic strip. A suitable material is available from Aerotech Laboratories in California.

Unfortunately, I do not have a detailed specification on this as the material I used was part of a free sample sent to Dick Ferren of Pennwalt Corporation.

The sound velocity in PVF2 is 2.2 mm per μs.

The BASF tape and the PVF2 were then treated with a 2% solution of tetra butyl titanate in petroleum ether to improve bonding. This process must be carried out in an arid atmosphere and then the surfaces should be exposed to a humidity of 100% or greater at a temperature of 40°C. The process is extremely tricky since, if moisture is present before the evaporation of the petroleum ether, the titanium will not bind through the metal layer on to the PVF2 or mylar. This can be diagnosed by the white powdery appearance of the surface. If successful the surface will exbibit a slight iridescence.

Once the petroleum ether evaporates and the iridescence is present the exposure to humid atmosphere takes place. This will sometimes produce a slight trace of the powdery surface but this may be washed off in petroleum ether or toluene. DO NOT USE ISOPROYL ALCOHOL!!!

Cyanoacrylate will not polymerise in the presence of protons, i.e. at any pH below 7 the surface of PVDF will release free protons in the presence of isopropyl alcohol and thus prevent secure bonding. The titanate layer helps to maintain a surface pH above 7 in a moderately dry atmosphere but can not fight the catalysis of the propyl groups in the alcohol.

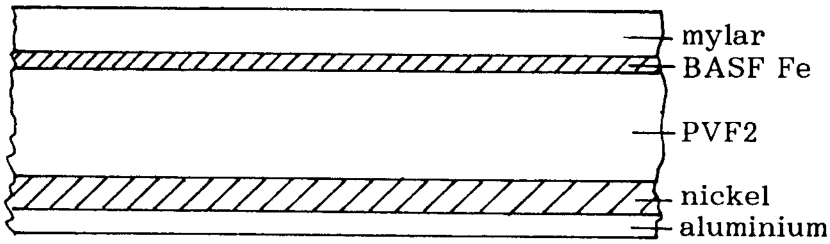

Fig. 1 Layered composition of laminate formed

The greater the care taken at this stage, the more chance of success later. Every single strip should be examined before lamination for any signs of wear on the surface or any trace of white titanate. Failure to do this will virtually guarantee delamination the instant any voltage is applied. This process is time consuming and the several thousand strips will take several weeks to laminate, even working ten to twelve hours a day. But skimping the preparation means that there is no chance of creating any percentage of intact stacks and the entire effort will be entirely wasted. The lamination jig surfaces should be positively charged PTFE. The layers may be added one by one for a period of time equal to one quarter of the anaerobic cure time of the ethyl cyanocrylate. Then a press is applied at a pressure of between 1 and 6 tonnes whilst an ammonia atmosphere is blown past the stack to catalyse curing. Then the process is continued. Time is the main enemy. Since each layer must be examined and the quarter cure time is typically 30 seconds, this is a very intensely stressful process. I managed to complete only one stack on the first day and had scrapped nearly a thousand layers in the process. Practice improved the situation.

The PVF2 and the BASF tape were laminated together layer by layer to reach a thickness of 0.55 mm, i.e. half λ at 2MHz. This process was repeated until a large number of stacks were produced. Next a 5,000 volt supply was connected across each stack and those that vaporised were discarded. A suitable breathing apparatus should be worn during this process since the fluorine gas emitted as the PVDF breaks down is highly poisonous. It is also corrosive and so the entire process should be carried out at a suitable location and well away from glass, since the hydrofluoric acid will cloud the glass, making you unpopular with your colleagues! The percentage of stacks that break down depends on the defect density of the original PVF2. That percentage depends on whether a gel colloid or suspension process was used during polymerisation. The use of gel tends to leave micro bubbles of gel in the PVF2, reducing the breakdown voltage.

The surface chemistry of a poled polymer is a constant problem since the creation of compound acetates with various metals can occur with very little encouragement. The passing of a current through the cyanocrylate often starts a cascade catalysis which, once started is unstoppable. This is worst with copper where even a few seconds of current will produce a sufficient 'seed' to result in the total acetisation of the metal within a month or so. With nickel the process is less easily turned on since a sulphate must exist before the process starts. The initial test voiltage does not usually initiate a corrosion and so the elements may be stored anaerobically and aridly for an indefinite period. Once the elements are subjected to operational voltages or are even accidentally squeezed, which produces enormous voltages in local areas, a gradual decay of metal begins. This will begin in spots surrounding any non-polymerised cyanocrylate. Such spots exist since, even with all the precautions described, certain free H^+ ions will be present preventing polymerisation. This is why such care MUST be taken. The metal layers can disappear in just a few hours if the defect density in the bonding layers exceeds 2 per cm^2. The reduction in decay time is exponentially proportional to defect density.

The remaining stacks were now measured for electrical conductivity and those that showed a resistance of greater than 0.001 ohm from side to side were discarded. The apparatus for measurement of the resistance is designed to cancel the apparatus resistance. The electrodes of the apparatus were a pair of steel slip gauges. This is needed in the ultrasonic device to prevent the waveform from distorting. **In the thermoelectric application this stage-by-stage testing is even more critical since it defines both the electrical and thermal conductivity of the stack**.*

Those elements discarded for resisitivity reasons were reground on the edges with a fine diamond wheel in liquid nitrogen to improve flatness and were set aside for an attempt at a slightly thinner stack. (As it happened these discards were lost and only found again at the end of last year [1993] when they were used to construct the third thermoelectric demonstration device.)

The original batch was divided into several sets of 50 elements.

Each element was coated with Emmerson and Cumming silver loaded epoxy and bonded to a thin copper or silver strip, top and bottom. Silver is preferable to prevent the production of copper acetate from the cyanoacrylate but I did not have a large quantity of this and by this time was pretty impatient to see if the device would produce the high power ultrasonic pulse I hoped.

Each element was then laminated to a layer of hard acrylic half λ thick as shown in Fig. 2 below.

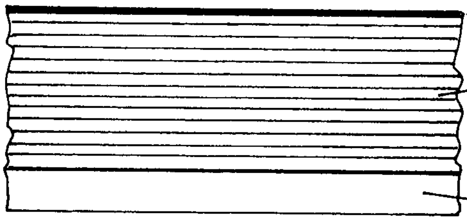

Fig. 2 Composition of bonded element

*

Emphasis here added by H. Aspden, this being the first reference to the thermoelectric properties and much of the foregoing description having concerned the fabrication of a structure intended to withstand mechanical oscillations at acoustic frequencies. The thermoelectric application requires the nickel and aluminium layers to remain intact and in mutual interface contact and does not require those metals to be as thin and fragile as they were in the process described by Strachan. [This footnote by H. Aspden].

These elements were then assembled as shown in Fig. 3, with the ceramic driver at one end.

Each element was then connected by its electrodes to a drive circuit. The ceramic transducer bonded to the end of the stack was connected to be pulsed by a conventional driver. As the wave passed through the stack an electromagnetic signal from the moving magnets triggered the pulses through the stack in a cascade. By adjusting the

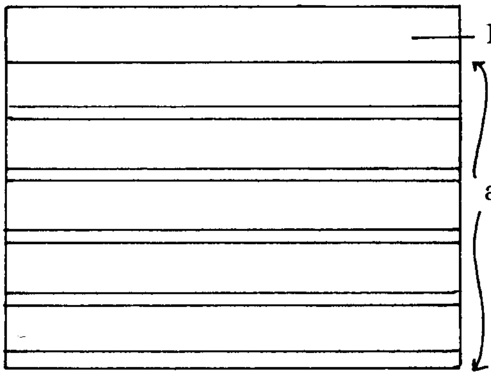

Fig. 3. Final stack assembly

threshold of the trigger circuit, the frequency could be tuned to match the oncoming wave. Thus, even though the delay through the stack was inconsistent due to the variation in the bonding thickness, the cascade of pulses could always be kept in phase with the advance of the compression wave. A straightforward sequential delay could not do this, which was why other attempts at 'sonic lasers' had failed to produce the expected amplification.

Everything worked fine except that as soon as the stack was moved, almost as soon as it was touched, the drive circuit would blow. This was surprising since this was no wimpy drive and had the capacity to deliver more than a joule per pulse. But closer examination revealed that the circuit was not blowing in the 'ON' cycle but in the 'OFF' cycle.

A sector of the stack was connected across an oscilloscope and the waveform in Fig. 4 was observed when a thermal gradient was across the stack while only noise was visible in the absence of the gradient.*

At first I naturally assumed that this pulse was a high impedance phenomenon, but I had to wait for a couple of days to investigate since it had blown the oscilloscope.

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* Emphasis added by H. Aspden.

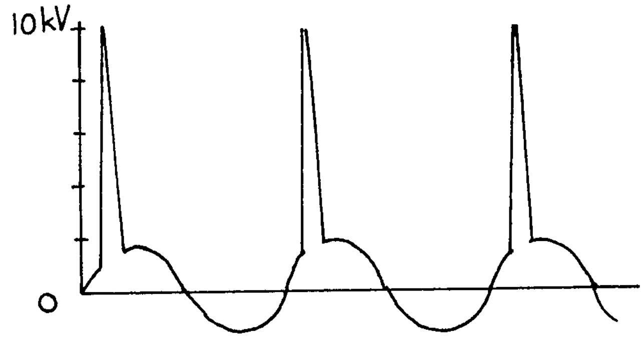

Fig. 4. Spike voltage waveform produced by thermal gradient

A charge amplifier arrangement with a virtual dead short was now attached to the sector of the stack and the waveform had the shape shown in Fig. 5. Note that both of these measurements are of a sector of the stack **not connected to the drive circuit**.

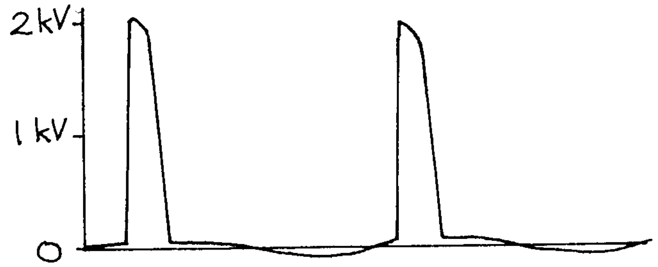

Fig. 5. Thermally developed spike voltage with circuit protection

This was very surprising. Clearly the spikes carried a lot of current and in fact even the impedance of the charge amplifier was too high to discharge the spike before it was driven off. As lower and lower impedances were tried it was eventually possible to discharge the spike in the 200 ns of its duration and get a measure of the number of joules involved.

This turned out to be broadly proportional to the temperature differential across the stack and reached a peak at about 0.05 of a micro joule at about 70° C temperature differential.

The lithotriptor circuit was redesigned to short out the stacks behind the wavefront but even the VMOS kept blowing in the 'OFF' state now, as the voltages were just too high. This was bitterly disappointing since the acoustic energy in the pulse from a single full

25mm stack was truly immense and the full array would have been capable of pulverising a 10 mm stone to dust in a few seconds without the sharp edges in the remnant rubble that cause much trouble in laser lithotriptors. By this time, however, high power lasers were already beginning to fall in price and it seemed as though the window of opprtunity for the device was closing.

I had reported the thermoelectric effect to Dr. Aspden at this stage and I had suggested that perhaps the pyroelectric and thermoelectric effects were interacting in some way. Dr. Aspden was sceptical and proposed a number of alternatives. I built some devices using diode arrays as disclosed in an early patent* but my experimental technique was appalling and so I cannot rely on the measurements made on the device.

The exact number of layers in each stack in the device tested to obtain the above signal waveforms is not known, since the acoustic thickness was all that mattered, but a fair estimate would be about 20 - 30 layers. Thus the assembly would represent 20 series stacks connected in parallel when connected as a finished assembly.

For the thermoelectric application I rewired the stack to produce a standing wave rather than a travelling wave and set up the circuit with a combination tuning transformer, thus creating a stack consisting of a combination of serial and parallel connections in a series resonant circuit with the stack and with an omnitron SCR.

The circuit configuration is as shown in Fig. 6.

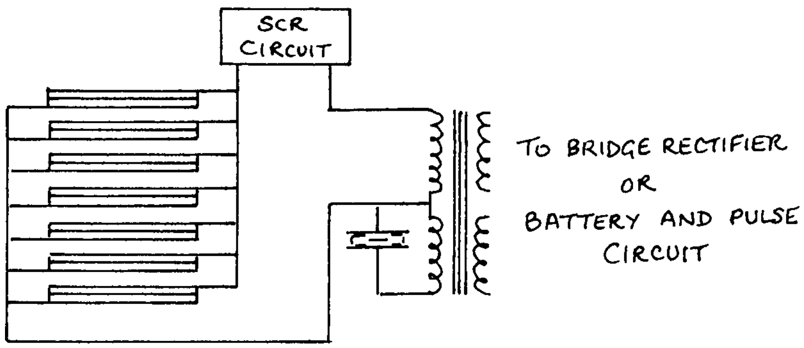

Fig. 6 Series-parallel connections of laminar stack

*** This is the subject of U.S. Patent No. 5,065,085, whereas the later prototype laminar stack thermoelectric devices became the subject of U.S. Patent No. 5,288,336**.

Off voltage was now less of a problem since the actual rising edge of the spike would turn on the CRS before the junction blew, but even so the resonant circuit meant that flyback voltages were still dangerous in the OFF condition. Keeping the output of the transformer coupled to low impedance prevented this from being terminal.

The amount of energy in each pulse is difficult to explain since the capacitance of the stack as measured by a bridge was far too low to account for the energy magnitude of the pulse. The combination of pyroelectric behaviour and thermoelectric behaviour seems to combine with either a sudden increase in the effective capacitance or perhaps a brief conductive phase through the PVF2. The resulting stack was connected to an input circuit and to an output path via a transformer and then through a rectifier circuit. The rectifier circuit should use very low voltage drop diodes to reduce voltage drop losses.

The rest of the story is well known* but a few points are worth making. The first and third prototype devices produced a reversible effect, ie. the provision of high energy electrical pulses to the stack resulted in the appearance of a dramatic temperature differential across the stack. The second device, built without the magnetic interface strips, did not do this and also was incapable of self-driving through an SCR. The electrical efficiency was measured accurately in terms of the transfer of heat and the electrical output of the device but the amount of breakthrough from the external drive circuit was ignored. Were the measurements valid?** As I recall several results were surprising but were explained away by some fancy footwork from Dr. Aspden. The third device did indeed produce a reasonably impressive thermoelectric efficiency as a generator but detailed analysis of the measurements of the device as a heat pump show that its performance is nowhere near as efficient as would be expected. While this is explainable to some extent from the predicted behaviour of the protection circuitry, the fact remains that as a heat pump the device performs no better and perhaps worse than several commercially available heat pumps. What if the discrepancy between the thermoelectric generator effect and the heat pump effect is the result of a transient electrochemical effect? The chemical interaction of cyanoacrylate and metal is already known to be charge sensitive and is very temperature sensitive. This is a

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This is a reference to the information which has been published by articles, conferences and patent specifications in endeavouring to promote interest in the Strachan-Aspden invention.
** Underlining by H. Aspden. This is a surprising statement. The tests in question are the subject of Appendix IV already presented. As stated on page 42 we used a function generator to provide an input signal to regulate electrical power delivery in pulsations at the control frequency. The signal input of a few volts was fed through a high-valued resistor so that minimal input current could 'break through' to feed power into the output circuit from the function generator. It would seem therefore that Strachan here is registering his own

personal reservations about the high operational efficiency of that now-defunct tested device. [Footnotes by H. Aspden]

major nightmare for me. What if, in fact, all we have is an endothermic electochemical reaction? Several gels exist that freeze when subjected to an electrical current. And a lot of those are acetates! The electrical generation effect is even more common.

The current device is now inert but it is likely that not all elements will have decayed. I am now dismantling the device and will attempt to recover as many elements as possible. I would propose the best use that could be made of these is to distribute them to various laboratories that propose to attempt to construct a device.

[End of Strachan's February 2, 1994 Communication]

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Concluding Comment

It has become clear, and especially in the light of the above-stated position taken by Strachan, that ongoing experimental research on the phenomenon underlying the Strachan-Aspden invention will need to be undertaken by Strachan's coinventor, myself, as author of this Report, in following my own different convictions concerning base metal properties when activated thermoelectrically using a.c. However, I can but hope that research interests of those having the appropriate academic or corporate affiliations who come to read this Report will see the merit in the Nernst Effect interpretation of the tranverse a.c. action, as described in the initial commentary of this Energy science Report No. 2, and will undertake their own investigations in pursuit of this new technology. The outcome of my own efforts will be reported in Energy Science Report No. 3.

ENERGY SCIENCE REPORT NO. 3

POWER FROM ICE: THE THERMOELECTRIC REGENERATOR

Contents

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POWER FROM ICE: THE THERMOELECTRIC REGENERATOR

Introduction

This Energy Science Report is one of a series concerned with new energy technology and the fundamental energy science that is involved. In this series of ten such reports this is listed as No. 3. Its first version was dated June 4th 1994 but made available in confidence only to sponsors interested in funding development. It concerns onward progress on the project of the 'Strachan-Aspden' invention, the subject of Report No. 2. The invention as demonstrated proved that it was possible to take energy from melting ice and run an electric motor by tapping into the heat flow drawn from the prevailing ambient background as it migrated through the device to reach and so melt the ice. The device was remarkably efficient, also in its reverse operation mode, in which it froze water upon input of electricity.

The invention is seen as the basis for future non-polluting refrigeration and noiseless air-conditioning as well as providing a solid-state, maintenance-free technology for generating electric power.

At the time the initial version of this Report was written the author was intent on pursuing the research himself, co-inventor Scott Strachan having abandoned further work on the project. For some mysterious reason all of the operative devices he constructed had worked well for a period of months but then deteriorated rapidly and ceased to function. As this author saw the problem, a funded university project and even corporate research involvement committed to discovering the reason for this failure was needed, given the importance of the underlying discovery.

In the event, though corporate interest had been aroused, that interest depended upon the sustained ability to demonstrate operation. Scott Strachan reverted to his research pursuits on laser devices, whilst this author, whose primary interest concerned power generation by a new type of magnetic motor was diverted by success in August 1994 in winning a U.K. government research award on that latter project.

In these circumstances at this time, October 1996, the author is endeavouring now to complete both this Energy Science Report No. 3 and also Energy Science Report No. 9, which relate, respectively, to the thermoelectric project as now seen in retrospect and the status of the research on the motor.

Admittedly also the author has been stimulated into completing this Report No. 3 by the very recent publication of a book entitled '*The Coming Energy Revolution*' by Jeane Manning (ISBN 0-89529-713-2) Avery Publishing Group, Garden City Park, New York. It was at pages 124-128 that there was reference to the Strachan-Aspden device. Reference to that book will show that I had speculated that it might be a combination of heat and vibration that had progressively affected the device's electrical storage capacity and so interfered with its operation. However, as this Report will explain, I have now formed a different opinion, based on some of my early background research experience with ferromagnetic steel laminations that are tough enough to withstand such effects.

Much of what I am now introducing in this Report will explain why any bimetallic laminar structure involving a ferromagnetic substance must have a tendency to polarize magnetically when subjected to periodic temperature changes and that is, in my opinion, the true cause of failure in the three Strachan-Aspden devices tested. To remedy the defect all one then has to do is make provision for `degaussing' the bimetallic laminar structure. The bimetallic feature is an essential limitation in the claims of the main U.S. patent on this device (U.S. Patent No. 5,288,336). The reason is that it expedites the entry of heat into the body of the device and that can make a very substantial difference by reducing its physical size for a given power output.

Hopefully, with this insight for solving our earlier problem now put in proper perspective, the publication of this Report will rekindle interest in corporate and academic laboratories who will now see purpose in mounting research to apply this technology commercially. In this regard the author, who will be 69 years of age before year end 1996, will be able to act in a consultancy capacity and assist in such endeavour.

Rather than making this work a complete rewrite of the original 1994 version of Report No. 3, it is intended, following this brief introduction, to present as PART I an informal overview of the underlying invention and suggest a new way by which the technology can be harnessed. Furthermore, since the author now knows why the original devices failed after a few months of operation and since the remedy is so very simple, that will be explained at the outset. Part II of the Report will be the more formal account of the technological subject matter as contained in the 1994 version. The latter has not been edited, save in that its list of contents has been merged with those of PART I and it will seem incomplete. It was the version in note form which was intended to brief would-be sponsoring research interests. It left open questions which the onward experimental research would need to resolve. It will, however, serve a purpose and though much of the material will no doubt need to be discarded in the light of developments it will, it is hoped, inspire effort to explore different options until the best solution is found.

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PATENTS

As part of this Introduction it will be helpful to summarize the patent position as it stands at the time this Report is published (namely in February 1997). For cost reasons during our period of concern about overcoming the defect encountered, certain patent applications, particularly in Japan and Europe have been abandoned. However, with confidence restored, the following patents are now to be regarded as available for acquisition by parties interested in developing the technology for commercial application. This Report, together with Report No. 2, plus the patent specifications identified below and some further patents that will be listed only on request, constitute the briefing material which is available. Enquiries of a commercial nature concerning the patents should be addressed to Dr. Harold Aspden, Sabberton Publications, P.O. Box 35, Southampton SO16 7RB, England, the publishers of this Report.

U.S. Patent No. 5,065,085

U.S. Patent No. 5,288,336

U.S. Patent No. 5,376,184

PART I

The 'Impossible' Dream?

I am going to describe something which physicists will declare to be 'impossible' and then I am going to explain in simple scientific terms why I believe many of those physicists will see the need to retract and pay attention.

I am a physicist myself, by professional qualification and by vocation, with an academic research background in electrical engineering, though my working career has been in that field of corporate management concerned with inventions and patents dealing with technology rooted in electronics and magnetism. I would not therefore be writing the words which follow without being sure of my ground.

Imagine that in your dreams you catch a glimpse of a house of the mid 21st century and notice that in its cellar there is a rather curious elongated structure that you can best describe as pipework. You suspect it is a heater or air-conditioning unit. The owner of the house explains its function and how it works.

Firstly, the main pipe section is composed of steel or nickel, according to whether the air flow through it is hotter or colder than the exposed outer surface of the pipe. Peripheral to the pipe is a unit described as a pump. It is a heat pump, a mid-21st century model. It does what heat pumps are supposed to do and does it rather well. It is quiet and efficient. It requires an input of electricity and it pumps heat. It can pump 100 joules of heat between two temperatures, one ambient and one 30 degrees C above or below ambient, and do that with an intake of 15 joules of electricity. Physicists know that is possible because it fits within the Carnot efficiency limitations imposed on heat engines and knowledge of 19th century technology explains how it works. It is very familiar territory to those expert in thermodynamics.

Now, about that pipe. Here again, in history, going now into the latter part of the 19th century, there was the discovery of a phenomenon by which heat flow through a metal could generate electricity. Assuming the heat flow was through the walls of a long pipe, it needed a magnetic field directed along the length of the pipe to promote the setting up of an electric field, or EMF (electromotive force, otherwise expressed as a voltage), the latter being directed at right angles to both the magnetic field and the direction of heat flow.

So, you see, if we magnetize the pipe along its length any heat flowing through its pipe walls, that is between its outer surface and its inner bore, will set up circulating electric current inside the pipe.

Now, if you use your imagination, you can see that here is something physicists discovered over one hundred years ago (in 1886), a fascinating way in which to convert heat into electricity, but if you, the reader, are a physicist, have you ever heard of this before?

I know about it because it was mentioned at page 592 of a book I was given on 20th December 1945 because I had won that year's `Physics Prize' awarded at my school. The few words on that page 592 did not refer to tubes of circular section. They referred to experiments on metal sheets, but I knew how to roll a metal sheet to form a tubular pipe and so here was a book I have had in my possession for more than 50 years and it told me that it had been known for some 60 years before then that heat could convert directly into electricity merely by flowing through metal!

Of course, now assuming you, the reader, are an engineer, you will say that electric current flowing in the pipe is not doing anything but turning back into heat, so there is a no-win situation. On the other hand, if you are a physicist, you will say that it is a thermoelectric effect and such effects are notoriously very weak and so can offer nothing of practical importance.

However, that book of mine that I won in 1945 included a table of data, backed by references, which showed that at the dawn of the 20th century it was known that in steel as much as 16.6 volts could be set up by a temperature gradient of one degree C per cm if the magnetic field strength was 10,000 gauss. That magnetic field is less than half of the saturation field strength in steel. In nickel the direction of the electric field is reversed, but the voltage induced can be as high as 35.5 volts in such a field, though that is nearly double the saturation condition of nickel. Either way, whether we use steel or nickel, we are involved here with the prospect of generating 16.6 volts per cm. of path within a steel or nickel pipe magnetized close to saturation, given a heat flow rate through the section of pipe corresponding to a one degree of temperature drop per cm.

It never occurred to me when I first came to browse through that book given to me as a school prize that it contained technological information of such importance to the world's energy future. Instead, I became indoctrinated in the principles governing physics, which say that it is impossible to convert heat into useful work except in compliance with the laws of thermodynamics. A pipe with one degree temperature difference between its outside and inside could not be even one per cent efficient in converting heat into electricity according to those ‘laws’.

I am now a wiser being and it took me nearly half a century to acquire that wisdom and become a law breaker. One cannot argue with the facts of Nature and it was to be experimental discovery that obliged me to shift my ground, realising that Nature herself has not seen fit to comply with the wishes of whoever decided to formulate that Second Law of Thermodynamics. You see, when heat flows through metal it is carried by electrons in the main and some is transferred by atoms vibrating into one another. Those electrons, which are shed by atoms, get deflected by a magnetic field and can get reabsorbed into other atoms part way along their journey through the metal. Once locked inside an atom the electron can even migrate back in the opposite direction to the heat flow. After all, there is no net current flow in the heat transport direction, so the electrons have to go the other way too. However, in the latter motion they are paired with an atomic nucleus and so the magnetic forces acting on them are unable to move charge laterally with respect to magnetic field and heat flow.

It is as if the electrons are girls in a barn dance and can go one way freely but, in migrating the other way, they have to hold hands in swinging around a boy, but they can progress from boy to boy transferring their hand hold. In their forward free motion they do not bang into the wall at the end of the barn, because some boy or other captures them and sets them into the sequence of their reverse motion.

So those heat-carrying electrons seldom travel all the way through the pipe section before shedding their heat and producing that lateral EMF. To comply with the Second Law of Thermodynamics they all need to go from the higher temperature towards the lower temperature at the pipe surface, but they are not completing that journey. They never ‘see’ the lower temperature. Instead, they are deflected to confront a back EMF and it absorbs their energy very efficiently, indeed with a near-to-100% efficiency. There is no such thing here as the physicists `Carnot' criterion. All there is is a temperature gradient governing the heat flow rate.

So our mid 21st century homes will have pipework in their basements which use nickel or steel pipes and be designed to have heat flowing through their pipe walls. How then do we provide that heat input? Well, you have been given the answer to that question, we use the heat pump accessory already mentioned. We feed in 15 joules of electricity to generate 100 joules of heat flow through the pipe walls and we convert most of that 100 joules into electricity which we use to supply the 15 joules input and to deliver the rest to meet our domestic needs. There is energy conservation because there is net cooling in that basement appliance and we will need to let heat flow in from the atmosphere somehow to keep the balance, but the result is a cold basement and a warm house or an air-conditioned cool house with a hotter climatic condition outside.

If you see this as `perpetual motion' and so 'impossible' then stay in the 20th century and skip the future, because you choose to ignore what Nature has on offer.

If you are shaking your head, as an engineer, and still thinking about how that electric current circulating around the tubular pipe form can get out and into your wire circuits then read on.

First, let me go back to those school days of mine once again. I was taught physics at a time before our student-time absorbing computer age began and so could learn a little more about old-fashioned subjects, such as ships having magnetic compasses and why ships needed `degaussing'. I want you to imagine that steel pipe mentioned above as being, in effect, a ship structure during fabrication. I was told that when a ship was made it would tend to become magnetized because of the hammering and rivetting on its steel plates which vibrated the magnetism in the steel to cause it to turn into the direction of the Earth's own magnetic field. The ship became weakly magnetized, enough to affect the reading of a ship's compass and that magnetism could not be eliminated. One had to compensate for it in some way by putting magnets close to the compass. Furthermore, my school years of learning physics being World War II years, I was told that the magnetism of a ship could attract magnetic mines set floating on the sea by the enemy and so the ship had to be `degaussed' by using currents flowing around parts of the vessel.

Yet, when I took up my Ph.D. research (1950-53) on the subject of how there were anomalous excess losses occurring in electrical sheet steels as used in power transformers, I directed much of my attention to examining how mechanical stress affected those losses. I can say, quite categorically, that my research experience assured me that mechanical stress and vibrant stress would reduce, rather than increase, residual magnetism. However, I was not sufficiently enlightened as to question what I had been taught and it was of no importance to me how ships became magnetized during construction. Indeed, nor was I sufficiently enlightened at that time as to see the connection between my research and page 592 of that school book I mentioned.

I went through three years of Ph.D. research on the subject of anomalous eddy-current loss in electrical steel, losses involving heat generation, without it occurring to me or the professorial supervision I received, that heat itself could be a regenerative electrical factor in enhancing those losses.

There were two dominant factors, not mentioned as such, but inherent in our instinct by training, namely that in the absence of both a bimetallic structure and a temperature differential there could be no regenerative effects and, further, that any strengthening of a magnetic field meant enhancement of resistivity. As a result the whole emphasis of interest was centred on how waveforms were distorted during the alternating cycles of magnetization, owing essentially to non-uniformities attributable to the domain structure inside a magnetic material.

Here the lay reader should understand that inside nickel or iron there are everywhere regions fully magnetized to saturation and all we do when we `magnetize' is to turn some of those around in their direction of polarization. This is why it makes sense to imagine that vibration can produce magnetization.

However, I am now suggesting here that the ship lying in its fixed position relative to the Earth's magnetic field during its construction is far more susceptible to the effects of temperature changes than to workmen's percussion tools banging on the ship's bodywork. Heat flow through its steel plates, transversely with respect to the Earth's magnetic field, will set up current flow around the body section of the ship. This will itself set up a magnetizing field along the length of the ship, one way as the ambient conditions warm up and the other way as they cool down. Each day there is a cycle of change and it becomes interesting to ask if this thermal cyclic can build up the gradual magnetic polarization of the vessel.

At this point I will jump way ahead to refer to our invention, the Strachan-Aspden thermoelectric device. It was demonstrated repeatedly by using ice to cool its working surface and deliver electrical output and then by putting in electrical power to show the equally-amazing rapid regeneration of ice on that same surface. Internally the device operated by electrical current oscillations at quite high frequencies but these were not oscillations of the magnetized state. However, by its nature the device would be subject to some magnetic changes as the temperature cycled. Now presumably it takes hundreds of days of climatic heating and cooling before a ship acquires its full measure of magnetization. Equally, it would seem that a hundred or so sequential cycles of heating and cooling between the temperature of ice and a warm room occur before the evident deterioration of the operation of the Strachan-Aspden device is registered. Accordingly, I make the observation that it would seem that the thermal cycling is a factor which polarizes its magnetic state. Comprising, as it does, a thin film ferromagnetic material (nickel), its full polarization would destroy its operability. The principle on which it works requires the domains in each nickel layer to be fairly equally apportioned as between one orientation and the opposite orientation, because the transverse current flow, which is a.c. seeks passage through one or other form of polarized domain according to its flow direction. It chooses the one offering negative resistance and if such passage is denied then there is no regenerative conversion and simply loss.

By considering the problem of ship's magnetism one can then understand our problem with the Strachan-Aspden device, the subject of Energy Science Report No. 2 and Part II of this Report No. 3. It needs little imagination to see that, just as for the ship, we simply need to provide for that `degaussing' process. How to implement this effectively will depend upon the specific assembly plan for the main thermoelectric devices, which will need some adaptation to incorporate the controlled degaussing feature. In the development stage, if not in the final product, the incorporation of some diagnostic sensing circuitry which can be used to monitor the unwanted polarization will be necessary to provided the feedback control which keeps the device in a healthy state. Such issues are matters for consultation with commercial developers who decide to exploit this thermoelectric technology and will not be addressed in this summary Report.

However, concentrating on the underlying function of the thermoelectric power generator, let us go back to our mid-21st century house and that pipework in the basement. We still need to explain how it produces electricity that we can extract and use.

One initial question that will interest some readers is how this topic relates to that reference I made to something that eluded me in my years of Ph.D. research. I was researching the question of why eddy-currents in electrical sheet steels could generate as much as six times the loss expected from accepted theory. It did not occur to me that heat flow from the steel laminations could regenerate EMFs that would cause the current to be far greater than the value determined by resistance and normal Faraday induction.

My research clearly demonstrated that the loss anomaly was progressively eliminated as the steel became more and more polarized. By this I mean the ratio of the actual eddy-current loss to the theoretical loss. In other words, it was the fact that the magnetic domain regions in my transformer steel provided a optional current path through the metal, one that is obstructive for thermal reasons and one that aids current flow, also for thermal reasons, that created the anomaly.

It vanished once those domains had been polarized so as to eliminate enough of those that aided current flow.

So, if our mid-21st century basement air-conditioning unit is to generate a net output of electrical power, we must avoid that regenerative eddy-current syndrome in its pipework.

We do that by laminating the pipe assembly and avoiding its closed conductive sectional form and the laminations are provided, not because we seek to use alternating magnetic induction, as in a power transformer, but rather because we want to set up the non-linear thermal gradient and avoid a mismatch of thermally-induced EMFs which would otherwise promote unwanted current circulation. The circumferential magnetic field effects are thwarted by introducing a break in the circuit path and tapping off the current flow by diverting into a battery which becomes charged or into a load circuit such as a motor or an electric heater in another room.

Hopefully, given a modest pipe radius plus a high enough heat throughput rate we should be able to develop a normal cell voltage for this purpose. Given a steel pipe of radius 5 cm. and wall thickness 1 cm. with a 20,000 gauss magnetic flux density along its length, one degree C of temperature drop between its inner and outer surfaces corresponds to a thermal induction of 1,000 V. That, at least, is the theoretical result using empirical data for the relevant thermoelectric coefficient as listed in that book mentioned above. I have verified the source data by tracking back to the original research reference [H. Zahn, Ann. der Phys., **14**, p. 886 (1904) and **16**, p. 148 (1905)]. Of course, working with a 30 degree C air temperature difference, it is unlikely that even a one degree C drop of temperature through metal can be set up, owing to the limited heat transfer rate across the pipe surface, but one fiftieth of this seems not unreasonable in a thick-walled pipe giving 20 volts output from each pipe section. Six sections connected in series would deliver 120 V d.c.

Such, at least, is the prospect ahead and I would urge interest in this subject by those having a corporate interest in developing new technology for the world's energy needs of tomorrow.

Now, the above pages have been written without referring to any supporting illustrations because I wanted the message in my words to register. The diagrams now follow and then the remainder of this Part I discourse will deal with two separate topics. The second of these is more specifically concerned with the use of bimetallic thin film layered structures of the kind which featured in the main Strachan-Aspden invention, the subject of US Patent No. 5,288,336. The other topic deals with a theme which has been left aside so far, namely the subject of the secondary, in fact the first Strachan-Aspden invention, as disclosed in US Patent No. 5,065,085.

The latter invention will be addressed first, but after the pictorial review.

Review of the Nernst Effect

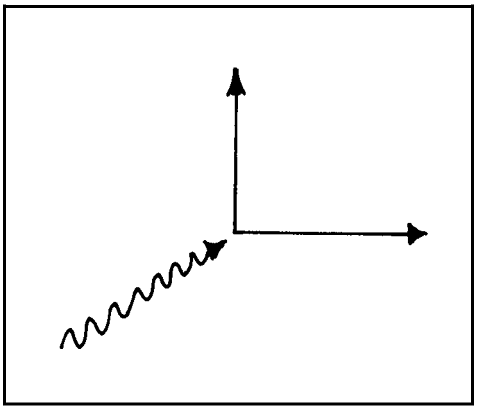

Figure 1

Referring to Fig. 1, if heat flow in a metal is depicted by the wavy line, and dT/dz represents temperature gradient, with B representing a magnetic field in the x direction, then there is an electric field of strength E in the mutually orthogonal y direction, given by:

$$E = N(B)dT/dz$$

Here N is the Nernst coefficient and it may be positive or negative, according to the choice of metal. In a sense this phenomenon is akin to the better-known Hall Effect, where a field E is generated in the y direction by the passage of an electric current in the z direction, given a magnetic field B in the x direction.

In the Hall Effect we know that the power transferred to that E field arises because the current overcomes a back EMF, the magnetic field B being a mere deflecting agency, just as a railroad track deflects a locomotive but does no work itself. Energy is conserved at all times.

However, in the case of the Nernst Effect, although there is also energy conservation, we are setting up an electric field which can deliver electrical power output and the heat input is the only energy source available. The Hall Effect, apart from some small resistance loss, is 100% efficient and, since the Nernst Effect is concerned with temperature gradient, rather than absolute temperature, we have a straight analogy with the Hall effect and so can expect that near-to-100% conversion efficiency.

There are only two problems. One is understanding why electricity is generated with no electric current in the heat flow direction and the other is in devising a physical structure that will let heat flow one way while we take off electric current delivered by that E field in a direction at right angles to the heat flow. Heat conduction and electrical conduction tend to share a common path!

To resolve the first problem, note that it is well accepted that most of the heat conducted through a metal is carried by electrons. The magnetic field will surely not act on 'heat' as such. It asserts forces on the flow of free electrons carrying that heat. Note that I have used the word `free', because electrons can move through metal in two ways. They can travel freely with little restraint or they can migrate as members of the electron families seated in the outermost shell of the atoms comprising the metal. The electrons in the latter state will, as they move from atom to atom, be subjected to the usual deflecting magnetic forces, but they are held in their quantum states by the succession of atoms in their path and those forces so far as they arise from their transfer from atom to atom are thereby absorbed by the crystals forming the solid body of the metal. Imagine, therefore, that the free electrons transport heat in the z direction and that that heat has the form of kinetic energy which is used, upon deflection in the B field, to stack the electrons up sideways in the x direction against the back EMF of the resulting E field. There will be some back EMF set up in the z direction as well and this must encourage the bound atomic electrons to migrate from atom to atom against the z-direction heat flow. The net result is the slowing down of the electrons carrying heat and the transfer of that heat energy into electric potential that allows the E field to deliver power.

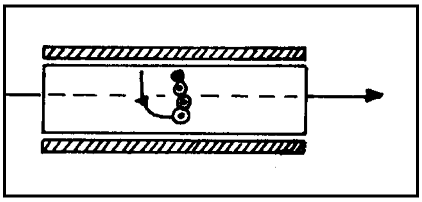

Figure 2

The full line (curved, with arrow) in Fig. 2 depicts the free electron path, transverse to the E field (linear in direction of arrow) and the B field (direction normal to the page). The electron flow can be arrested as the electrons are reabsorbed by the atoms and then, as they belong to overlapping electron shells of adjacent atoms, they can migrate back to their starting point. There is no current passing through the metal, shown in Fig. 2 as a solid layer located between and electrically, but not thermally, insulated from the faces of two heat sink plates. By applying different temperatures to the two plates there is a resulting temperature gradient in the metal and, given the B field, the E field follows as a consequence of the Nernst Effect. The positive or negative polarity of the Nernst coefficient poses an interesting question, but its answer need be no more mysterious than the orthodox `positive holes' as referred to in the theory of semiconductors. It is simply a question of mobility of the charge carriers and understanding the quantum-electrodynamic attributes of electrons in motion. It suffices here to let Fig. 3 serve as a guide as to how `bound' electrons can migrate through a metal without developing an E field. They are moving around the orbits in their atomic shells and they are distributed in energy bands which govern their relative freedom. From the statistical mix of their activity in transporting heat and the building of concentrations of free electrons which set up the E field effects, they somehow contrive to reveal to us the phenomenon which is termed the 'Nernst Effect'.

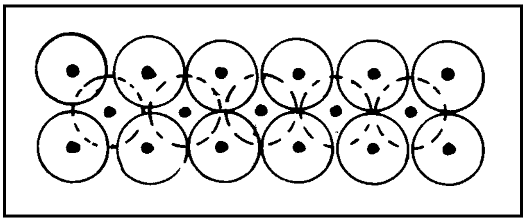

Figure 3

Sadly, technologists have not exploited this phenomenon, even though it has enormous practical potential. The reason is two-fold. Firstly, they are given scientific training which says that the second law of thermodynamics reigns supreme and, secondly, as engineers, they seem to have lacked the necessary imagination. I am mindful that it was not in a book on physics or one on engineering that I saw this subject properly addressed. It was a book on '*Physical Chemistry*' written by Walter J. Moore, Professor of Chemistry at Indiana University. My copy was the third edition published in Great Britain in 1956 by Longmans, Green & Co. Ltd., but the original 1950 edition was published by Prentice-Hall Inc., New York.

The words which I now quote were on p. 85:

> "The laws of thermodynamics are inductive in character. They are broad generalizations having an experimental basis in certain human frustrations. Our failure to invent a perpetual-motion machine has led us to postulate the First Law of Thermodynamics. Our failure ever to observe a spontaneous flow of heat from a cold to a hotter body or to obtain perpetual motion of the second kind* has led to the statement of the Second Law. The Third Law of Thermodynamics can be based on our failure to attain the absolute zero of temperature."

Note that the laws are not 'the word of God', but a consequence of man's experience and frustration at trying to replicate something following God's example, because the creation of the universe introduced perpetual motion into our environment and, indeed, in our own composition, a system of atoms, each of which involves electrons kept in a state of motion, even when the atom as a whole comes to rest at that supposedly non-achievable zero temperature on the absolute scale.

Having mentioned 'God', I should say that I believe we can only go so far in our understanding of God's creation as to reach the point where we face questions such as "What is space?", "What is energy?", "What set that energy in motion in space?", "What came before?" and "What follows as destiny?" The human race is a life-form on one planet amongst the numerous astronomical bodies forming that universe and our immediate concern is survival based on a deeper understanding of the energy conversion processes governed by those laws of thermodynamics. However, if those man-made laws are wrong then we need to revise them before we finally accept the inevitable decline in our energy fortunes.

Although Professor Moore said that the failure to invent a perpetual motion machine had meant human frustration and resulted in the First Law of Thermodynamics, I must ask how Professor Moore would view the 'Moving Sculpture' which we are told was seen on Norwegian TV as an exhibit by its creator Reidar Finsrud. It is mentioned in the July 1996 issue of the Utah publication `New Energy News'.

* ‘Perpetual motion of the second kind’ is the continuous extraction of useful work from the heat of our environment, whereas ‘perpetual motion of the first kind’ is the production of work from nothing at all.

A steel ball weighing 2 lb. runs around a 25" circular aluminium track and rolls towards the pole faces of a horseshoe magnet suspended by a lever and pivot system just above the track and ahead of the approaching ball. As the ball gets close to the magnet it encounters a ramp linked to that lever system and the weight of the ball in riding over the ramp displaces it downwards to lift the magnet sufficiently so that the ball can roll on and pass underneath it. The magnet imparts a forward drive force as it attracts the ball and it needs less energy to lift the magnet clear of the ball than is gained from the magnet when in its lowered position.

The report states "A working model has been running for over one month in full public view in Norway".

Now, given that this is a genuine account of a real machine, we confront the reality of perpetual motion. On the face of it, the First Law of Thermodynamics has been disproved, but I remind the reader of those words above from that 1956 edition of the book by Professor Moore, "The laws of thermodynamics are inductive in character." What that means is that the laws are not `proved' 100%, because they are worded so generally as to extend far beyond the immediate experimental circumstances which have been taken as their basis, but that one seems able to predict from them what may happen if applied to hitherto untested circumstances. Now, from that year 1956, I have been declaring to whoever was willing to listen that the setting up of a magnetic field by the process we call `induction' sheds energy into space (even vacuous space) as heat, where it is dispersed by merger with the omnipresent vacuum energy activity of the aether. I have urged recognition that the aether becomes polarized by reacting and so is conditioned to shed its own energy when we demagnetize that field. So, if you regard that aether energy as heat, whether at zero temperature absolute or at 2.7 Kelvin, the cosmic background temperature of space, then you can see how `thermodynamics' gets into the act.

In the latter case the inductive process is a mysterious exercise of influence by an electrical current in a circuit, as it somehow affects energy transfer across space to where a secondary circuit is located. My inductive powers then tell me that, for energy to go from A to B via empty space C, I cannot say space is empty if energy is to be conserved according to the first law of thermodynamics. Then, if space is not empty, since space is open terrain not assigned to the exclusive use of the energy source at A, I ask if that space could pool energy in transit from a multiplicity of sources. In that case I would hesitate before ridiculing the possibility that energy shed by A may arrive at B supplemented by an excess of thermodynamic energy drawn from C.

Now, if you do not like to think about ‘space’ in this context and you choose to regard the ‘aether’ as non-existent, then that process of electromagnetic induction means an exchange of energy with something that does not exist and so the process cannot occur, according to the First Law of Thermodynamics as a statement of ‘perpetual motion of the first kind’. Yet, we have built electrical technology on the discovery of electromagnetic induction, building on the recorded experience of Michael Faraday.

If you choose to regard the ‘aether’ as existing but describe it as a ‘field’ then you are playing with words and have defined ‘aether’ as something other than simply an ‘energy medium’. In that case would you say that a ‘field’ has a ‘temperature’? It is difficult to see where `thermodynamics' comes into play unless we have heat. Physicists speak of 'entropy', which is a word expressing something far more mysterious than what I understand by the word 'aether'. Entropy is heat degraded by temperature, it being Q/T, a quantity of heat Q divided by temperature T. We shed energy into 'empty' space by heat radiation and we say that entropy always increases, but yet we do not say that that 'emptiness of space' has a temperature. In other words, most scientists who refer to thermodynamics and entropy, really do not know what they are talking about and, certainly, they could never believe that the Norwegian 'Moving Sculpture' mentioned above is anything other than a trick aimed to deceive.

When one then considers the Second Law of Thermodynamics there is even greater confusion, because one needs two temperatures to account for heat flowing to a greater entropy state as it converts into useful work, but always needing to find a cooler destiny. Does that Norwegian perpetual motion machine run on heat? It cannot, according to the Second Law of Thermodynamics, unless we feed in some heat at a temperature higher than ambient.

So, what can the Third Law of Thermodynamics tell us? We can never attain absolute zero of temperature! Well, why should we want to do that anyway and, if we did, how far might we get? Professor Moore in that book which dates back more that forty years states:

"In 1950, workers in Leiden reached a temperature of 0.0014 Kelvin."

They did that by a process of demagnetization. In telling this story Professor Moore reaches his conclusion which is that:

> "The Third Law of Thermodynamics will, therefore, be postulated as follows: It is impossible by any procedure, no matter how idealized, to reduce the temperature of any system to the absolute zero in a finite number of operations."

Yet, I recall a recent mention of researchers at M.I.T. having achieved a temperature that was a low as a few billionths Kelvin, and so presume that, whatever purpose there was in devising the Third Law, it is hardly important technologically.

Now, I really have little patience with scientists who tell me I cannot do something or other owing to one or other of the laws of thermodynamics. Each of those laws involves `small print' and needs scrutiny to see what is meant by the `let-out' clauses. In enforcing those laws one has always to adapt their interpretation to the `case law' on which they were founded, the experience of the past. However, we must accept that we are inevitably destined to experience new discoveries as technology advances.

To come to the point about what is disclosed above by reference to Figs. 2 and 3, does an electron in motion have a temperature and is that temperature different from that of the metal conductor in which the electron transports heat? Scientists can refer to Fermi energies and temperatures of electrons that can run into millions on the centigrade scale but they will not accept the possibility of using electron flow conveying heat in metal as a means for breaching the laws of thermodynamics. This Report faces up to that issue and challenges the Second Law of Thermodynamics by the facts of experiment, just as that `Moving Sculpture' in Norway challenges the First Law of Thermodynamics unless one sees the aether as an energy source in its own right. There seems no point in challenging the Third Law of Thermodynamics, because, as it is worded above, it merely says that there is a final line to be drawn between what is measurable in terms of temperature and what is not measurable and that we can only reach that line by taking one step at a time.

An atom, the centre of mass of which is at rest, has zero temperature, even though its component electrons and nucleus remain in motion. A free electron moving through a metal at what is virtually zero absolute temperature, might still be said to have a temperature. As such it has the capacity to do useful work.

If we can extract some of its energy by slowing it down and it can get recharged by being drawn periodically into the quantum world of an absorbing atom, then there is scope for technological advantage which breaches the laws of thermodynamics. The free electron can be deflected by a magnetic field. It can act in concert with other free electrons to set up mutual inductance electromagnetically, which is a thermodynamic process shedding heat. Our task is to see how we can use magnetism to our advantage and, though Report No. 9 in this Energy Science series concerns tapping energy from the aether, our horizon in this Report No. 3 is more modest in seeking only to tap the ambient heat resource of our environment. We will defy the Second Law of Thermodynamics, but do so by harnessing a phenomenon discovered by Nernst, whose name is closely associated with that Third Law of Thermodynamics. However, we will not be doing anything in breach of that Third Law. Experiments using the Strachan-Aspden devices already tested show cooling to minus 40 degrees C from an environmental temperature of a normal laboratory and that is sufficient to challenge the Second Law of Thermodynamics and gave basis for useful technology.

Unfortunately, I cannot see a way in which to build a 'Moving Sculpture' which can demonstrate this process, but it may help to portray something along the following lines. Refer to Fig. 4. Imagine that steel ball to run down the slight incline of a straight track, where the incline represents a temperature gradient. Then suppose the track is curved through a right-angle at a low level so as to deflect the ball and cause it use its kinetic energy by rolling up a steeper but short incline. The ball represents the electron and the deflecting track represents the action of a magnetic field.

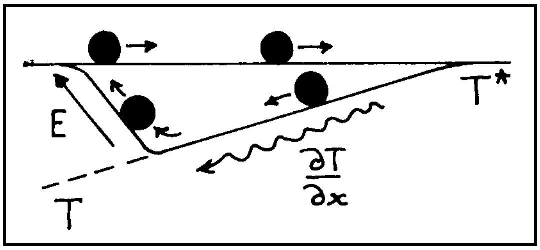

Figure 4

Now, if the ball is set free at the top of the main track and given a starting velocity it will have enough energy, not only to reach the same height in climbing the branching track, but it will crash into other such balls that got there ahead and try to push them out of the way. Happily we provide a power-driven conveyor system by which a ball reaching that position can be carried back to the start position before being release again to start the ball rolling once more. That power-driven conveyor system is shown in Fig. 4. The conveyor is the zero-point activity of that microscopic quantum world of electron motion in the bound states within the atoms forming the metal conductor.

The balls will circulate around that system and allow us to extract some of their energy just before they board that conveyor system, just as surely as conduction electrons are set free from host atoms of a metal and are reabsorbed by those atoms, even though they have spent some of their energy. This is an ongoing process whether or not the metal has a uniform temperature, but we need to set up a temperature differential (T to T* in Fig 4) so as to create that track which allows the applied magnetic field to serve as a deflecting influence. The temperature difference is needed to initiate the electron flow which allows us to relate this to what is shown in Fig. 1.

In referring to the way in which electrons have two ways of spending their time, one where they roam free in gliding past atoms as they wander through a conductor and one where they have found lodging inside at atom, we are discussing something real and active in the world of physics. This is not imagination. It is a physical system in which energy exchanges processes occur on an ongoing basis without suffering any restraints imposed by the laws of thermodynamics. Why, one may wonder, is there not a law of thermodynamics which declares that a body at a uniform temperature cannot sustain activity in which there is any ongoing changes of state as between its component parts? Such a law would not be contrary to our experience of what we see in our environment. All we can `see' inside the microdomains of a solid metal conductor using electron microscopes and the like is evidence of a crystal structure and a state of order, but yet we have not adopted a law of thermodynamics which says that there is no ongoing activity exchanging energy states in that conductor.

Without such a law I am free to ask what happens when an atom with a single vacancy in its electron 'lodging' capacity moving one way collides with an electron moving the opposite way and absorbs it. Obviously, it becomes a neutral non-ionized particle of matter and we know from Newton's laws of mechanics how to interpret momentum and the resulting energy deployment. However, Newtonian mechanics also do not tell us what happens to the magnetic inductance energy that the system had before the collision, owing to opposite polarity electric charge travelling in opposite directions, but yet does not have immediately after that collision.

Suppose, just for the sake of argument, that the atom before collision had the same mass as the electron before collision, then Newtonian theory tells us that both particles could come to rest momentarily before separating again by moving in opposite directions with the same relative velocity. We have then full conservation of energy because the net electric current has reversed direction and so the self-inductance energy of this two-charge system is unchanged.

Go further and allow for the atom having a normal mass much greater than the electron. Now, even with the electron having high speeds governed by the Fermi-Dirac statistics, the speeds of the atoms at normal room temperature will inevitably result in energy being transferred to those electrons by those collisions. Heat latent in the motion of atoms will transfer to the electrons, but the effect of current and the field reaction associated with inductance can play a role which ensures that the energy added to the electrons is not lost as heat but deployed in motion that sustains the overall level of that current. In short, there can be a superconductive state owing to the regeneration of spent heat as it converts into electricity which can be harnessed.

Therefore, as we see superconductivity develop and come into use in room temperature applications, so we will have another route available for breaching the accepted laws of thermodynamics, but the immediate task is to describe the technology which exploits the Nernst Effect.

The First Strachan-Aspden Invention

It is possible to combine three different metals to form a composite conductor which operates in a magnetic field so as to convert heat into electricity, without being subject to the Carnot efficiency limits. It is even possible to generate alternating current as output, which means that it can be extracted through a transformer coupling at an elevated voltage.

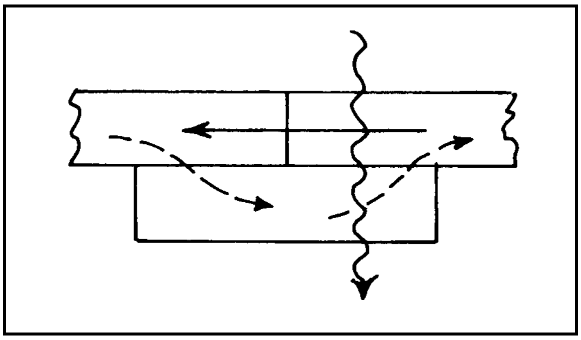

Figure 5

Consider Fig. 5. There are three metals Cu, Ni and Zn bonded together in the manner shown. The wavy line indicates the passage of heat, its direction being transverse to the direction in which electric current oscillates. A magnetic field is applied in the third orthogonal direction. The magnetic field acts on the nickel to polarize it sufficiently, say to about 80% saturation.

When current flows to the left it favours passage from Ni to Cu, owing to the fact that there is Peltier cooling at the junction between the nickel and the copper. When current flows in the reverse direction, to the right, it flows from Cu to Zn and from Zn to Ni, cooling at the first junction and heating at the second. Of itself, this Peltier action of cooling and heating is productive of heat overall, meaning that the a.c. current will result in conversion of electricity into heat, which is not of special interest. However, that heat flow through the nickel plays an important role by virtue of the Nernst Effect.

When current flows to the left much of it flows through the full body of the nickel sector. In travelling transversely with respect to both a magnetic field and a temperature gradient the current is aided by an induced E field. There is additional cooling in the nickel. When current flows in the reverse direction it is opposed by that same E field in the nickel induced by the temperature gradient, which is why it flows through the zinc instead. It finds passage into the nickel only at the extremity of the nickel sector. As a result, the overall effect can be a Nernst cooling which far outweighs the Peltier heating and that means that we can generate a.c. from the heat flowing into this metal structure.

Note that with astute use of thermal insulation over the Cu section and on the left hand portion of the Zn as well as on the right hand edge surface of the Zn section and underside of the Ni section, the heat flow can be guided along the required path.

This is sufficient to explain the principle of operation implemented in what is a fairly robust design, but one demanding the external application of strong magnetic fields (as by use of permanent magnets), a mutually orthogonal flow of heat. It needs some confidence to go to the trouble of building such a device but there is little complication in circuit design if the an a.c. power source is used as input and the load circuit is itself an electrical resistor which represents a load for test purposes. The initial prototype design could aim to take an input of heat at, say, 30ºC and allow its passage through the device to a cold heat sink at ! 10ºC.

Now, if you have understood what has already been said about the Nernst Effect you will know that the temperature gradient promotes heat inflow to the device and that we use magnets to deflect that energy so that, instead of reaching the output to the cold heat sink, much of that energy is converted to augment the electrical power in the load circuit. Temperature, as such, meaning an absolute measure in Kelvin does not feature in the coefficient governing the Nernst Effect and so one could expect, say, 50% of that heat to convert to electricity that can reach the load.

So now suppose that you can demonstrate this, guided by what is disclosed to you here in this Report and also in Energy Science Report No. 2, and consider how you might develop the prototype to the next stage.

This involves using a reversed heat engine, such as a vapour compression machine. A coefficient of performance of 6 can be expected for the above temperatures, meaning that for every joule of electrical input there is 6 joules of cooling. Yet, at the 50% conversion efficiency rate of the Nernst device, this would mean a heat input of 12 joules from the 30ºC heat sink. As augmented electrical circuit power we would generate 6 joules of electricity from the heat absorbed in transit. Of that, we can feed the 1 joule back to the reversed heat engine to sustain its operation. There is margin here for a good measure of operational losses, but a significant net power gain delivered as electricity is seemingly quite feasible, with other spin-off benefits if we wish to use the device for heating purposes as well.

To keep the energy books balanced there has to be a matching external inflow of heat energy at 30ºC equal to that delivered as electrical power. The logical source for that heat is the ambient atmosphere and so, if that temperature is lower in value, then the engine must be designed and set to operate between different temperature limits.

Conclusion

There is one point at this stage that warrants comment. So much is said about the First Law of Thermodynamics by those not involved in the real technology of the thermodynamic field, everyone quoting it as a statement of something that says it is impossible to do what we have described above. However, Thermodynamics was one of the five final examination subjects I took in my honours level university degree. It was in engineering and involved extensive practical testing of many different heat engines. The '*Heat Engines*' textbook we used was written by the Director of the Engineering Laboratories of that university. In his words, the First Law of Thermodynamics "may be stated as follows: Heat and mechanical work are mutually convertible."

To me, that is implicit in the 'thermo' and 'dynamics' expressions, just as if we refer to 'electrodynamics' we are discussing the conversion of electric to mechanical work and vice versa. In mechanics generally, which embracing heat as the kinetic energy of the molecules in the heated fluid, there has to be compliance with the laws of action and reaction and `perpetual motion' is ruled out on that count. In electrodynamics generally, as is well known from the accepted theory of the interaction force between two isolated charges in motion, there can be out-of-balance forces. These signify energy exchange with the inductive field environment. In my above account concerning the Nernst Effect I am referring not to the motion of molecules as conveyers of heat, but electrons moving freely as discrete charges, these being the primary carriers of heat through metal. The magnetic field effect harnessed puts the action discussed outside the realm of thermodynamics and brings it into the field of electrodynamics. The latter is a subject I have researched far more than thermodynamics and the motor research, the subject of other Energy Science Reports in this series builds on that research background.

Whatever the expert and academic background of the reader, the interdisciplinary nature of the subject I am discussing here cannot be ignored by assuming that someone else will be able to fault my claims. If I am deemed to be wrong, there is need to prove me wrong, not just assume I am wrong, because, if I am right, then the technology is indispensable in the onward quest to solve our energy needs. As a starter, one ought to begin by explaining an observed fact evident from the Strachan-Aspden devices as demonstrated. Though we do not have an operational unit any longer, there is a video record of operation. They were bimetallic assemblies of symmetrical construction as between the two heat sinks. When operating in Peltier mode to generate a heat difference with electrical power input along a transverse path parallel to the planes of the heat sinks, it should have been a 50:50 chance at switch on, whether heat sink A cooled or heat sink B cooled, as the other heated. That transverse path was through the planes of Ni-Al metal layers, stacked between those heat sinks. Yet, in every test witnessed, there was always cooling of the exposed heat sink, whereas the other heat sink was a metal base on which the electric circuitry was mounted, which meant that any excess power generated was dissipated as circuit current heating. The logical answer, as I see it, is that there was a cooling process supplementing and indeed overriding the Peltier Effect, and that cooling, I submit, can only be the Nernst Effect cooling which I have discussed at length above.

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NOTE THAT THE REMAINDER OF THIS REPORT IS A TEXT DATING FROM A 1994 VERSION AND IT STANDS ON ITS OWN, SEPARATE FROM PART I ABOVE, EXCEPT THAT THERE HAS BEEN ADJUSTMENT OF THE FIGURE REFERENCES TO PROVIDE CONTINUITY OF SEQUENCE.

PART II

Introduction

This is the third of a series of reports which are intended to serve as a technical briefing helpful in the evaluation of invention rights by expert opinion more familiar with conventional technology.

The subject matter concerns thermoelectricity and ferromagnetism as applied in a novel combination aimed at a fundamentally new technique for converting heat and electricity using a solid state apparatus. It is foreseen that the technology proposed will allow the efficient generation of electricity on a scale that can serve as a main power supply based on non-polluting heat sources that need not necessarily be nuclear in form. The same technology is also seen as a substitute for CFC refrigeration and air conditioning systems.

The background to what is here described is the demonstrated research prototype devices built by John Scott Strachan and incorporating principles which are the subject of patent rights of which this author and Strachan are co-inventors. Both Strachan and the author are independent in a research sense, meaning that the project work reported is not the work of research in a corporation or institutional laboratory. The physics involved in the invention is somewhat challenging and, in the light of established doctrines and practice, not easily understood without a special briefing. Indeed, without such a briefing as this, comment by experts on the technical viability of the technology, notwithstanding its demonstrable features, could impede the assessment task confronting technical advisors to those corporations we hope to interest in the needed R&D that the technology warrants.

This Report No. 3 sets out to explore a new aspect of the technology and is supplemental to ENERGY SCIENCE REPORT No. 2 which is really a packaged assembly of prior reports and patent information covering the earlier activity on the Strachan-Aspden invention. The latter Report plus a demonstration of the working device in its refrigeration and power generation modes, as shown also in a video record, have been the basis in our efforts to engender interest by those who can take the R&D forward.

This Report aims to point researchers in the direction which this author perceives as being the most promising from a product development point of view. However, in the absence of documented legal agreements, the Report should in no way be deemed to confer any implied free right of use in connection with what is disclosed, as proprietary rights are reserved, as by prior patent filing.

Preliminary Observations

The prototype demonstration devices all had a working core assembled from strips cut from an electrically polarised polymer sheet that formed the substrate for a very thin bimetallic surface coating of nickel and aluminium.

The relevant features from a functional viewpoint are:

(a) The fact that the nickel is ferromagnetic.

(b) The fact that the two metals have contact interface that can intercept heat flow confined to the plane of the material.

(c) The fact that, in being very thin, the metal, when transporting heat, could operate with fairly high temperature gradients in the metal.

(d) The fact that the substrate was a heat insulator and a space filler separating the conductive metal films and so ensuring that losses by heat flow between hot and cold heat sinks were minimal.

(e) The fact that, in lending itself to assembly in a structure that became a series-parallel plate capacitor, we could excite electrical oscillations transverse to the bimetallic junction interface plane, which meant that Peltier EMFs were directed in the line of current flow and such flow was through metal over an area of large cross-section which meant virtual elimination of I^2R loss.

(f) The fact that the two metals were opposite in electrical character, meaning that their charge and heat carriers were of different electrical polarities, a feature which, by virtue of the Thomson Effect, means that in-plane current flowing and circulating between the hot and cold sides of the device derived its power directly from heat throughput and did not drain the electrical power fed by the Peltier EMF.

(g) The fact that the device functioned as it was designed to function with a.c. as the transverse input-output form of power, because the Thomson current could divert the flow between hot and cold junction sides of the device according to the reversals of current polarity.

What we did not know is the design scope for increasing the thickness of the laminar metal in the device and whether the use of an a.c. operating frequency measured in tens of kilohertz was essential. It seemed from our earlier research that we needed that frequency activity to prevent a kind of lock-in effect forming super-cold spots in the Peltier-cooled portions of the junction interface or one needed a prevalent magnetic field which, by Lorentz force effects, could promote a shifting or displacement of the current flow traversing a junction. Strachan had suspected that there were oscillations developing in his d.c. experiments on thermocouples subjected to strong permanent magnet fields.

Furthermore, and having regard to certain other early experiments that were performed on thick metal assemblies subjected to high temperature operation, but operating at power frequency, we may well have neglected the role of the Nernst Effect in interpreting the performance data in our high frequency capacitor coupled devices. It is noted that it was the Nernst Effect which this author saw as the crucial factor in the operation of the three metal device that became the subject of our U.S. Patent No. 5,065,085 (corresponding U.K. Patent No. 2,225,161). However, Strachan in his funded experimental work concentrated attention on the form of device that was so impressive in generating power from ice and in freezing water with electric battery power input using that capacitor assembly and the subject of those other patents remained undeveloped.

It may be noted also that the whole foundation of the cooperation between Strachan and myself was our correspondence and exchanges some time even before we first met en route to a 1988 Canadian symposium on 'clean' energy. Those exchanges concerned the prospect of fabricating thermocouples by laminar thin film assemblies, virtually almost as a book-binding operation, and particularly our findings that magnets have a significant effect on the way thermocouple junctions perform.

A practical problem which confronted Strachan was that a great deal of effort was needed to cut and assemble hundreds of tiny pieces of polymer film in a way which avoided short-circuits between adjacent metal films and yet allowed connections to be made linking into what was a combined series-parallel capacitor structure. In being of small size, meaning limited power rating, there was then the task of designing and connecting an electronic circuit that could develop the necessary oscillations and take off power without interposing obstructive circuit contact and threshold potentials, whilst, to get adequate current flow through the series-connected sections of the capacitor, resonant operation at high electrical stress in the polymer dielectric was necessary.

Indeed, the manual assembly problem and circuit design exposed, in a sense, Strachan's Achilles' heel and it was this that precluded extensive onward diagnostic testing based on building several test structures using different design parameters, eg. choice of metal combination, metal film thickness and substrate material. There were other factors too, mainly arising from the route Strachan had followed in his earlier corporate research employment, which had involved the bonding of stacks of the polymer film in a structure which was acoustically tuned to set up mechanical vibrations for a medical application. That project had encountered operational difficulties owing to delamination and the assembly technique, though tedious, had evolved to overcome that problem whilst still needing excessive care to avoid electrical end-shorting as the bonded film components were cut to size.

In testing the structures assembled for that project Strachan had found that spurious electrical effects were overloading his test circuits and that there were instabilities that could be stimulated, seemingly by static charge, heat or mere physical displacement associated with manual handling.

Another problem, concerning the later thermoelectric research, was that there was some uncertainty, at least in Strachan's mind, as to whether the piezoelectric properties of the polymer were contributing in some way, even though this seemed to be ruled out of significance by the a.c. operation. My assumption on this was that the heating and cooling that accompanies cycles of voltage potential would compensate one another. There simply had to be an operational asymmetry from a functional point of view if net heating and net cooling were to link with the highly efficient electrical energy exchange that was in evidence.

It was only late in 1992, stimulated by a new funding sponsor interested in the power generation applications, that Strachan about measuring the magnetic field that was of necessity produced in the thin film by the Thomson Effect current circulation. His findings were of such an unexpected nature that he then stated we need have no more circuit switching problems. He became convinced that we were dealing with a phenomenon in the metal and not one in the polymer dielectric.

Thermodynamics Limited, which was the vehicle through which the patent rights were to be exploited, was granted an option to acquire rights under the U.K. patents which allowed the contractual arrangement with the sponsor and the R&D appraisal funding was passed on by sub-contract to Strachan's laser-orientated venture Optical Metrology Limited.

Strachan's research findings were then covered by Thermodynamics Limited filing a U.K. patent application on 6th February 1993, but since then no further progress has been made and no information forthcoming from that project. In the event, therefore, though this patent application was officially published as GB 2,275,128 it was not taken further and so became abandoned.

However, it is of relevance to this Report to summarize the scientific nature of the above discovery and, no doubt, more information will eventually be forthcoming from research endeavour of others now interested in that subject. In this connection, it must be stressed that, although we believe the phenomenon of interest is occurring in the metal, it is clear that there are some advantages in using the polymer PVDF because, in the form used, it has a strong electric polarization which allows one to control the cyclic changes of very strong electric fields at the interface with a metal film. This had a quite remarkable effect on the magnetic polarization developed in nickel but only when a temperature gradient was present in the plane of the film.

The main thrust of this Report, which does not concern polymer features, is the onward research now needed to fabricate a product version, based on this author's own independent research findings, and this requires some discussion of the Nernst Effect.

What will be described below is a way of building a `solid-state magneto-hydrodynamic power generator' that has features which allow one to probe heat-to-electric-power energy conversion efficiencies not hitherto believed possible in a thermo-electric power converter.

The Nernst Effect in thermoelectricity is one for which a temperature gradient in a metal in the z direction will, in the presence of a magnetic field acting in the x direction, produce an EMF in the y direction. The polarity of this EMF can be positive or negative according as to whether the heat transport is propagated by charge carriers which are of positive or electric polarity. The effect arises by analogy with the high power plasma technology involving thermal activation of ion flow in a magneto-hydro-dynamic (MHD) generator. In simple terms the magnetic field acts as a catalyst in asserting the usual Lorentz force action and causing the ions to be deflected from the z direction to the y direction. Heat is thereby deployed into an orderly electrical form which means that if electrical power is taken off in the y direction there is cooling and heat flow in the z direction loses temperature at an accelerated rate.

In practical terms, of course, the problem is one of taking the electrical power off in the y direction without losing heat through the current conductor leads. In a MHD generator this poses little problem because of the plasma is transported at high speed and the heat is not merely that of conduction in a static gaseous medium. This eliminates the contest between metal conduction of heat and electricity that one finds in normal Nernst Effect devices.

The Strachan-Aspden configuration is abnormal in this sense because the heat flow contest is between a polymer and the bimetallic laminations and the polymer, as a dielectric, transports electric current by Maxwell displacement processes which are unrelated to heat conduction.

Now, what was the late-1992 experimental discovery? It may have been illusory, a kind of ghost action related to magnetostriction in nickel and the Villari Effect, by which a stress induced piezoelectrically in the substrate polymer and subject to applied heat conditions was affecting the polarization of the nickel. On the other hand, it could come to be regarded as a new thermoelectric effect, ranking alongside those of Seebeck, Peltier, Thomson, Nernst, Ettinghausen and Leduc, all of which are different and yet somehow related phenomena. The discovery indicated that the application of a thermal gradient in the z direction combined with the application of an EMF producing a potential drop through the dielectric interfacing with the metal and perhaps communicated into the metal in the y direction will spontaneously affect a magnetic polarisation in the x direction. On the face of it, the experiment showed that a powerful magnetic field could be switched on and off in the x direction by regulating that EMF and no significant electrical power input was needed. Strachan proved this by feeding the control signal through a very high resistance and we saw this as amounting to a kind of solid-state grid-control device by which a powerful magnetic field could be switched on and off, even at a frequency measured in tens of kilohertz. What was needed was the heat input setting up that temperature gradient.

It was on this basis that the above-referenced patent application was filed, because one could see this as a way forward for converting heat input into electrical output via magnetic induction based on the use of transformer principles. However, with no useful detailed measurement data adequate at this time to determine the true nature of the action, this writer has been left in a quandary on this issue.

Whereas the basic Nernst Effect is the use of magnetism as a mere catalyst in converting heat into electricity and vice versa, we had here sight of the possibility of using a controlling electric field as a mere catalyst in regulating energy exchange as between heat and magnetic induction power output. The latter represents control, modulation, operation at a power frequency and voltage output governed by the turns on a inductively-coupled winding, all of which is good news for commercial exploitation.

This finding by Strachan must be researched further, in the light of the fact that the discovery was made using very thin film metal on the polymer substrate, and Strachan's later attempts to replicate the control action in a unit assembled from metal sheet stock were also successful, though only partially so when the metal thickness exceeded 10 microns. The research was abandoned before he had performed enough diagnostic testing of the phenomenon and given enough attention to magnetic inductive coupling problems in his test rig. One remains in doubt, therefore, as to whether or not it may be possible to exploit the above discovery in a heat pump or in fully operative heat to electricity converter.

This is where this author decided to get involved directly on an independent experimental venture which has, however, been of minimal scope so far owing to the problem of setting up a home laboratory facility with no external funding source.

My objective was to see through a form of experiment where heat gradients are established in bimetallic laminations by inductive in-feed of eddy-currents. That might seem the wrong way to go about the research, bearing in mind that one seeks to avoid loss and have heat transfer supplied via external heat sinks, but the physics of the internal eddy-current heating action can be quite revealing. Also, I had become mindful of the fact that research on cold fusion had proved unrewarding as soon as `expert' verification had involved extra care in keeping temperature constant in a test calorimeter. This, I had interpreted as a recipe for choking off the action, in that it might require a temperature gradient in the host metal cathode used in cold fusion to set up the electric nucleating charge effects that could initiate the reaction. So, my feelings were that there was sense in our thermoelectric situation in feeding heat into the metal to set up the initial temperature gradients which could act as a switch-on trigger in activating the Nernst Effect.

Accordingly, with this preliminary commentary, I draw attention to the reference to my thermoelectric research reported at pp. 21-30 of ENERGY SCIENCE REPORT NO. 1 which gave me confidence in the energy regeneration potential possible from use of the Nernst Effect in the manner of the Strachan-Aspden invention. ENERGY SCIENCE REPORT NO. 2 gives the full background of record concerning the 1988-1993 activity on the Strachan-Aspden invention. This Report concerns therefore what this author now sees as the most promising way forward, presented as part of an overall project, but the general effort, as funded by future sponsoring interests, still ought to proceed on several parallel investigations to ensure we do know the best route to expediting commercial development.

There are four separate research avenues warranting such exploration and, in retrospect, the first, which involves use of polymers, is the one that seems to be the most difficult but yet it is the one used by Strachan in all three demonstrated prototypes. The reason is that the evidence of an anomalous thermoelectric effect presented itself as unexpected spin-off from the prior research performed by Strachan for the medical application. That, fortuitously, upon special development, made it possible to table a demonstration of something that was quite tantalizing but somewhat ahead of the understanding of the true physics involved. However, in being linked to the polymer feature, that predisposed research effort in a way that has thwarted rapid progress. Strachan's full report on this background technology is an Appendix to ENERGY SCIENCE REPORT NO. 2.

The four research routes can be summarized as:

1) The development of thin-film polymer-based devices replicating the design features of the three prototype devices already built by Strachan and all of which functioned

well. Strachan has not run the two devices designed to work in refrigeration mode much below !40º C and the object should be to see how low one can take the temperature in view of the cryogenic possibilities. Strachan has avoided upper temperatures beyond that of water under normal pressure, because the polymer substrate properties would deteriorate and he relies on that for the capacitor activation. Here, however, one can see the potential for using polymers which are electrically conductive but heat resistive, i.e. not exploiting their dielectric capacitative properties, and that certainly warrants full scale R&D investigation.

2) Effort on developing the design embodied in the magnetically activated thick metal structure disclosed in U.S. Patent No. 5,065,085 (U.K. Patent No. 2,225,161). Test results on this have not been documented by Strachan but he reported that he had in fact done tests which were successful and it was on that basis that the subject patent applications were filed. Flame heat was apparently used as input and that promises something of interest to higher temperature needs of the power generating industry.

3) There should be effort to explore the `discovery' of the electric field control further, first from the pure verification aspect of this as a new scientific 'effect' and then as an application study to understand if the principle can be built into a practical heat-electricity transformer device. If that proves impractical it is important to know the reason why.

4) There should also be an experimental investigation based on the theme now to be discussed in the remainder of this Report, which aims directly at a regenerative action by which heat is converted into electricity. The prospect in sight here is not just the generation of main power from heat, but the refrigeration features that are entailed in the same process.

<u>Solid-State Magneto-Hydrodynamic Power</u>

It is assumed at this stage that the reader will have access to the detailed description of the Strachan-Aspden technology as described in ENERGY SCIENCE REPORT NO. 2, it being the sole objective now to develop the research theme (4) of the above list.

In order to focus the attentions of industrial interests it seems best to outline at this stage the anticipated constructional form of a possible product.

The core design would seem to be one having two planar metal heat transfer surfaces bounding an internal assembly. A temperature differential between these two surfaces is associated with heat flow through laterally-disposed metal ‘rib-like’ connections within the structure. Some means for electrical activation of a cross-current flow transverse to the heat flow direction is then needed inside the panel unit thus formed.

The latter could, as simple logical alternatives, be couplings or connections that are either capacitative, directly conductive (through heat insulating polymer) or magnetically inductive, whichever is the most effective and reliable as well as viable on price considerations.

This description, however, presents a quite ingenious way of using the conductive coupling without the design limitations of capacitance coupling. It has the merit of also being the most expeditious research route for this author in present circumstances, pending developments on the conductive polymer front.

THERE IS NO PAGE 22

In outlining this specific product form, this author is relying on his assumption that it is the Nernst Effect that can be exploited by a special combination of design features and it is important, therefore, to give a solid physical scientific basis for that assumption.

This is based on a logical consideration of the problem of harnessing the Nernst Effect and, more particularly, upon an experiment. The experiment is that discussed below under the heading 'Nernst Effect in Relation to Eddy-Currents'. The logical theme is that of the following argument.

A conventional MHD generator feeds heat into an ionised gas by combustion leading to ionisation. The gas is caused to flow along a channel subjected to a lateral magnetic field. This deflects positive ions one way and negative ions the other way, causing them to develop a back EMF across the side electrodes, which EMF acts against their motion in the direction of deflection and slows them down. In cooling they have transferred energy into electric potential that feeds a current drawn off from those electrodes.

This process is subject to the Carnot efficiency limitation, because the gas has a temperature and as much gas flows as output as enters as input, losing temperature on the way. The Carnot efficiency concerns the amount of heat energy extracted as electricity in relation to heat input, but that gas emerging as waste heat at a lower temperature carries away the energy that cannot be converted into electricity.

Note that the Peltier Effect or Seebeck Effect have a Carnot limitation because here the relevant action occurs at a junction interface between two metals having a contact potential set up between them. Here there is a circulating current confined to the metal circuit, but the crossing of the current at the hot junction interface results in a cooling because the current is produced by an EMF proportional to the contact potential (Peltier EMF) at the higher temperature. All that power is transferred into electricity which goes around the circuit, not as heat, but as electrical action. The current, unfortunately, has to cross the other cooler junction and so it has to allow much of that electrical power to come back into the thermal picture and go to waste by producing heat related to that cooler junction temperature. This is what brings the Carnot energy conversion efficiency restriction into play.

Then, there is the Thomson Effect by which the very presence of a temperature gradient, even in a single metal substance, results in heat flow conveyed by electric charge carriers. These are like the ionised gas in the MHD generator. They do not escape from the metal but if two metals work together, one conveying negative charge and the other positive charge, with that heat flow, so the action can occur to transfer heat whilst the process complies with the Carnot criteria.

It is here that a discerning scientist might ask whether one can arrest the flow of heat in a metal by applying a back EMF. The answer is negative, but the answer is not to be found in textbooks. The reason, undoubtedly, is that heat flow is a shared and collective action involving all free charge present in a metal, whereas the moment one applies an EMF to a metal there is an unstable effect and a current discharge that drives electrons against the heat flow by allowing some to group into a fast-moving filamentary flow. This is seen as accounting for the `cold-spot' effects occurring at the cooled thermoelectric junction, as discussed in an Appendix to ENERGY SCIENCE REPORT NO. 2.

Now, let us consider the Nernst Effect. Here there is a temperature gradient, which means a flow of heat energy carried by free electric charge in metal. In iron or nickel this becomes subject to the magnetic action present in all the microscopic domains, but we will simply consider that, owing to the ferromagnetic nature or iron or nickel, we can set up a strong magnetic field transverse to that heat flow.

This is nothing other than a solid-state MHD scenario which suggests a Carnot limitation on performance. However, consider here what it is that is carrying that heat. It is the electrons or positive 'holes' and we need to ask how these are affected in transit between the hot and cold sides of the metal host conductor. Firstly, they are deflected by the usual Lorentz forces to set up the EMF transversely in the metal. That means cooling as energy feeds into electric potential. Secondly, is there a difference between this and the MHD generator? Yes, there is, because once an ion in the MHD generator has cooled by delivering the electrical output, that ion merges with other gas ions <u>that are all flowing with it along the channel towards the exhaust end of the generator</u> and it can acquire no further energy able to generate more electricity without depriving another ion from asserting that role. In the metal, on the other hand, there are atoms vibrating about 'rest' positions in the structure that act as mediators in the thermal exchanges. This means that the heat shed by an electron can be promptly replenished while still in the hot zone, replenished by a source that does not itself have to move on to the lower temperature region. Note here that when an electron is deflected by the magnetic field to set up that transverse EMF it knows only the local temperature. It cannot just shed an amount of heat energy that leaves it at the temperature at the cooler end of the system. Indeed, it may be brought to rest in a thermal sense and have to merge with the environment by picking up heat which implies conservation of `cold' in the process. If energy and heat can be conserved, so can `cold', meaning that, if the electron has shed its heat by the Nernst Effect, it will need some action at the low temperature end of the system to bring the Carnot regime into this scenario. Yet, as the electrons reach the end of their passage through the metal and the magnetic field they are still subject to same heat-to-electrical transfer action because the Nernst Effect is still active so long as some heat is flowing.

The result of this is that the Nernst Effect becomes a function of <u>temperature gradient</u> and not <u>temperature</u> as such. The temperature gradient is a measure of the relevant electric current flow as carried by 'free' charge. Heat flow carried by electrons in passage through a strong transverse magnetic field and subject to a high temperature gradient will then develop an EMF which, if allowed to feed current, will, in turn, develop a cooling effect which has no regard to the absolute temperature except to the extent that the heat content per electron is determined by that temperature.

If one assumes that an electron giving up its heat energy to set up a Nernst potential loses only a proportion of that energy and recovers none in its onward passage to lower temperature regions in the metal, then one can logically argue that the Carnot efficiency factor applies as in the MHD generator. However, this seems not to be a correct physical picture of the true events occurring with the Nernst Effect. Indeed, it seems one can think in terms of a near 100% efficiency of heat-to-electricity energy conversion, just as the operation of Lorentz-related electrodynamic forces in electrical machines operate at near to 100% efficient mechanical energy-to-electricity conversion.

This author submits, particularly in the light of the experiments described in this Report, that the facts support the logic of this challenging argument and this, therefore, gives us a route forward to an energy technology that has enormous implications.

The only question we really face from a practical point of view in performing an experimental test is the task of deciding how to cause heat to flow one way through a metal whilst we take off electric current in a transverse direction without diverting heat flow in the same direction. This assumes that we can set up a magnetic field at right angles to both, which is clearly very possible.

Having considered this at some length and in the hope of exploiting that unwanted heat generated, if it is confined to the region where it can still do useful work, the author has devised the following structure expressly to perform the thermoelectric power conversion using the Nernst Effect.

Skin Effect Segregation

In order to get current to traverse a metal in the y direction with heat flow in the z direction and a magnetic field in the x direction, one can provide a metal interface between metals A and B across the xz plane and feed a.c. current through the structure in the y direction in a way which restricts the current flow to a metal surface of the A metal, whereas heat flow in the same direction is spread over the cross-section of the conductor and not subject to such a restriction. Then that heat flow can enter metal B from metal A at a position in metal B behind the current traversal position. This means that the heat entering metal B can then turn to flow in the z direction transverse to that current in the y direction.

The way to do this at normal power frequencies is to provide a rather thick high-permeability ferromagnetic conductor as metal A with metal B being a very thin ferromagnetic conductor. The current-heat segregation arises from eddy-current skin effect in metal A and, in traversing a thin section of metal B, the current will choose a flow path that is through a single ferromagnetic domain in metal B in which the magnetic polarization is transverse to the heat flow path and the current flow path and also in the direction that causes the Nernst Effect to develop a forward EMF.

An experimental test rig by which to verify this action is depicted in Fig. 6(a) and Figs. 6(b) to (h) apply to its operating principle.

Referring first to Fig. 6(f) the intention, for operation in the power generating mode drawing on heat supplied through a duct intermediate two panel structures in Fig. 6(a), is to cause heat to enter a thick metal heat sink layer of a ferromagnetic material coextensive with the surface of the duct. Then the heat flow is guided through 50 micron (0.002 inch) steel film which greatly reduces the thermally conductive cross-section and so results in a steep temperature gradient in that film. If much of this heat can be removed at entry into the film owing to a thermoelectric action there will then only by a small residual heat flow of much reduced temperature gradient left to provide direction for that flow towards the other heat transfer interface.

To use the Nernst Effect to discharge this cooling function one needs, firstly, a strong magnetic field, then, secondly, a flow of heat and, thirdly, a route for current flow, all mutually orthogonal. This means that one must contrive a way of ensuring that the heat flow does not automatically assume the same path as the current.

How can we separate heat flow and current flow in a common metal structure without having the current flow through a capacitative gap in the metal? Consider Fig. 6(d). Here a thick steel rod is shown to have an external current circuit which is arranged to magnetize the rod along its axis. One can set up a temperature differential along that axis and have heat flowing through the rod distributed uniformly over its cross-section. If now the current is a.c. and the rod has a high magnetic permeability and is thick in relation to that frequency, eddy-current skin effects will confine the current to a section close to the perimeter surface of the rod. Most of the heat will then enter the rod along a path that is different from that of the current. Should that rod be cooled in some way from the outside, as with the Fig. 6(f) representation, that small amount of heat loss will require heat to be diverted radially, and so orthogonally, with respect to any d.c. magnetic field along the rod axis and with respect to the induced skin current.

In this scenario one would have heat converting into electricity by Nernst Effect cooling, but all that would occur would be enhancement of the eddy-loss as the current escalates and the skin-effect becomes even more restrictive. Heat would be regenerated and there would simply be anomalous eddy-current effects, a phenomenon actually found in normal transformer sheet steels, but one that has not been understood by the academic establishment.

The way forward is to consider now Fig. 6(e). Here, the circuit loop is an elongated part-tubular thick ferromagnetic core and it is presumed that the a.c. current is supplied in the manner shown. In this case, the eddy-current skin effect is not on the outside of the core. The current is concentrated at the inside surface. The reason is that the current follows the path of least resistance and it would rather flow around a thin metal path embracing what is mainly an air core than around the highly inductive ferromagnetic core as well.

This configuration allows us to intercept the EMFs that are developed by the Nernst Effect, because they constitute `forward' EMFs assisting flow, meaning that, if we can conceive heat action bringing about electrical current oscillations in a converter which incorporates the principles being described.

Now, rather than providing a special magnetizing winding for producing a powerful magnetic field in the metal and then contriving the heat transfer interfaces inside that winding, it seems best to make use of the intrinsic domain magnetism in a core comprising thin steel film.

Refer now to Fig. 6(b). Here, several such films or laminations are shown to be sandwiched between two steel bars. The bars form an energy route for heat which is to flow through the steel laminations and be bled off through those laminations to seek a cooler heat sink at their extremities. A conductive metal, which need not be ferromagnetic, in between the base section of the laminations merely serves to provide the conductive path makes their connection.

Looking at a single lamination, one can see from Fig. 6(c) how the saturation magnetic flux in the domains can be directed. The dots and crosses denote arrow directions as pointers indicating the magnetic flux orientation. Any current passing transversely though the lamination will be aided by the intervening non-magnetic highly conductive metal to guide it through the domain which offers least resistance. Going one way through a domain will develop a back Nernst EMF and going the other way will develop a forward Nernst EMF. According to its polarity the current will always choose a route through a domain which offers a forward Nernst EMF. There will always be cooling if there is an orthogonal temperature gradient.

This is shown in Figs. 6(g) and 6(h), with the skin effect serving to separate the heat flow path (broken lines) and the current flow path (full lines). The domain pattern in the thin film, whether in nickel or iron, which have different polarity Nernst Effects, will always govern the current flow and contribute to cooling.

Note that, by using thick steel bars to provide the heat sink spacer members, the heat can flow freely to the entry into the domains in the film. The skin effect, even if such that current is confined to what is effectively a 10% section of the thick steel bar, will only suffer the resistance losses that relate to flow in that restricted section, but set alongside the power generated by the Nernst Effect cooling action, this is a quite small loss and it merely regenerates heat input. The only loss as such is that of heat conducted to the remote secondary heat exchange interface.

Thus, in Fig. 6(a), the structure shows how current circuit connections can be made to link with a transformer core and other windings coupled to external circuits. The bold lines indicate a thin layer of electrical insulation, which still allows passage of heat, it being necessary to avoid the short-circuiting of the power generated. The rib-like connecting films can, in functional terms, be left floating in a cooling medium with no assembly for the secondary heat exchange interface.

An inert gas blown across the fins thus formed would serve as the means for assuring the temperature gradient which activates the main cooling function drawing on heat supplied to the inner duct.

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THE ABOVE TEXT WAS WRITTEN IN MARCH 1994 WITH A VIEW TO INCORPORATING A SECTION HERE WHEN A PRELIMINARY EXPERIMENT ON THE ABOVE LINES HAD BEEN PERFORMED. IN THE EVENT THE EXPERIMENT WAS DEFERRED PENDING COMPLETION OF THE EXPERIMENT REPORTED IN THE NEXT SECTION.

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The Magnetic Inductively-Coupled Device

Whereas the above description concerns a electrically-conductive coupling between separate compartmented sections of a thermoelectric power converter and uses a transformer coupling externally to bring together the power generated from heat in each metal film current crossing, one can see scope for building a version which relies directly on a magnetic inductive coupling in each cell of the structure. In effect, this involves building a transformer within each compartment. This is shown in Fig. 11 of a recently filed patent application. (See Appendix I on page 37).

The device would comprise internally a series of longitudinal compartments each containing a slender rod-like magnetic core. A winding on the core would provide the circuit by which input or output a.c. is fed through all such windings connected in series and possibly through an isolating transformer.

The heat transfer problems of the outer bounding metal surfaces and their design will not be discussed as these are familiar terrain for those involved in the relevant industries and this is not intended to be part of a business proposal for setting up a manufacturing venture.

Noting that the bimetallic metal circuit linked by each ferromagnetic core is virtually a short-circuit, the reader will understand that very little EMF has to be induced to set up the internal current circulation. That said, the cross-section and operating magnetic flux density can be quite small, even though the design aims to take off substantial current by transformer action. A very close coupling as between the heat-driven primary circuit and the secondary as output winding is then essential and that is assured by the enclosed compartment feature which provides a conductive housing along the whole length of the ferromagnetic cores.

The latter do not need flux closure structure in small product applications, because being very long in relation to their sectional dimensions, they have very little demagnetizing effect and such inductance as does exist is to the good, because it will serve to smooth out the loading as between the several cores.

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THE TEXT JUST PRESENTED WAS WRITTEN IN MARCH 1994 BEFORE THE AUTHOR'S OWN EXPERIMENTS ON THIS CORE SYSTEM WITH MULTI-BIMETALLIC-LAMINAR STACKS WERE PERFORMED. TWO SUCH EXPERIMENTS ARE NOW REPORTED BELOW.

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(a) First Experiment

Two ferrite-cored transformer units were used, each having a primary input winding and a secondary output winding, arranged side by side and parallel-connected to feed a common short-circuit single turn tertiary winding, the latter comprising strips of aluminium through the cores bridging external stacks of multi-laminar metal composed of alternate layers of 50 micron steel shim and electrolytically tinned sheet steel of 200 micron thickness. There were about 140 layers of steel in each of the two stacks and the thin layers of tin provided electrical contact between them and separated the current flow paths through the magnetic domains in the steel.

In principle, current flow in the primary induces an EMF in the tertiary winding which, given a temperature gradient in the bimetallic stacks, should develop a negative resistance owing to the Nernst Effect. This should cause current to flow augmenting the action of the primary current in overcoming the reaction set up by a load current. Hopefully, heat input to the bimetallic stacks would then result in electrical power output from the secondary windings whilst the power supplied to the primary winding would be mainly reactive in sustaining the magnetization.

The result of the experiment was that a comparison of power input versus power output from the secondary indicated that the transformers were functioning as if the tertiary single turn winding did not even exist! It did not seem to draw any short-circuit current that could effect the operation and did not contribute any thermoelectric current to the output, so far as could be judged. However, no heat input was applied and there was little point in making that provision, given that the current flow through the bimetallic stack and on which the experiment relied was not in evidence.

Since ferrite cores were used in the transformers it was possible to connect a capacitor to tune the input impedance to unity power factor and run on secondary load at an audio frequency so as to explore the possibility that the short-circuit path was obstructing current flow owing to it having a high self-inductance. A resonance at 12 kHz was observed, but energy accounting in this state revealed no thermoelectric anomaly, albeit with no heat input. It was evident that there was some unexpectedly high resistance effect in the short-circuit path through the bimetallic stack, sufficient to restrict the transformer action to interplay between the primary and secondary windings, inasmuch as the short-circuit tertiary winding embraced both of those windings. Yet, the very existence of the changing core magnetic flux should still produce EMF in that circuit through the bimetallic stacks.

It was decided to establish just how much of the action could be conveyed through that bimetallic stack circuit, by constructing new apparatus, the subject of the second experiment.

(b) Second Experiment

Here two 100 VA 50 Hz power transformers were coupled to form a unit with a primary winding on one and a secondary winding on the other, the coupling being through a single turn circuit through two copper bars linking two stacks of about 200 steel laminations, with intervening tin coating, which formed the secondary output from the first transformer and the primary input to the second.

The power finding its way through this system would have to involve current flow through the bimetallic stacks.

Tests were performed which, again, confirmed that the current circuit through the laminations was sufficiently resistive to preclude any chance of a thermoelectric gain, at least with a modest heat input, though, again, no provision for that was made at this preliminary diagnostic stage.

The two transformers and their windings were identical and so, in voltage terms at 50 Hz, the no load secondary output voltage should be reasonably close to the no-load primary input voltage, if the common coupling circuit through the bimetallic stacks could function to carry sufficient current to supply the magnetization needs of the second transformer.

The first test gave the following data:

Primary	Secondary
50 V	0.111 V
100 V	0.227 V
150 V	0.349 V
200 V	0.493 V
250 V	0.640 V

Prior to this, the input transformer of this identical pair was tested to determine its no-load magnetizing input current. The standard rating at 240 V by the manufacturer of the kits from which the transformers were assembled was 120 mA. The following test data apply:

Voltage	Current
10	0.80 mA
20	1.39 mA
30	1.88 mA
40	2.40 mA
50	3.02 mA
100	6.19 mA
150	12.58 mA
200	53.8 mA
240	121.8 mA
250	154.0 mA

It was clear from this that something significant was obstructing this 50 Hz current flow through the bimetallic stack.

It was possible, from the symmetry of the apparatus, to test the d.c. resistance of the two stacks as if they were parallel connected rather than series connected. A current of 96 mA gave a potential drop of 2.5 mV, corresponding to a parallel resistance of 0.026 ohms and a series circuit resistance of 0.104 ohms. When tested at 340 mA the potential drop was 9.3 mV, meaning a loop circuit resistance of 0.109 ohms.

The problem now was that, having passed some d.c. through the bimetallic stack, there was the possibility that some circular in-plane magnetic polarization had taken place in the steel laminations, possibly affecting the inductance to a.c. current flow. Accordingly, and also because the d.c. might have affected contact resistance, the primary to secondary voltage ratio was again measured, with the following improved results:

Primary	Secondary
20 V	7.57 V
40 V	11.22 V
80 V	13.61 V

120 V	14.30 V
140 V	14.69 V
180 V	14 83 V
240 V	14.95 V

To make sense of these results, it is noted that at 240 V, the rated induced EMF per turn of the transformer is 0.37 V and to feed enough magnetizing current to develop reaction flux corresponding to 14.95 V in a magnetizing winding the above magnetization current data show that about 1.20 mA will suffice in the 240/0.37 number of turns. This translates into a magnetizing current of 0.78 A generated in the stack loop with a 0.37 V signal. The impedance of the loop is 0.47 ohms at 50 Hz.

This is rather curious. If the current flow is resisted by the contact potentials in the bimetallic stack then one would expect the increasing induced EMF as the input volts range from 80 V to 240 V to cause a progressively increasing current flow, whereas the data suggest a saturation effect. Something is limiting the current.

That loop current of 0.78 A passes through 400 junctions from steel to tin interleaved with 400 junctions from tin to steel. It could therefore be that the Peltier heating and Peltier cooling at each junction pair sets up sufficient temperature differential in the current flow direction for a limiting current situation to develop which overrides any hope of exploiting the Nernst Effect. Remember that in the dielectric stack assembly built by Strachan there was thermal separation between adjacent junctions in the transverse current direction through the stack and this thermal isolation of junctions could well be essential.

In this author's own experiments with a transformer assembled from bimetallic laminations [See Energy Science Report No. 1] the laminations are insulated from each other as in a conventional transformer and so the close dual junction crossing does not occur in that situation either.

To sum up, at 0.109 ohms, we have a higher d.c. resistance than is expected when 0.34 A flows through the loop circuit. The 50 Hz a.c. impedance at 0.78 A is 0.47 ohms, which seems enormous for a stack path through metal conductor of about 2 sq. cm cross section and 10 cm length linked by copper bars of 20 cm length and 0.5 sq. cm section. Even allowing for the self-inductance attributable to the high permeability of steel, that permeability would have to be truly enormous to account for the 0.47 ohm impedance at 50 Hz.

Accordingly, the author is inclined to suspect that the Peltier effect of two closely adjacent junctions in the current flow path is defeating the scope for tapping the Nernst Effect, but, whatever the cause, it seems logical to abandon attempts to build a through-conductor metal coupling between laminations in the bimetallic stack.

This causes attention now to turn to the alternative of harnessing the Nernst Effect by virtue of its interaction with eddy-currents in transformer laminations.

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<u>Nernst Effect in Relation to Eddy-Currents</u>

It is assumed that the reader is familiar with the way in which eddy-currents are induced in a sheet steel lamination as used in a power transformer.

The cyclic oscillations of the magnetic field cause an EMF to be induced in any circuit conductor wrapped around the core. This is why power can be taken off from the secondary winding. Given then that the steel laminations are of metal and that they share in carrying that magnetic flux oscillation, each lamination experiences a small circuital EMF internally and this causes a circulating current flow around what is a short-circuit path. As a result there is a loss which is termed `eddy-current' loss.

This loss is small in comparison with the power that can be transferred between primary and secondary windings by the transformer action, but yet it can be significant and the design reduces such loss to a minimum by using steels which have higher resistivity and laminations which are small in thickness. The loss can be avoided by use of ferrites but commercial power transformers are subject to other design criteria related to size and I^2R losses and steel laminations offer the best design option.

It so happens that this author devoted three years Ph.D. research effort to the study of anomalous eddy-current losses in sheet steels (1950-1953) and is aware of the fact that there has been little progress in the further understanding aspects of those anomalous losses since that period. Indeed, not many academics working in electrical engineering today even know that there is a loss anomaly. Yet, under certain circumstances, the loss, as observed experimentally, can amount to a tenfold increase over what theory based on Ohm's law prescribes. Moreover, as this author's research verified, the momentary values of the loss factor (experiment versus theory) varies significantly around the magnetization loop and in dependence upon mechanical stress and d.c. polarization.

From the viewpoint of this Report the introduction of heat by eddy-current induction as a way of testing a thermoelectric action is an interesting proposition, because adjacent laminations in a transformer are electrically insulated from one another and this must, in some measure, mean that the eddy-current heating and hysteresis loss as well will involve thermal conduction in plane in the laminations. This is what we have in the Strachan-Aspden thermoelectric device, but whereas heat flows from one side of a laminar assembly to the other in that device, the flow is from the centre outwards in the transformer.

Now, in spite of the fact that the writer, as an undergraduate, had in his possession a textbook on physics which includes a very extensive section on thermoelectricity and does explain all the named `Effects' mentioned above, it did not at any time in that later Ph.D. research era occur to him as relevant to study thermoelectric action in the conventional transformer core. One thinks of thermoelectricity as being something involving two metals and, if one does ponder the single metal situations where heat gradients apply, the effect of an a.c. magnetic field oscillating at 50 Hz or 60 Hz can hardly be expected to develop a non-cancelling thermoelectric action. The heat energy cycling at such frequencies by sequential cooling and heating in equal measure will, one might presume, not do much to the temperature profile in a steel lamination and so any heat that is produced by magnetization loss is seen simply in that light as being mere energy wastage and having no thermoelectric implications.

What the writer completely overlooked, even though professing expert insight into eddy-current phenomena, though well knowing that magnetic domains in ferromagnetic crystals are a factor in enhancing losses, was something that is now blindingly obvious. It has taken the diagnostic testing of our Strachan-Aspden devices to turn the essential key by seeing reason to challenge the way we accept that d.c. electric current flow in metals is uniformly distributed over the conductor cross-section, whilst a.c. current flow might experience some surface concentration as a function of frequency.

Suppose that the flow is carried by electrons and ask the question as to whether electrons can convey current if they all share the action equally at every instant or if they find it easier to carry current by getting in line one behind the other and all moving together. In short, for a given limited current flow, may it not be that filamentary current surges can occur by electrons taking turn in joining a team and forming sporadic fast-moving surges, whilst those left out of such teams enjoy freedom from the current transport task?

If this is seen as `no more than an idea' I invite readers to wonder why there is something magical about a current of 19 amps. This is a level of current at which current discharges in certain plasma type experiments divide into separate filaments. It happens also to be the current carried by a flow of electrons, lined up one behind the other, with each electron moving forward past a check point every time, as it were, that the whistle blows, assuming that the frequency is that we associate with the Compton wavelength of the electron.

Current flow through a metal could well involve short-lived filamentary surges comprising discontinuous elementary circuit elements of a momentary 19 amp strength. What we measure might seem to be a continuous mere milliamp current uniformly distributed over the metal cross-section, but what may be happening inside that metal is something else.

It is for this reason that in the earlier research on the Strachan-Aspden thermoelectric device it was concluded that the a.c. activation is what precluded cold-spots forming at junction interfaces. The transport of current across the Peltier cooled junction in a metal as opposed to in a semiconductor would obviously act to cool the metal in the very limited territory of that junction and that means enhancement of electrical conductivity owing to that supercooled region. There is every reason then to believe that with d.c. operation the formation of a filamentary flow would cause the filament to lock into one junction spot. Effectively the spot would cool until it nearly was at the temperature of the remote Peltier heated junction and that would mean that d.c. thermocouples composed of base metals, such as aluminium and nickel, would have very poor thermoelectric power properties. With a semiconductor the cooling usually tends to increase resistivity and that would drive the filament away to a path of lower resistance and so preclude that cold-spot locking.

Now, keeping in mind that current flow may be filamentary and that currents like to follow the paths of least resistance, consider that steel transformer lamination and suppose we apply a strong d.c. magnetic field plus a relatively weak a.c. field which puts some eddy-current heating into the lamination. We then have a situation where, by the Nernst Effect a temperature gradient on one side of the lamination will interact with the d.c. magnetic field to produce an EMF directed through the thickness of the lamination. Similarly on the other side, because heat flow is in the opposite direction, we have a Nernst EMF directed the other way through the thickness of the lamination.

This is a recipe for setting up a current circulation in the lamination that is not an eddy-current but a d.c. current flow. Now, depending upon the polarity of the Nernst Effect for the metal, such current would either act to strengthen the d.c. field or would act to suppress that field. In one case, the action would, in theory, mean an escalation of the d.c. field strength. In other words, unless there is something that qualifies what is being described, a ferromagnetic lamination could conceivably become a bistable element, polarized overall in one direction or the other and lock in to that state by virtue of the controls we exercise on heat gradients. Note that nickel and iron have opposite polarity Nernst coefficients and so one or other should meet the specified criteria.

The phenomenon suggested is, however, is something that I believe can rightly be declared as `contrary to experience' and therefore unlikely. However, it means that we have to explain now why it does not occur and so, since I did not argue the filamentary current case, in developing that polarization theme, I will now reexamine the question assuming filamentary current flow.

To proceed, take note that in truth the steel lamination comprises magnetic domains all of which are magnetized to saturation in one or other of the three orthogonal axes in its crystals. Imagine that the Nernst Effect is at work setting up those circuital EMFs but pose the question as to which magnetic field direction really governs the action, because any externally applied d.c. field is not going to affect much the strength of the local magnetic field in the domains which happen to be momentarily occupied by the filamentary current.

Consideration then shows that the filamentary current flow will, if the `hypothesis' holds, always choose a path through a domain having the magnetic polarization in a direction which corresponds to cooling since this is the path of least resistance, indeed of negative resistance. In short there could be a net cooling effect if the ohmic losses arising from in-plane current flow are less than the Nernst power action that is generated. Indeed, such a scenario would be one that escalates because the heating in the central region of the lamination would enhance the temperature gradient as that heat is conducted back to the edges and, in effect, the action would be self-regenerating and run continuously with no intervention from outside. If the applied field were an a.c. field the action would see the filamentary current direction reverse, it having then the phase of the eddy-currents, but in physical terms it would be as if the resistivity of the steel lamination had, in effect and overall, reduced virtually to zero.

To summarize the position, either one accepts the filamentary current hypothesis or one does not. If it is not accepted, then one has the problem of explaining why a steel lamination in a transformer does not virtually convert into a permanent magnet. Also one cannot then explain the very high thermoelectric EMFs which we measured for Al:Ni junctions using a.c. activation, because there is then no reason why the very much lower d.c. thermoelectric power of record in reference data should not apply to the a.c. embodiments. That also leaves us with a problem.

If it is accepted, then one can predict a very high anomalous eddy-current loss under circumstances where the lamination thickness is small enough to imply single domains over that thickness.

The issue is intimately associated with the exploitation of the Nernst Effect as a cooling process because the interaction of our external controls and the internal current circulation inside the metal lamination can greatly enhance the scope for practical energy conversion.

Experimental Investigations

The objective of the experimental investigations can be set in context if one refers to a vector diagram showing the normal operation of a power transformer on load and on no load.

The focus of attention is the eddy-current induced in a single lamination as normally used in a transformer.

The current flow parallel with the surface of the lamination is subject to resistance and that flow accounts for virtually all of the eddy-current loss, whereas the flow of current at the edges and transverse to the main flow makes the short crossing of the thickness of the lamination and will take the path of least resistance.

A lamination that has a 200 micron thickness is one in which single magnetic domains could well span the full thickness, meaning that a current which has, near those edges of the lamination, to flow from one side to the other can do that by passage through that single lamination. This contrasts with the main flow parallel with the surface, in that the latter has no choice but to travel through the succession of domains in its path which have polarizations first one way and then the other way. Given that the temperature gradient in the lamination will normally be confined to flow in the plane of the lamination and across its width as opposed to its length, that makes it orthogonal with the current crossing the thickness and with the magnetic polarization of some of the domains. That current can choose a domain for which the Nernst Effect asserts a cooling action to give an EMF impetus to the current flow.

In summary, therefore, we see that the Nernst Effect in a thin transformer lamination will drive eddy-currents as if it introduces a negative resistance in the eddy-current loop circuit, given the natural heating that occurs anyway with the presence of magnetization loss.

The question at issue is how this Nernst Effect can be represented on a vector diagram showing transformer core operation and the answer to this is that it amounts to a forward EMF driving a current in anti-phase with the back EMF and so amounting to a magnetomotive force (MMF). It may now be realised that there are interesting considerations when one makes a comparison between the on-load operation of a transformer and the no-load operation of a transformer.

Remember, however, that, without the temperature gradient, there is no Nernst Effect. Provided, therefore, we operate the transformer on load and try to avoid the no-load situation, which aggravates loss owing to the Nernst Effect, there is special advantage from a power generation point of view in accentuating the Nernst Effect by incorporating the bimetallic lamination feature. This transfers heat in a way which can sustain the thermal gradient and allow the transformer to provide more output electrical power than needed as input, by virtue of the Nernst cooling action which draws on the external heat source.

In its own curious way, this on-load-no-load distinction between the magnetization loss action in a transformer can account for the lack of concern about the eddy-current anomaly by transformer design engineers. The loss anomaly is there to be seen if one tests the no-load properties but transformers are so efficient when operating on load that one need not worry about it at all. However, if the subject under discussion in this Report becomes a technological reality, the transformer that accentuates the Nernst Effect by using thinner bimetallic laminations will bring that eddy-current anomaly more to our attention.

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At the time of writing this Report the author has encountered the problem that the same test device, albeit after a lapse of time and following some spurious testing involving connecting a capacitative load across the secondary winding, has exhibited operation in a different mode when comparison is made with the initial tests.

It is therefore of interest to explain first the test protocol and objective of the experiment, but to facilitate latter analysis this will be done from two viewpoints related to the two different temperature profiles that might be set up in a lamination.

The laminations were bimetallic and of Fe:Ni composition. See Energy Science Report No. 1 for description of the test apparatus and results.

Assumption I

The temperature profile from edge to edge of a lamination is deemed to be of the kind shown in Fig. 7(a). This assumes that the heat flow by normal conduction through metal is from right to left and that any excess heat generated by eddy-currents is mainly shed on the left hand edge of the lamination. We do not consider the thermoelectric current circulation owing to the Peltier and Thomson Effects at this stage, though their action would affect the heat deployment.

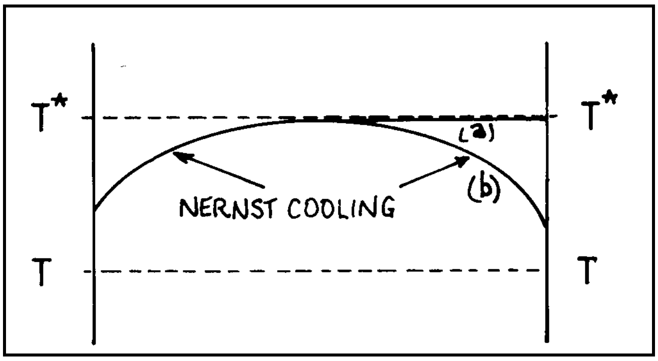


Figure 7

Assumption II

The temperature profile from edge to edge of a lamination is symmetrical as if eddy-current heating occurs normally and heat flows to both outside edges. This is shown in Fig. 7(b).

Now, by having Fe and Ni as the two metals in the lamination, both having opposite Nernst coefficients, we will examine the action where there is a rapid change of temperature. The heat flow in these regions crosses the strong saturation fields in successive magnetic domains and this induces Nernst EMFs which will set up microscopic current circulation around loops through adjacent domains. This is a parasitic action that does not interfere with the main eddy-current effect; it feeds on heat produced by self-cooling and the energy books balance as part of the natural thermal equilibrium inside the ferromagnetic metal.

However, we have a circulating loop of eddy-current that changes from a clockwise to an anticlockwise current flow and vice versa at the power supply frequency. This current, regardless of direction will always follow the path of least resistance, which is the one through the forwardly directed Nernst EMFs in the domains which have the polarization direction giving the forward EMF.

In other words, but only deriving from where the temperature gradient profile is steep, there will be substantial cooling adding power to drive that eddy-current and there will be ohmic I^2R heating in the mid-range where the current flow is, in any case, not transverse to the temperature gradient.

By the Assumption I temperature profile, this means that the eddy-currents will enhance the temperature gradient on the left hand side of the lamination and merely feed the balancing heat as a build-up on the left-hand side, so preserving the profile.

By the Assumption II temperature profile, the Nernst Effect action will be to take heat from the sides of the lamination and feed it to the centre, so preserving that form of temperature profile.

Conceivably we have a bistable thermal situation sustained by the eddy-current action. In both cases, however, the Nernst Effect will have enhanced the current flow as if the resistivity of the lamination has been reduced. Indeed, the eddy-current flow will be enormous and, even though heat is merely moving around a loop by virtue of the Nernst Effect, there is added input of energy needed from the external induction source because the superimposed action has reduced the path resistance.

It is as if a resistor R is fed by current from two sources I from A and I_o from B. When we work out the loss this suggests $(I+I_o)^2R$ but source A contributes I^2R plus $I_oI^2R/(I+I_o)$ and source B contributes $(I_o)^2$ plus $I(I_o)^2R/(I+I_o)$, whereas the latter is matched by an internal cooling effect. We still have to feed in extra power from source A. That extra power is anomalous eddy-current loss.

From an experimental viewpoint it is then of interest to find which situation, temperature profiles I or II apply, given that we can check our theory by examining the level of that eddy-current anomaly observed.

Now, let us consider the Peltier Effect as superimposed on this situation. The eddy-current component seems to have no relevance because the oscillations mean heating and cooling in balance, though one could suspect that an overall added heating effect might apply if the Peltier EMF exceeds the Nernst EMF and the Peltier activity is biased towards heating. For the temperature profile of Assumption I there will be a d.c. current circulation which will partially polarize the state of magnetism in the lamination as a whole. For the temperature profile of Assumption II there will be no overall d.c. polarization but there could be two d.c. current loops, one clockwise and one anticlockwise, whereby one half of the lamination is biased in one direction and the other half is biased in the other direction.

Any such d.c. effect, in either case, will limit the range of flux change as evidenced by a **B-H** loop test. In the first case of assumption I, the loop will be displaced.

So, in mounting the experiment, the writer was just curious to see what happened and was expecting the assumption I scenario. The plan was to build a test rig with no provision for asymmetrical heat exit from the test specimen and then rebuild with the eddy-currents generating heat but with one core edge insulated from heat egress and the other having a cooling facility. This latter version of the experiment has not yet been implemented and it may, indeed, be facilitated by co-operation with an institutional laboratory, should such assistance be proffered by sponsors.

The report on the initial experiment, some of which was recently published, as in the Australian magazine NEXUS (pp. 48-51, February-March 1994 issue), has also been presented and in its updated form in ENERGY SCIENCE REPORT NO. 1, the findings suggest that the test device is bistable and can be made to work in either assumption I or assumption II mode.

Discussion

The tests just reported tell this author that the Nernst Effect, if exploited in thin ferromagnetic laminations, having surface provision for guiding conduction current through single domains selected naturally by `path of least resistance' action, and having a temperature gradient that is in-plane in the lamination, will serve as a very efficient cooling device.

The findings reported in the test conforming with assumption I are very exciting in that, given confirmation by further experiment, there is reason to believe that a self-generating action is possible. It may even be that we can feed heat into a transformer implementation and with a controlling primary input get the main power from the secondary.

This combines refrigeration and power generation, not just as variants on the same technology, but as one and the same, though to get main power generation on a kW per unit weight of apparatus basis one will need to force-feed heat energy input.

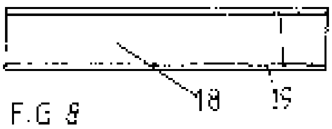
The technology needed on the basis of the reported experiments is one of intercepting the `eddy-current' flow and that is essentially what we see in a power transformer, because the secondary windings are circuits in which eddy-current flow if the output connections are shorted. We simply need to incorporate a secondary winding that can react inductively to the `eddy-current' circuit or include the Nernst activated elements into that secondary circuit directly.

These issues, therefore, become design questions that involve R&D of a proprietary nature and it is submitted that this ENERGY SCIENCE REPORT has served its purpose of introducing prospective development interests to the potential of the technology outlined above.

The technology is destined to provide a very effective route to converting heat into electricity and, since the principles of operation depend upon temperature gradients and not absolute temperature in Kelvin, there is no Carnot factor to limit performance. There is therefore, with some internal heat recyling, clear scope for a near to 100% conversion of heat into electrical power and at least refrigeration prospects down to 77K, where the warm superconductor regime offers future promise.

HAROLD ASPDEN

15 MARCH 1994



F.G 8

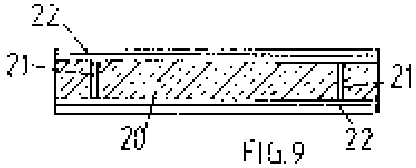


FIG.9

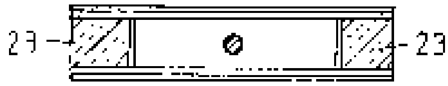


FIG 10

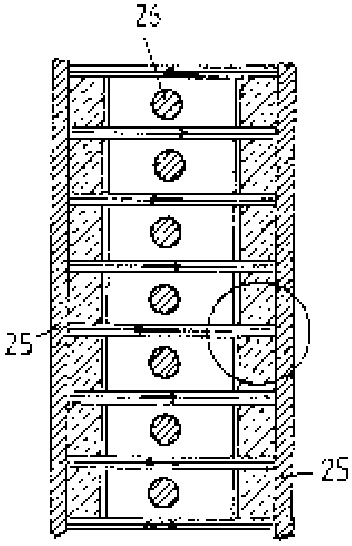


FIG. 11

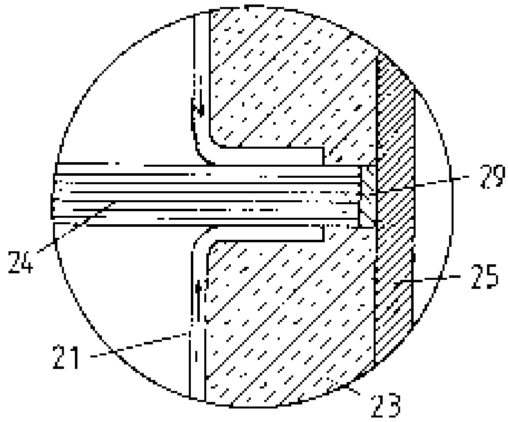


FIG.12

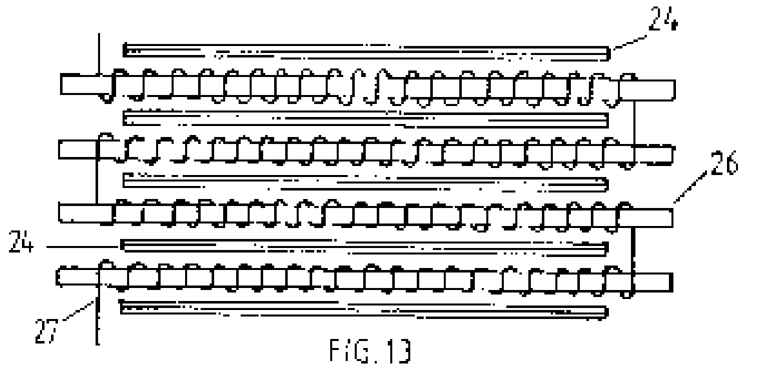


FIG.13

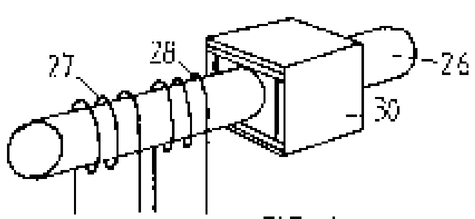


FIG.14

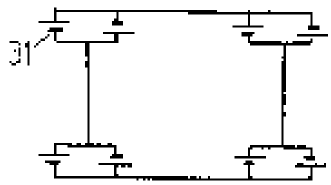


FIG.15

ENERGY SCIENCE REPORT No. 4

This Report was first published in 1994 at a time when the author was involved in experimental research aimed at seeing if one could tap energy from the vacuum medium. This might seem to be an absurd pursuit but there were certain anomalies in experimental findings and debatable issues of a theoretical nature that needed resolution. As this Report shows, the author was not alone in seeing the need to clarify some of the mystery which clouds our understanding of magnetism. This version of the Report now published on Internet some nine years on from its printed publication in 1994 is an unamended copy of that original text, made available here for historical record of the author's efforts........... Harold Aspden, 18 June 2003

ENERGY SCIENCE REPORT NO. 4

POWER FROM MAGNETISM: THE POTTER DEBATE

Contents

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POWER FROM MAGNETISM: THE POTTER DEBATE

Introduction

This Energy Science Report is written at a time when a surge of activity has developed on the 'free energy' scene concerning the prospect of tapping energy from the quantum action of the vacuum state - the aether.

The research claims of New Zealander Robert G. Adams have become the focus of attention owing to his disclosure of the design of a motor which performed anomalously and which was said to deliver more mechanical power than was supplied as electrical input. This has been mentioned in ENERGY SCIENCE REPORT NO. 1 in this series and more on the motor topic generally will be reported in later reports. The scenario developing at the present time has become one of contention amongst different proponents working in this field as the struggle for recognition begins to cloud the interpretation of the evidence and results in the withholding of information.

The 'free energy' prospect is still an issue of debate awaiting the clear demonstration of a working machine that can withstand all tests and scrutiny by experts. It had been hoped that the Adams motor would have featured in such a demonstration at the Denver, Colorado symposium in May 1994 organized by the Institute for New Energy, but, at the present time, April 1994, that is no longer in prospect for reasons totally unrelated to the technical merits of the Adams development.

This author seeks by this Report to draw attention to what, in a sense, has been a 'behind the scenes' secret debate pursued by Frank F. Potter of Croydon in England who has aroused the interest of a few physicists in British universities. His topic is that of calculating the interactions and behaviour between magnets and a magnetizing solenoid. His concern is to get an answer to the question of how the energy involved can be formulated theoretically in a way which allows experimental testing. Potter's intuition has, it seems, followed for many years a track not too different from that which may have inspired Robert Adams and others, including the German, Hans Coler, whose experimental work, after confirmation, became the subject of a secret government report dating from the World War II era. What is so fascinating about the Potter interest is that, although it dates from many years past, it has not surfaced hitherto in a way which has become known to those now interested in the 'free energy' field. It is especially interesting because Potter's correspondence indicates that academics skilled in mathematical physics, though showing diligence in their efforts, have been unable to provide answers that satisfy Potter.

The Potter debate provides a new perspective and a new starting point for resolving the 'free energy' issue concerning magnets subjected to solenoidal fields, bearing closely upon the theory of operation of the Adams motor. It is timely to discuss openly the answers to the questions raised.

Preliminary Background

It may interest readers to know the background of how it was that this author came to hear about Frank F. Potter.

For several years there have been annual meetings held in September at Cambridge University in England by an organization named ANPA, the Alternative Natural Philosophy Association. One theme pursued with great interest by many members of this association is that of calculating the basic physical constants, such as the proton-electron mass ratio, by mathematical techniques involving what is termed a 'combinational hierarchy'.

This author has long been interested in the creative activity of the vacuum energy field in producing protons and that research had led to published work on the calculation of the proton-electron mass ratio by methods distinct from those of special interest to ANPA. A spin-off from that research was the theoretical derivation of the measured properties of the deuteron. The author had been especially interested also in the electrodynamic properties of these particles and electrodynamic actions within metal conductors and so, with the advent of 'cold fusion', there was purpose in extending the research with the 'alternative energy' scene in mind.

A particularly interesting development was the extension of the theory to the theoretical derivation of the properties of the third isotope of hydrogen, namely the triton and it was the simple derivation of the lifetime of triton, which the author saw as confirming his theory, that gave reason for an initiative to attend the 1993 ANPA meeting in Cambridge to present that theory.

That latter subject warrants its own Report in this series of ENERGY SCIENCE REPORTS and will be dealt with separately.

Now, in attending that September ANPA meeting, the author had very much in mind the fact that he had earlier, in April 1993, attended the Denver, Colorado symposium on New Energy and become very interested in the reports on the Adams motor. Also, in August, the author had attended a meeting in Atlanta, Georgia to report experimental progress on energy conversion technology in which magnetism affecting electric free charge carriers in metal can convert thermal energy into electrical output. In a sense, this is magneto-hydrodynamics at work within a solid metal. This is the subject of ENERGY SCIENCE REPORT No. 2 and No. 3.

Therefore, although in Cambridge to talk about protons, deuterons and tritons in a theoretical context, the author had become more preoccupied by his interest in the extraction of power from magnetism, as evidenced by the Adams motor technology and as researched somewhat superficially by the author in his own earlier work. It was the Adams situation that gave stimulus for new experimentation, and it was a question of being patient and waiting for Adams himself and others to take that work forward or whether to divert effort into one's own experimental programme.

One thought had been to build a kind of recriprocating engine, resembling a steam-engine piston-and-cylinder action, there being a soft-iron 'piston' member moving inside a solenoid and interacting with a permanent magnet to open and close an air gap.

Indeed, owing to the fact that there was a corner shop at the junction of Trinity street and Bridge Street in Cambridge, located between Trinity College where the author was lodging and the college venue of the ANPA meeting, the author had pursued enquiries in that shop with the experiment in mind. It had a model steam engine in the window.

So it was later that morning that, in a side discussion with Professor Clive Kilmister during a coffee break at the Cambridge meeting, the author mentioned the growing interest in USA in 'free energy', centred on the Denver, Colorado event. Specifically mentioned were the claims made by Adams in his description of the motor as reported in the Australian magazine NEXUS.

Surprisingly this evoked the comment from Professor Kilmister that for several years he had been exchanging correspondence with a person named Frank Potter who had been suggesting something very similar. He resolved to tell Potter about my interest in the subject and it was this which gave the basis for this Report.

Extracts from some of Frank Potter's letters to this author are to be found in APPENDIX A and B.

Having promised Potter a full reply, on the basis that what was said would be published in some way, that reply is documented here as the subject of this Report. It was intended to allow this to evolve with a view to presenting a summary account at the September 1994 ANPA meeting and in the hope that Professor Kilmister might participate in the discussion, but in view of the surge of criticism that is currently affecting the Adams motor project the author has brought this version of the Report forward so as to have it in hand at the May 1994 New Energy Symposium in Denver, Colorado.

The reason for this is that it is better to address the basic physics of the subject from a new starting point, one that has background in U.K. and has involved some discussion in academic circles, rather than building a physical account which relies on a version of a motor for which there is no authenticated performance data.

It could well be that different implementations of the Adams-type motor may function differently, some operating 'over-unity' and some not, this being owing to a lack of design understanding of the basic physical factors that are at work. Hence, a first-principle analysis has merit, especially if it meets Potter's objective of providing what hopefully is a reliable theoretical model on which to base experiment.

Finally, as further background, it should be mentioned that research reported by Stefan Marinov is relevant to the subject under discussion and no doubt Marinov will contribute to the later debate which this Report initiates. However, as the sole object here is to answer Frank Potter's questions the commentary below will be confined to that pursuit.

The Kilmister Introduction

The following is a confirming letter dated September 18, 1993 sent to the author by Professor Clive Kilmister.

"Dear Harold,

It was very interesting hearing your talk at ANPA and even more so hearing what you say about magnetism.

I have for a long time been exchanging letters with someone who is convinced that there is something odd about the energy of permanent magnets and has devised mechanical devices (a bar magnet suspended entirely within a large solenoid for example) to show this.

I have taken the liberty of suggesting to him that you might be able to give him some references to other work. Sorry about the handwriting - I haven't been home since ANPA. The man's name is Frank Potter.

Yours,

Clive."

Readers familiar with the 'free energy' research involving magnets, research which is seldom mentioned in the orthodox scientific literature, will understand how it is that there can be questions in this field that really do need answering in open debate but seldom surface for fear of the 'perpetual motion' issue that pervades the subject.

There is, it seems, something lacking in our world of education when the doctrinaire background of physics sets up a barrier in the form of statements of physical law, without involving discussion in a tolerant, patient and in-depth way of the factors that govern ferromagnetism at its energy frontier with the sub-quantum world. This is not just a question of classification of what is observed as a hierarchy of quantum behaviour of electrons in atoms; it is really the issue of how the action we associate with such quantum theory delivers energy able to sustain the properties of a ferromagnet. How is it that permanent magnets can suffer fluctuating field influences continuously for decades, if not centuries, whilst keeping their magnetic vitality? The word 'permanent' has meaning, as does the word 'perpetual', but scientists accept 'permanent magnetism', which is, in a sense, 'perpetual magnetism', whilst showing amusement and derision at the idea of 'perpetual motion', even though 'permanent motion' or motion at a uniform velocity is countenanced in mechanics.

There is a case to answer and it is hoped that this Report will serve in making that case, if not the answer, clear enough for the scientific community to take this subject seriously.

The intention in the pages which follow is to follow standard physics to give prediction of what is to be expected in the Potter experiments proposed. We will not restrict ourselves to the short-cut of the doctrinaire route, not because one sees merit in challenging doctrine and discrediting established physics, but more with a view to directing experimentation at what potentially is the key area that has been neglected for too long. Only the subsequent experimental investigation can give the final answer to this probe into energy matters, but we must not allow a restrictive interpretation of energy conservation doctrine, as such, to stand in the way of such experiment.

The subject of a new energy source is far too important for us to allow any stone obstructing our path to remain unturned and, even if the 'thought' experiment which is our starting point might not have practical application in the form presented, it is worth scrutiny.

The Rotating Magnet in a Cyclically-Excited Solenoid

One can conceive building an electric motor by mounting a magnet to rotate inside a large solenoid, so that the plane of rotation of the magnet lies along the longitudinal axis of the solenoid. Then by reversing the current in the solenoid periodically the magnet should turn at the same rate and so be driven as the rotor of a motor. A schematic illustration of such a system is shown in Fig. 1.

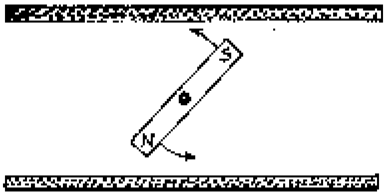

Fig. 1 Solenoid excited rotating magnet motor

Readers may say that this is only a special, and rather poor, form of a class of motors known in standard technology where permanent magnet rotors interact with the commutated excitation of a stator winding. Such motors are known to comply with energy conservation principles and perform in accordance with well-established design practices and pose no anomalies. Indeed, their performance efficiences are clearly set out in the commercial literature used to market them and it might, therefore, seem absurd and pointless to even consider the theory of operation of the motor system shown in the figure.

However, Frank Potter has a way of putting his question logically, if not concisely, and guiding us into a state of doubt (See Appendix A). To put this in context it is not just a question of observing a real motor performing overall on a duty cycle averaged over a complete revolution of the rotor. Like a tight-rope walker who stays on the rope, one may well perform a balancing trick by which the energy books are kept in balance, but this does not preclude a tendency for that tight-rope walker to fall off the rope and draw on gravitational energy in the fall. If he does not fall off, he is nevertheless constantly exchanging energy with the quantum world that powers gravity, drawing on that as his centre of gravity drops and giving that energy back to Nature's store of gravitational potential as he recovers an erect posture. The overall equilibrium performance disguises the fact that he is a kind of human 'free energy' machine at least for about half the time he is on that rope.

So it may be that, if we study the energy action step-by-step as the motor rotates, conceivably the magnetic energy can cause a 'fall-out' which we can use beneficially. Remember that the magnet keeps its magnetic polarization even though it may have done some work and it has its own way of recovering naturally. Our task is to work out how to exploit the energy released in a way which allows us to refuse to give it back, or renders us unable to give it back because the energy has been spent, whilst leaving the motor magnetism to recover its equilibrium by drawing on its own reserves in what is known as a 'magnetocaloric' thermal action!

It is not easy and not normal practice to calculate energy deployment step-by-step in a real motor without begging the question and assuming non-thermal energy conservation. Designers only think of heat problems in relation to I^2R losses and hysteresis loss and do not factor into their design the magnetocaloric effects which are intrinsic to actions where the strong fields of permanent magnets play a special role. Being blind to this possibility they would have little patience with the questions raised by Frank Potter, but his approach is to present a design configuration which, though still far from posing an easy calculation task, nevertheless is one that is amenable to definitive calculation.

It is this that characterizes the Potter approach. If the calculation can be done, it should be done and the energy deployment traced step-by-step.

There is, as already noted, something special about a permanent magnet. It has an endurance when confronted with moderate demagnetizing fields and not enough is said in textbooks about the real action that underpins that endurance. Giving reason for what is known as 'coercive force', is not tantamount to explaining how a magnet sustains its polarization, even though one can draw a line through a stable state represented in a quadrant of a B-H magnetization loop.

Indeed, harping back to the Adams motor, and noting that Adams has used Alnico magnets, one will find that textbook authority on the understanding of the high coercive properties of that particular material reveals some uncertainty as to the physics involved.

This author is especially interested in this aspect of the problem, because the thermoelectric conversion devices with which the author is associated as inventor use a laminated structure of nickel and aluminium and exhibit anomalous behaviour in converting heat into electrical action, including the heat-driven internal generation of powerful magnetic polarization.

So, it may be understood why the line of reasoning adopted by Frank Potter in his communications in Appendix A has interested the author.

Our task is to perform the necessary calculations.

One aspect of interest to Frank Potter concerns how a rotating magnet inside a long solenoid of large radius can couple inductively with the windings of the solenoid. There is the question of how a back EMF is generated in that solenoid as the magnet rotates. Potter realises that without a sufficient back EMF there is no adequate way in which energy can be fed into the rotor motion and yet there is a cyclic magnetic field which sets up the forces turning that rotor. Accordingly this leads him to ask for calculations applied to a practical structure of a large solenoid of reasonable length to radius ratio.

As will be seen, this author feels obliged to separate that issue concerning back EMF calculation and the large radius solenoid from the more important underlying energy balance question which involves ferromagnetic properties, whether those of a rotating electromagnet or a permanent magnet.

However, before entering the calculation phase on that lesser issue, Frank Potter's question which relates more to the practical prospect of an operating Adams-type motor will be introduced.

Axially Reciprocating Magnet in an Cyclically-Excited Solenoid

If one has a permanent magnet and a soft iron core of an electromagnet mounted coaxially side-by-side in-line within a solenoid and the soft iron core constitutes an electromagnet which can reciprocate axially to open or close a gap between it and the permanent magnet, so one can imagine a motor which operates by magnetizing the electromagnet on the closing half-cycle of the motion and demagnetizing it during the opening half-cycle of the motion. This is depicted in Fig. 2.

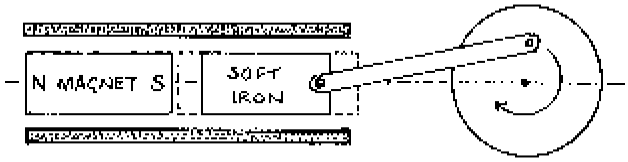

Fig. 2 Reciprocating magnetic reluctance motor

In an Adams-type motor the action just described is reversed in the sense that there is no electromagnetic excitation during the closure half-cycle but there is magnetization of the electromagnet in opposition to the field direction of the permanent magnet during the opening half-cycle.

However, the calculation task posed by Potter is much the same for both of these configurations.

Preliminary Remarks

In approaching the question of calculating the actions in which Frank Potter has expressed interest, the author is mindful of the mathematical analysis which he has prevailed upon others to perform and Potter's problem of understanding the methods they used. A valid and correct answer expressed in a 'bottom-line' formula is not convincing to someone who has approached the problem along a different intuitive route and hopes to match the result with that personal perception of what is involved.

Yet, one can perform calculations in electromagnetism by using magnetic potential techniques or by routine calculation of inductive couplings or by methods involving systematic field calculation and flux linkage rates of change to determine EMFs. All of these methods give the same results because electromagnetic theory is self-consistent and its techniques are well-established. It is just a question of deciding what form of answer one seeks, whether in terms of energy, force, EMF or whatever.

Also, in performing calculations one either has to adopt special finite element methods of computation and pursue rigorous computer analysis or make simplifying assumptions, such as apply, for example, to uniform current excitaton of infinitely long solenoids or solenoids of finite length with simplified geometry for the component acted on within that solenoid.

The object of the exercise, however, is to present a case which Frank Potter can understand and verify from his own position, directed essentially at the key issue of the energy deployment. Frank Potter has expressed a desire to see calculations which derive EMFs in terms of field actions and motion affecting field rates of change. In energy analysis he wishes to see inductance energy calculations rather than magnetic potentials. He further insists that the calculations conform with orthodox physics, meaning that the basis of communication has to be that generally accepted. The latter, of course, is the only way in which one can develop a valid basis for any research in this field, but the concern is understandable because the author has given reason in ENERGY SCIENCE REPORT NO. 1 for interpreting energy storage by inductance as a vacuum field reaction. However, that development concerned causal features underlying theoretical physics, a topic touched upon in APPENDIX C, and it in no way affects the proven principles of physics as applied to calculating closed circuital interaction which is the subject now under study.

Within these constraints, this author offers the following sequence of argument to set out the scope of the investigation here reported. The text used is written as if addressed directly to Frank Potter. Note that the question of the effect of expanding solenoid radius will be dealt with before the primary issue of the basic motor operation.

It should be read after some scrutiny of the subject of the Potter correspondence as set out in Appendix A and Appendix B.

Step-by-Step Analysis of the Problem

1. Since your ultimate objective is to determine whether energy is conserved rather than determine EMFs or forces, the logical method of analysis is to work directly in terms of deployment of field energy density.

This does not preclude calculation of back EMF generated in the magnetizing solenoid, especially if there is intention to perform an experiment to rotate a magnet inside such a solenoid and measure that EMF. However, some general conclusions from this analysis need to be developed first and this is best done in terms of energy as such.

I intend to avoid what is known formally as 'magnetic potential' but will need to distinguish energy of a form that seeks to decrease from that which involves a tendency to increase. Thus I will need to refer to the former as having a 'potential' character and the latter as having a 'dynamic' or 'kinetic' character. The way to look at this is to say that if one pushes a ball up a hill it will have a higher potential energy at the top of the hill but as it rolls back down the hill that potential energy reduces as energy transfers into a kinetic form.

Magnetic field energy is energy of motion. If we try to describe it as having a 'potential' then we need to bring in a minus sign to convey the message that it tends to increase in magnitude. This is a subterfuge of modern physics. If one seeks to work with equations and wishes energy change to relate to force it becomes a problem if energy of different kinds has to be put on opposite sides of the equation. One wants all the energy terms to be on one side so that the other side is left clear for symbols relating to force action.

By making magnetic energy 'negative' it can be deemed to have a 'potential' alongside electric field energy, but one does see a perplexing anomaly in this area when applying Maxwell's equations to a propagating electromagnetic wave. Here there are no forces on empty space and so, given that energy is assumed to propagate with the wave, physicists need to think of magnetic energy as positive in a real sense. The alternative to this is not something we should discuss here, but if that energy were seen as 'negative' in potential terms or as exchanged with electric energy when expressed by real, positive and dynamic terms, so an electromagnetic wave would, in theory, not transport energy by waves as such. Indeed, one would then have to think of the momentum transfer by photons and see the waves as the catalyst in conveying information about the energy activity in a universal standing vacuum energy field.

All this is a little complicated but there is an underlying consistency with the prospect of there being a standing energy background. I refer to it because you have urged a need to comply with Maxwell's equations and, if taken literally, that may put the argument in a straight-jacket. I will proceed therefore without further mention of Maxwell's equations but I will comply with the standard teachings on the subject of electromagnetism because, as you may know, most electrical science textbooks adequately cover the basic ground that applies to power circuits before worrying about wave propagation and bringing in the Maxwell wave formulations.

2. Remember now that two magnets attracted into close proximity will exhibit strong field interactions. They have a way of increasing the strength of the magnetic field and, in energy terms, to make sense of this, one must see the action as a dynamic effect arising from charge in motion.

I will address first the problem of the magnet mounted to rotate within a long solenoid excited to produce a uniform internal magnetic field of intensity H which is reversed cyclically so that the system works as a motor.

3. If the magnet has an intrinsic strength that is constant and independent of the field H and is orientated with its north-south poles producing a field opposed to H, the magnetic energy of the system will be lower than for the pole orientation the other way. The potential energy will be higher. The energy difference between the two orientation directions is simply a measure of the amount of energy fed into the solenoid every half cycle as needed to run the motor. There is no reason whatsoever to suspect that there can be non-conservation of energy.

For example, if the magnet itself produces a field component H' at a point in the solenoid, outside the body of the magnet, the energy density there will be proportional to $(H'-H)^2$ and when H' reverses as the magnet rotates to a corresponding reversed position this will be $(H'+H)^2$. The difference 4H'H, when summed within the space bounded by the solenoid, is a measure of the work fed into the solenoid as the magnet is primed to reverse direction.

4. Now, it might seem that I have made this assertion blindly, based on the principle that energy is conserved and not by proving my case, as by calculating the back EMFs induced in the solenoid and then merging this with solenoid current over the half-cycle period to evaluate the energy input.

However, let us examine what happens to the mutual interaction component field energy term 2H'H when we reverse H. Note that this applies to the permanent magnet rotor situation.

5. At the point in the field under study, H' is constant and so all the mutual action depends upon the reversal of the current in the solenoid. This current change occurs with no back EMF attributable to induction produced by change of H'. Therefore, in theory at least, there can be no power input surge accompanying that current reversal in the solenoid. How then does the solenoid drive the motor? The answer lies in the fact that H', as a component in the H field direction, increases in that forward direction of H as the magnet turns through 180 degrees. This increase in the H' component, as seen by an imaginary loop circuit at the field location, develops a back EMF which interacts with the now-constant field H to put all the work action onto the power supplied to the solenoid. Note that the ampere-turns comprising the solenoidal excitation operate to produce a uniform magnetic field H within that solenoid and so can be said to comprise numerous contiguous loops of current all having the same current strength per unit length of solenoid. Any back EMF in each component loop

which tends to resist the setting up of the field by the current is overcome by the forward EMF transmitted from the solenoid through contiguous imaginary current loops that fill the space within the solenoid. Without such action there would be no basis for explaining how it is that a uniform field component H can be produced and sustained within the solenoid when current is fed into it.

I have enlarged on this theme in Appendix C so as not to detract here from the flow of the argument.

6. Consider now the electromagnet rotor. Here, at the point under study, when H reverses, so it is that H' also reverses, but in this case the mutual energy density in the field becomes proportional to H^2 because H' is proportional to H. We are assuming that the core has a constant magnetic permeability over the range of magnetization used. In order now to operate the device as a motor we must cause the rotor to turn through 90 degrees with H zero and then switch the power on for the next quarter turn to bring the rotor into line with the solenoidal axis before repeating the action and having a quarter turn with power off followed by a quarter turn with power on. See Fig. 3.

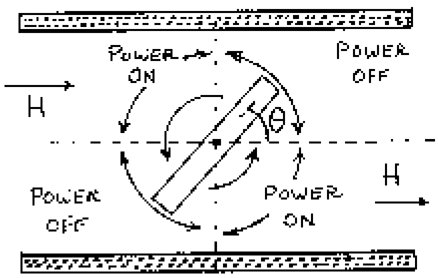

Fig. 3

Here, the same argument about back EMF applies, because H' is µHcosΘ, where Θ is the angle between the rotor axis and the solenoidal axis. At the moment when Θ is 90 degrees we switch on the current, but the H' component is then zero and so there can be no surge of power drawn from the solenoid or the rotor core at the moment of switch-on, at least so far as feeding the mutual interaction field energy as opposed to the self-inductance field energy. What then happens is that the rotor turns so that the magnetic interaction field energy density increases, but this again sets up the back EMFs in those imaginary current loops that make up the whole solenoidal field and put load on the forward EMF applied to that solenoid. The back EMF is proportional to the factor µ used to express the added field strength attributable to the magnetic properties of the rotor core.

7. It would seem therefore that the electromagnet rotor case just discussed is one that requires all the motor operating power to be fed in as current overcoming a back EMF induced in the solenoid. It is pertinent to mention that an electromagnetic rotor core can, in theory, be regarded as one of infinite magnetic permeability without changing this argument. The field action in the free space around the rotor is what is governing and that magnetic core will only accept the H' polarization governed by H if H does all the work of overcoming the back MMFs (magnetomotive forces) that apply in the demagnetizing sense in the pole regions.

8. To this point, therefore, there seems no case for suspecting any non-conservation of energy in motor operations for either forms described, but it is stressed that we have not gone out of our way to design a motor that makes unusual demands on the magnetic core and have applied basic physics to proving the case based on back EMF argument, as requested. Although those actual EMF values have not been calculated they are readily deduced, given the necessary design parameters and by working backwards from knowledge of the solenoidal current and the principle of energy conservation. See, however, the alternative treatment in Appendix D.

9. The next question at issue is the problem of how the motor functions with H being the same regardless of whether we use a solenoid that is very large in radius relative to the dimensions of the rotor. The thought that it might be impossible to justify the back EMF and solenoidal power drive coupling if the wire comprising the solenoid is far removed from the rotor is certainly thought-provoking. I would certainly expect the motor to run with the same performance regardless of the radius of the solenoid, if one could ignore I^2R losses, as you assume. However, though it might seem questionable, I hold to the view implicit in the above argument, namely that the back EMFs in those imaginary current loops in the solenoidal field are propagated back to the solenoid proper so as to prevent the vacuum field from becoming one turmoil of eddies and vortices responding to local EMFs induced in space. Again, I refer to Appendix C.

I stress here that it is an experimental fact that EMFs can be induced around loops which are not bounded by wire. A closed circuit through a conductor is not essential to define the action of an EMF. One can have partial EMFs acting around parts of circuits and these can vary in two identical halves of a circular wire loop embracing a varying field. The experiment is one discussed on pages 119-120 of my book MODERN AETHER SCIENCE.

10. The suspicion that the EMF needed to power the solenoid has to be weaker because the wire is removed from the magnet cannot be supported. The reason is that the physics of the probem is governed by energy supplied to the solenoid to meet the field requirements. The minute back EMF <u>in each cm length</u> of each turn of the wire in the solenoid is balanced by the inversely proportional increase in the overall circumferential length of that turn.

11. The question raised about calculating the actual EMF conditions in a system having a fixed ratio of solenoid radius to length, but on an increasing scale in relation to the rotor size, is one that I aim to avoid because I see no end purpose of value. I will, however, argue the case for a limiting situation, which applies regardless of the extended dimensions and shape of the solenoid.

Refer to Fig. 4 and imagine (a) that the rotor magnet and its field H' are confined to a spherical volume of fixed radius in which it interacts with the uniform solenoidal field H and (b) the separate remaining region of a non-uniform field H within the solenoid of bounded extent.

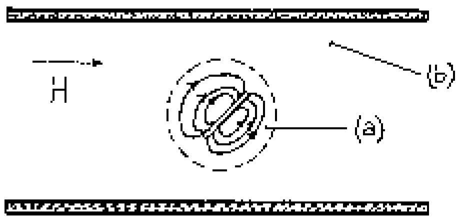

Fig. 4

The total field energy in the latter region (b) will not vary with change of orientation of the rotor magnet whatever the solenoid radius, whereas the total field energy of the former region (b) will so vary but will not vary with solenoid radius. Accordingly, the back EMF induced in the solenoid will not depend upon that radius and the motor will operate at the same power rating set by H and its reversal frequency.

12. There is, therefore, no valid basis for suspecting that the change of radius can cause non-conservation of energy and any calculation by EMF or magnetic potential methods is bound to give the same result, because the latter are based on magnetic induction principles which derive from the changing values and disposition of the field energy density.

Of course, owing to self-induction effects, the cyclic switching of current will prove more difficult with the much larger solenoid, but that is a practical consideration not relevant to the problem under discussion.

13. The important point so far as the permanent magnet rotor is concerned, however, is that the magnetization-demagnetization sequence has been symmetrical in its action and energy has merely been 'pumped' from the solenoid current source to the motor output in both half cycles of this sequence.

The scenario can be entirely different if the solenoid closely embraces and contains the permanent magnet fixed in a coaxial position with an air gap interfacing with a coaxial soft iron core that can reciprocate mechanically to drive a motor steam-engine-style via a connecting rod and flywheel.

14. However, let us first discuss a situation where the solenoid, as before, contains a rotating magnet but in addition also a non-rotating soft iron core or, alternatively, a rotating soft-iron core and a fixed permanent magnet.

Here we are looking at the prospect of using the primary solenoidal magnetic field H to produce a controlled magnetic field in the soft-iron core which then regulates the interaction with the permanent magnet resulting from rotation.

The problem becomes that of a three-part interaction.

15. Now, contrary to the prior situation, where the electromagnet had to turn through 90 degrees without power input and then be driven by power input over the next 90 degrees of motion, we can have here a situation where the permanent magnet does all the work in driving the motor in one quarter cycle and the input power operates to weaken the electromagnet in the next quarter cycle.

This brings the problem closer to the Adams motor principle.

The question then at issue is the calculation of the energy needed to be supplied as input in relation to that of the drive generated by the magnet, bearing in mind that rather special interactions between two ferromagnetic cores are now at work. This is not a proposal raised by the correspondence but it warrants consideration as part of the analytical treatment of the question that has been raised, because the same analysis applies to the reciprocating machine of Appendix B.

16. The key mathematical exercise is that of calculating the energy fed by solenoid current in setting up H in the system shown in Fig. 5.

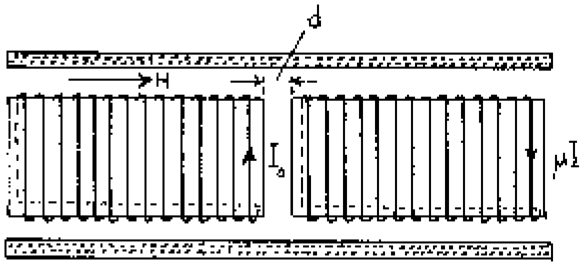

Fig. 5

The magnet is itself equivalent to an air-cored solenoid carrying a constant current I_o and the soft iron core defines a region of constant permeability µ.

The field action of the primary solenoid current upon the permanent magnet can be ignored in this analysis, at least initially, because the coercive force of the magnet material is so high that a relatively weak magnetic field could hardly affect its action.

The soft iron core can, therefore, itself be replaced by a solenoid carrying a current µ times that in the solenoid proper and we can dispense with the solenoid for the purpose of calculation. We are left simply with the analysis of the interaction between two coaxial solenoids spaced by a gap width d, one carrying current I_o and one carrying current µI.

It is assumed for convenience of preliminary analysis that the radii of these solenoidal representations of the magnet and the core are the same and that the turns per unit length are also the same.

17. Our problem has reduced therefore to that of working out the mutual inductance between two coils which can move relative to one another along the common axis.

However, we must be mindful of our objective, which is to see how energy conservation principles apply to this problem. If the only question at issue is whether energy is really conserved we do not need to work out the rigorous mathematical solution giving precise values for the inductances involved in terms of the finite lengths of the magnet and core.

18. As a function of the air gap width d and the radii and lengths of the two solenoids, we could calculate the following quantities L_m, L_c, M_{mc}, where L represents self-inductance and M mutual inductance and the suffix terms m and c apply to the magnet and the core, respectively.

The magnetic energy of the system is then expressed as an energy quantity stated in potential terms as:

$$- ½L_mI_o^2 - ½L_c\mu^2I^2 - M_{mc}\mu I_oI$$

This means that if we were to reduce the current we would recover energy because a time differential of $- ½L_c\mu^2I^2$, for example, becomes $-L\mu^2dI/dt$ and dI/dt is negative so that the energy change as measured by potential is energy returned. When seen from the viewpoint of the exciting solenoid the factor μ applies rather than μ^2 but there is return of energy according to such formulae when current is switched off.

19. Note now that, if d were to remain constant as I varies, the energy fed into or out of these inductances with cyclic change of I is the same on the up-cycle as on the down cycle, so to that extent energy must be conserved by the electromagnetic system. I_o is constant. Therefore, if d changes, only the mutual term depending upon d need be considered.

This leaves only the term in M_{mc} as a subject for detailed analysis.

20. Now, we can presume that the magnet and the core, though of finite length are very long in relation to the small gap width d. In this case we can follow standard magnetic circuit theory, where a long magnet has very small demagnetization effects due to free poles at the ends, but we will still develop this to allow for a finite valued ratios of length to radius for both the magnet and the core.

Here we are advancing the argument towards a point where we can calculate inductance attributable to an air gap in a magnetic core solely in terms of the field energy known to be stored in that gap. This is a valid proposition in accepted theory because leakage flux is deemed to be minimal and because the gap-dependent inductance energy is nothing other than the sum of the magnetic field energy in the system, this being a quantity that has a negligible component inside iron of high magnetic permeability.

However, as that may seem to be an easy way of escaping from the more difficult task of calculating the actual mutual inductance and proceeding from there, I will address the latter problem.

21. First, however, I emphasise that the reason a calculation of air gap energy offers a more direct route to a solution is that the flux density across the gap and through the interface between the magnet and the soft iron core will involve far greater energy density in a unit (vacuum) permeability zone than in the soft iron. The energy density is proportional to B^2/μ and μ in the soft iron will be very much greater when μ is unity.

Also, it must be remembered that even if a saturation level of magnetism in the permanent magnet implies a low differential permeability, the fact that it is saturated has predetermined the B-dependent energy density value and so it cannot contribute terms that are d-dependent in any significant measure when judged alongside the energy in that gap.

22. Now, having decided to represent the action between the permanent magnet and that of the magnetic core as notional solenoids carrying high currents, one might expect that the mutual inductance between two such solenoids will be very high. A small gap between two sections of a single solenoid does not affect its inductance to any significant degree, but a small gap separating two solenoids that happen to carry very high current can involve energy change in substantial measure. The energy of the

self-inductance intrinsic to our notional solenoids is really that of the intrinsic ferromagnetic condition of the magnet and the core and that energy is beyond our reach as it is locked into the atomic quantum behaviour of the atoms of the ferromagnetic material.

The mutual inductance energy is what is amenable to our control in our experiments.

23. To provide an interim summary of the purpose of this discourse, it is noted that, whilst aiming to show how the general problem can be analysed mathematically, we are scrutinizing energy conservation processes where we draw motor power from a magnet as the gap closes, then switch on the current I to oppose the magnet's field action across the gap so as to allow the core to be pulled away from the magnet with little energy demand. We expect, on basic physics teaching, to find that we must do work against a back EMF to achieve this condition, work exactly equal to that available from the magnet upon closure of the gap. However, we want to be sure that the accepted theory, when worked out in detail, does sustain this standard energy conservation assumption. Our hope, of course, if we are minded to probe new ground in the search for new energy conversion discoveries is that the energy books will not balance and that we might tap some of that thermodynamic energy resource which powers ferromagnetism at its quantum atomic level.

24. To proceed, the route to determining the mutual inductance will start from the formula for self inductance of a single solenoid which we will then divide into two sections.

By way of reference the author will take as a base the textbook 'Electrical Measurements and Measuring Instruments' (3rd edition) by E. W. Golding. It was published in London by Sir Isaac Pitman & Sons Ltd in 1946. It happens to be the university textbook used by the author in his early studies and similar reference data is probably available in other and more recent works, though there is a secondary reference to 'Nagaoka Factors' which feature in a paper by Nagaoka, Journal of College of Science, Tokyo, Art. 6, p. 18 (1909) and the data from the latter may be difficult to trace.

In any event the calculations pose no problems to modern computer analysis, but it suffices for the present purpose to rely on the textbook authority which is home-based in U.K. and dates from the era when we were both introduced to electrical engineering studies.

25. The self inductance of a solenoid of circular section and diameter a having N turns uniformly wound over a length D is:

$$L = K^2N^2a^2/D$$

nano-henries. This is given at p. 178 of the Golding book and K is the Nagaoka factor plotted in graphs on page 179 as a function of the diameter/length ratio of the solenoid.

For the onward calculation we now need to specify that ratio a/D and I will choose here three ratios for which D/a is 20:1, 10:1 and 5:1. The Nagaoka factors are, respectively, 0.98, 0.95 and 0.91.

Now, suppose we chop the solenoid in half, notionally, and see it as two coaxaial solenoids arranged adjacent one another with no gap in between. The overall inductance is then the self inductance of each half plus the mutual inductance between the two halves. Note that in energy storage terms, with a current I, the self inductance energy of each half is $\frac{1}{2}LI^2$ and the mutual inductance energy is MI^2. So, regarding this as a self inductance energy of a common single solenoid, L of the double length solenoid is 2(L+M) of the two-part configuration.

Thus, if D/a is 20 for the overall single solenoid and 10 for each half, N being double and D being double in the above formula gives 2K, where K is 0.98, as equal to 2(K+M/L) with K as 0.95, making M/L equal to 0.03, where L is the inductance of the half-solenoid of D/a of 10.

Alternatively, if D/a is 10 for the overall single solenoid and 5 for each half, we find that 2K with K as 0.95 equals 2(K+M/L) with K as 0.91, making M/L equal to 0.04, where L is the inductance of the half-solenoid for D/a of 5.

26. We have now determined the mutual inductance between two sections of solenoid of equal length and, as this holds regardless of the currents in the two sections, we can say that the mutual inductance energy is MI_oI, where, according to the choice of D/a ratios, M is 0.03 or 0.04 times the value of L as given by the above formula for the separate sections.

27. This is the amount of energy that can be expected to be extracted by the mechanical pull as the core is attracted from a well separated position to close the air gap between it and the magnet.

The formidable question now faced is that of deciding how energy is deployed if we decide to alter the current excitation so as to demagnetize the core before separating it from the magnet.

28. To proceed, we need to enter the territory of field effects from free end poles of a magnet. Suppose that the magnet exists at rest inside the solenoid and no current I is fed to that solenoid. The core is initially at rest spaced from that magnet by the gap distance d.

The magnet, unaided, will assert an attractive field which pulls the core into contact. This field will be deemed sufficiently strong to impart substantial polarization and set up a fairly strong level of magnetism in the electromagnetic core. Thus, even with no external exciting current present, there is an effective polarization current in the core of the order of I_o/μ, because the magnetic flux traversing the air gap will be the same on both sides.

On this basis we can confine our study of power input to the task of demagnetizing the magnetic core once it has closed into contact with the magnet. We divert therefore to the study of this problem.

29. We have, in effect, a magnet and we have put, as an extension of its length, a soft iron core in contact with it. This means that the magnet will transfer an end pole from itself, and through the core to its outer extremity. The magnet with a D/a ratio of 10:1 becomes, say, an extended magnet with a D/a ratio of 20:1.

The question at issue now is that of contriving to drive that pole back to the original position in the magnet proper and before we separate the core from the magnet.

Here, we need to keep in mind that a soft iron core needs very little field to determine the direction of its magnetization. The reaction owing to demagnetization effects set up at the free end poles is what makes the demand on any applied field. So, if we look to a mid position inside the core and ask how the adjacent magnet and the pole demagnetization effects and any external field cooperate in deciding a direction of magnetization, we can begin to see what is needed.

30. The demagnetizing field effective on a magnetized bar and equivalent to the offset needed in a magnetizing solenoid is known from data of demagnetization factors found in textbooks. The Golding book referenced above shows such data at p. 360.

For D/a of 20 the demagnetizing field intensity is 0.5% of the flux density and for D/a of 10 it is 1.6% of the flux density.

Now consider what this means in terms of controlling the magnetic flux density through an air gap between the magnet and the core.

Firstly, those demagnetizing factors apply to specimens that are not permanent magnets, so response to externally applied magnetic fields cannot be predicted so far as action within that magnet is concerned.

Secondly, the soft iron core will respond to net field action and if it were replaced by air we see that the additional demagnetizing field effect that comes into play is about 1.1% of the flux density in the magnet, this being the difference between the two demagnetizing factors.

This suggests that, even if the soft iron core were left in position, the additional application of a back field of the same amount, or possibly more corresponding to the 1.6% factor, would drive the pole back into the magnet.

If this were so, the energy needed to be supplied to the demagnetizing winding would be of the order of $½LI^2\mu$ which compares with the mutual inductance energy of 4% of $LI_oI\mu$. Remember then that I_o is of the same magnitude as $I\mu$ and that μ as it applies here is the magnetic permeability of the soft iron expressed in gaussian units, meaning that it is of the order of 10^3.

Very clearly, on this basis, it needs far less energy to demagnetize the core than we have available as mechanical work from the action of the magnet in closing the air gap. The above figures suggest an energy ratio of the order of 1:100.

But are we right in this argument?

31. Firstly, let us assume that we have a correct analysis. What does this mean in terms of energy conservation? Since energy has to be conserved in any physical process it simply means that the magnet can stand up to the demagnetizing field set up by its free poles by calling upon its atomic quantum-powered sources to keep it ferromagnetic, meaning that it gets energy from a thermodynamic interaction with the quantum world. Alternatively, if it owes its permanent magnetism to some internal thermally-related activity, it may simply cool to sustain the magnetic requirement.

That may be speculation, but one fact we do know is that the magnet has a way of recovering once we pull away the demagnetized core using very little effort and prior to switching off the demagnetizing current.

Secondly, let us assume we are wrong, but then how do we know? We set out to calculate the effect of a magnetizing field on a magnet and a soft iron core and we encountered the problem of deciding how the field set up externally from the free poles of the magnet affected the soft iron core. We had to estimate the back field needed to counter that influence. We know that the free magnet sets up its own back field and have used that as a measure for our calculations. If this is wrong how else can we proceed?

32. The only sensible way forward from this position is by experiment and already it should be said that I would never have begun this exercise had I not heard of experiments that purport to involve permanent magnets and reveal anomalous gain of electrical/mechanical power.

However, I have accepted your challenge to perform calculations which might give you some satisfaction in your pursuit over so many years to find an answer to your questions and although I think I have gone far enough in that theoretical endeavour I will go one step further.

33. We have considered above how two solenoids having a 10:1 length to diameter ratio, one representing a permanent magnet and one a soft iron core, interact magnetically.

A question of interest is that of determining what equivalent current strength I would suffice in an external magnetizing solenoid closely embracing the soft iron core to offset and cancel, at the centre of the soft iron core, the magnetic field set up by the equivalent current I_o of the magnet.

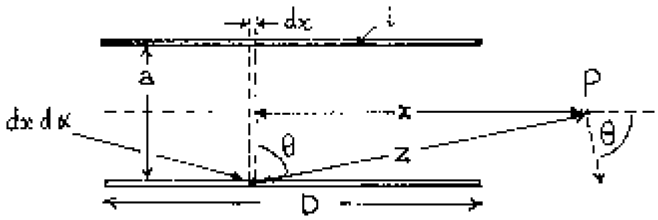

Fig. 6

Referring to Fig. 6, the task is to calculate the axial field at a point P set up by a current of i ampere turns per unit length of solenoid.

We consider an elemental section i(dx)(dα) of the energized solenoid and note that this angular element (α radians) of ring form, of diameter *a* distant x from P along the axis, will set up a magnetic field at P given by the formula $\alpha(a/2)(idx)/z^2$, where z^2 is $(a/2)^2+x^2$. This field is directed at an angle Θ to the axis, where x is $(a/2)\tan\theta$ and $(a/2)$ is $z\cos\Theta$. Then, since dx is $(a/2)\sec^2\Theta d\Theta$ or $(a/2\cos^2\Theta)d\Theta$, the component field at P attributable to idx over the $\alpha = 2\pi$ range of the ring element is:

$$(4/a)\cos^3\Theta(idx)$$

and, as dx is $(a/2)\sec^2\Theta d\Theta$, this reduces to:

$$2\pi i\cos\Theta d\Theta$$

This can now be integrated to obtain $2\pi i\sin\Theta$ and so determine the axial field intensity at P attributable to the whole length of the solenoid representing the magnet, namely from an angle for which $\tan\Theta$ is 10 to one for which $\tan\Theta$ is 30.

With $\tan\Theta$ as 10 this gives $\sin\Theta$ as 0.995037 and with $\tan\Theta$ as 30 this gives $\sin\Theta$ as 0.999445 so the difference is a factor of 0.004408.

In contrast the same current in the solenoid centred on P would develop a field at P given by the same formula applied between limits for which $\tan\Theta$ is 10 and -10, respectively. This gives a difference of twice 0.995037 or 1.990074 as the comparable factor representing axial field intensity at P.

The ratio of these two field strengths is 451:1, meaning that the field developed by a powerful current I_o in the solenoid representing the magnet could be cancelled at P by an opposing current in the magnetizing solenoid of the soft iron core that is only 1/451 of the strength of I_o.

34. It is submitted on the basis of this analysis that it is not at all unreasonable to contemplate that a small current supplied to a magnetizing coil around the soft iron core and directed in opposition to the polarity of the magnet can serve severely to curtail the attractive force between the magnet and the core.

This being so there is every reason to expect the motor contemplated to operate by drawing drive power from the magnet and using a relatively small amount of input power to restrain the braking action as the motor reestablishes the gap between the magnet and the core.

[This ends the author's formal response to Frank Potter]

Onward Experimentation

The above discourse has probed the principles of operation of a device which can possibly serve us as a new means for generating power.

Machines testing these principles must now be developed to verify what has been suggested by routine application of established scientific principle.

The only departure from established physics has been an awareness that there might be a hidden thermodynamic source of energy which could feature in the energy balance calculations, which has meant that we would not rely on taking the short cut of working out our answers by assuming that the only energy action is electromagnetic or mechanical in form.

So often, physicists who set out to calculate a result A assume a conservation rule by which A + B = 0 and then calculate B instead. That may well prove to be a very costly mistake that has had a damaging effect on progress in the energy field. One is thereby relying on assumption, albeit accepted doctrinaire assumption, and using inadequate knowledge of the range of the energy components that must be considered. Thermodynamics, meaning the realm of heat energy in some form, even the heat latent in atomic electron activity, is a subject of relevance to electromagnetic machine design that ventures into what seems hitherto to have been forbidden research territory, because, as already stated, researchers fear the stigma of addiction to 'perpetual motion'.

Given the kind of question asked by Frank Potter and his persistence in seeking answers after decades of effort, given the motor developments championed by Robert Adams and given the reports of the research of Hans Coler and others on solid-state magnetic devices posing energy anomalies, this author can but share their frustration and this is why this ENERGY SCIENCE REPORT is necessary.

One can do experiments, as others have done, but even that will not convince the skeptic who wants to adhere to principles of disbelief. Without a theoretical base moulded around the existing framework of physics one cannot get a hearing, far less attract the interest of those who will advise funding sources to invest in the 'free energy' field.

Furthermore one needs a basis on which to understand why those who try to get 'free energy' machines to work may fail. One cannot just throw a pile of magnets together and hope to work magic.

It is pointless to take this discussion theme much further, until the necessary experiments have been performed by the author and are duly reported in a sequel to this ENERGY SCIENCE REPORT.

Commentary on the Appendices

In winding up this introduction to the 'Potter debate', a few points outstanding from the correspondence initiated by the Potter letter of 15th October 1993 warrant comment. That letter is reproduced in Appendix A.

By letter dated 21st October 1993, Potter, by the following words, acknowledged my expression of interest:

"I think I will begin with the phrase in your first paragraph "what you say is right!", which caused me to rub my eyes in astonishment, because it is the first time that any reputable scientist has ever said that to me; not even Professor Kilmister who, although he has been most generous indeed in helping me literally for years past, and has acknowledged that I have been right on <u>some</u> points, is like all mathematicians and scientists extremely dubious about anything touching Conservation of Energy."

Later in the same letter:

"I was particularly interested in your phrase about a "hidden source that sustains the electron 'spins' in a ferromagnetic material". That is precisely the sort of thing that has been at the back of my mind for a very long time indeed (though I know little technically about 'spin' theory), in fact gradually since 1956. I really got going about 11 years ago with the ideas about which I wrote to you. That was in 1982, which also seems quite a long time ago now, when I approached Professor Kilmister on these matters."

In his 15th October letter, Potter had mentioned four issues of debate but disclosed only two. His letter of 7th November began with the words:

"Thank you for your further note and the extracts from New Energy News that you kindly sent enclosed. Before going on to some comments upon this very interesting material I would like to present the other two ideas that you said you would be willing to comment upon."

"The first one .... involves an experiment. I took a very good quality permanent magnet and wound a close-wound wire coil around it, and then passed a current through it in the opposite direction to that of the current that would have magnetized the magnet. At the start of the experiment, before the current was switched on, there were a number of soft iron tin-tacks adhering to the magnet. I got the result that I had anticipated. On increasing the current there came a point where the tin-tacks flopped off; and on increasing the current still further they jumped on again. All fairly obvious I suppose - the two fields cancelling one another. But the puzzle was this: Energy is supposed to be in the 'field' surrounding the magnet (or the coil), and yet, since the tin-tacks were not attracted at the particular level of current there must have been no field there to magnetize them. But there is energy inside the permanent magnet, and the energy must also have been put into the coil in the build-up of its own energy field, this energy coming from the battery. Where have these two energies gone to? On switching off, pretty obviously these two energies come back, though I was not able to check practically the restoration of the energy of the coil to its surroundings. The magnet appeared to be unaffected afterwards."

"The last of the four ideas (two in my earlier letter) depends upon the one just given, and concerns a small machine that I had an idea to build, but the practicalities of doing so were difficult with the tools or apparatus available to me; and also later on a possible snag in the idea occurred to me (which I will mention in a later paragraph); so, after doing practical work upon it, I gave it up for the time being and went over to the two ideas in my previous letter to you.

The machine was this ...."

This next portion of the Potter letter is in Appendix B. It is a description of what the author has referred to above in the context of a reciprocating steam-engine-style movement of a permanent magnet cum soft iron core combination.

As already mentioned, it is what this author had in mind before that first discussion with Professor Kilmister at the Cambridge meeting.

However, whereas the opening letter from Potter had concerned the mathematical task of analysing what could be said to be thought experiments bearing upon the conservation of energy issue, here was a third 'idea' raising questions of energy disposition based on an experiment with a magnet and a fourth 'idea' which concerned a machine that resembles the Adams motor. The difference is similar to that between the early reciprocating steam engine and the four-cylinder rotary engine.

In the above discourse, the author has already dealt with the themes Potter raised by his first, second and fourth 'ideas' and wonders now whether to comment on the magnet experiment of that third 'idea'.

The disposition of energy when work is done to 'demagnetize' a magnet has already been discussed in this Report. We are talking here about the physics of the process at room temperatures, temperatures well below the Curie temperature. In this situation one never demagnetizes a ferromagnetic substance, whether it is a permanent magnet material or soft-iron. All one can do is to 'depolarize' the specimen under test. Its intrinsic minute magnetic domain constitution becomes randomly directed amongst the axes in the crystals of the material and it merely appears to be demagnetized.

So, the primary energy is always trapped by the ferromagnetic state and any modest change that does occur involves, to some extent, that which can occur at the limits of transition as one takes the magnet through its Curie temperature. There is a thermodynamic energy exchange involving that hidden field we associate with quantum theory.

As to why Potter's magnet recovered its polarization after undergoing the 'opposed' current effect, as tin-tacks fell off and were picked up again, that is not easily explained without knowing precisely the properties and state of the magnet and the sizes of magnet, demagnetizing coil and current in that coil.

If the magnet reversed its polarity it is perplexing if it could reverse back again when the current was switched off. It could not have been one having a high coercive force if a small coil carrying current available from normal domestic sources could perform that polarity reversal function. If, however, the coil wrapped around it did extend, in its influence, to the tin-tack region, we may have here precisely the evidence that shows how a weak field on a soft iron core can affect the attraction of a magnet.

In the latter case the commentary above and the calculations which show how a small field action can limit the influence of a magnet interacting with a soft-iron core are very relevant to Potter's tin-tack experiment.

By letter to the author dated 23rd March 1994, Frank Potter acknowledged certain book references that I had sent him showing methods of calculating mutual inductance and included the comment:

"The interesting, but to me difficult, calculations that you sent (though, as you say, routine for engineers) are in particular for self-inductance and a lot about mutual inductance. The specific problem that I and my friends have struggled with for so long is not that, but rather the induction of <u>EMF</u> by a rotating permanent magnet --- in other words 'back EMF' in a rather special form of motor. This EMF is the thing that seems so difficult to get an exact answer for in this case; and the specific problem is whether the EMF does depend upon the ratio of the length of magnet to the radius of the solenoid. I think it does. I have, as you know, been hankering after a calculation on the basis of the Blv formula; but I shall be most interested in your own calculation, when you can do it, and I can only hope that it is as 'routine' as the ones you kindly sent me."

Upon reading this this author wondered about the emphasis placed on the ratio of the length of the magnet to the radius of the enclosing solenoid. In earlier communications the question had been understood to relate to the problem of using a solenoid of realistic (not infinite length) proportions, whilst increasing the radius of the solenoid, but at all times the magnet itself has to be 'within' the solenoid. In other words one should not just imagine something approaching a ring coil with a magnet mounted to rotate about the centre of the coil and having its poles sweeping through an arc protruding from the plane of the coil.

Accordingly, it was assumed that Frank Potter was primarily interested in calculating the EMF induced in a solenoid by a rotating magnet having a length that is small in relation to solenoid radius, but yet the length of the solenoid is large enough for it to be said that the solenoid encloses the magnet fully. In other words one seeks to rely on the assumption that the field produced by the solenoid and acting on the magnet is essentially that applicable at the centre of the solenoid.

On this basis, of course, one must surely agree with Frank Potter that the back EMF induced in the solenoid owing to rotation of the magnet does depend upon the radius of the solenoid.

As to the calculation of this EMF, this poses no real difficulty, but in view of Frank Potter's concern about method of calculation and his apprehension about mutual inductance formulae, the author has deemed it appropriate to provide the additional analysis set out in APPENDIX D. No doubt there will be others who read this Report that have interest in the general problem but are not too familiar with the various methods of calculation that can be used in electromagnetism.

Between 7th November 1993 and 23rd March 1994, and later, Potter wrote many further letters to the author prior to completion of this Report, mainly to be sure that his questions were fully understood and revealing his anxiety that, having found someone willing to resolve the issues raised, the main points would not be missed. The other letters bore the following sequence of dates: 26th December 1993 and, in 1994, 14th January, 16th January (two letters), 19th January, 8th February, 26th February, 1st March, 7th March and 7th April. The 23th March letter was followed by one dated 2nd April. All related to the general topic of the four 'ideas' that have preoccupied Frank Potter for so long and all were written before any of this author's response, as provided by this Report, was conveyed to him.

It will, therefore, be appreciated by the reader that this question of whether a magnetic machine can be operated in a way which breaches the Principle of Conservation of Energy, as interpreted in the realm of electro-magnetism and mechanics, is one very close to the heart of this 83 year old gentleman. His letters, as quoted, should show the reader that Potter is not a 'crank' experimenter who believes in 'perpetual motion'.

No doubt, much that has been said in this Report will not be easy to digest and there will be more that has to be said. The author has suggested to Potter that he should await events and see how the 'free energy' world that is now addressing similar issues progress with the experiments on new machines. Not surprisingly, Potter wants to keep involved and contribute to the momentum of something affecting his brainchild. However, there are limitations in what one can do in a disbelieving world that is competitive in matters scientific and so this Report can only serve to introduce Potter's interest to those few who may read what is said here.

It is hoped that the 'Potter debate' will arouse interest and lead to progress on the alternative energy field. In bringing a different perspective to the present scene, perspective which complements the ongoing debate that now centres around the claims concerning the Adams motor, hopefully something of benefit will emerge from what this author is contributing by issuing this Report.

This author acknowledges Potter's kindness in allowing this material to be presented in this Report form, with text from his correspondence, and ends by wishing him well in his further endeavours, coupled with the hope that he will see feedback as others now take up the debate.

10th April 1994

HAROLD ASPDEN

APPENDIX A

LETTER DATED 15 OCTOBER 1993 FROM FRANK F. POTTER

Dear Dr. Aspden

I hear from Professor C. W. Kilmister that during a discussion with you at Cambridge some weeks ago he mentioned to you my name and my interest in Magnetism and particularly in Conservation of Energy. He did not know your address at the time, but a few days ago he found it and sent me a most interesting letter stating that he had heard from you that some experiments with permanent magnets in USA appear to indicate that energy may not be conserved in some of the phenomena involved --- very remarkable news!

He also said that Magnetism is a subject in which you are an expert, and that he thought you would be willing to hear certain ideas that I have upon these matters concerning Conservation of Energy, particularly in relation to Magnetism.

So these are the reasons for my letter.

For myself, I have (very unfortunately) had no formal training in Science or Mathematics beyond school days 66 years ago, my work having been mainly in other fields, though I was a sergeant wireless mechanic on Ground Staff of the RAF during the War. Some of my main interests have been in Physics and Electricity and Radio and Mathematics and I have dabbled in these, though all at a rather low level in which I have regrettably had to be largely self-taught, though with some help from a few kind friends such as Professor Kilmister in particular. I am now 83.

There are two problems in relation to Magnetism and Conservation of Energy that I have discussed with Professor Kilmister for a very long time; or even three or four separate such problems, but it is two of them in particular that I would like to put to you. In fact, in this letter I will concentrate mainly upon one of them, which I think is much the simpler to discuss, but I will give a brief account of the second one at the end of this letter. I would be most happy to tell you full details of this other one (in fact all four) if you were interested to hear and pursue them later on. But in this letter I am keeping mainly to the one, as I do not want to burden you with a mass of material in which you might not be interested; nor do I want to go to unnecessary trouble myself.

Now to the one main problem: Suppose that an electro-magnet is rotating inside and at the centre of a fairly long (i.e. large length/diameter ratio) current-fed stationary solenoid, the plane of rotation being that of the long axis, the cause of the rotation of this electro-magnet being the magnetic field of the solenoid inside itself. In other words, this is a rather special form of electric motor, in which Motor/Generator theory and 'back EMF' will apply. For mathematical simplicity let it be assumed that I^2R heat dissipation can be ignored, since that is energy-conserved and 'wasted' only from an engineering point of view; and in particular let it be assumed that both solenoid and electro-magnet each have their current maintained constant by a separate 'extra battery' in series with the one heating the coils, these extra batteries in this 'thought-experiment' being infinitely and instantly adjustable to oppose exactly the EMFs that will be induced into both solenoid and electro-magnet by the fact that each is moving, relatively, in the magnetic field of the other. This will maintain constant current in both. (To ignore the I^2R heat dissipation one could imagine super-conducting circuits).

Now suppose, as one would be expected to do, that in this electro-magnetic arrangement (really a special type of motor) energy is exactly conserved. I found it more difficult than I had thought to work out just how this would be, partly because at the end of each half-cycle of rotation the constant currents (or anyway one of them) would have to be switched off for reversal of direction, and the energy 'stored' in the magnetic fields of the two coils during the momentary build-up at the start would need to be 'recovered' from the collapsing fields (or one of them anyway), and whether to switch off both or only one current, and if both in what order or together, and in particular the fact that at the end of the half-cycle the electro-magnet coil would be physically the opposite way around from what it was at the beginning. I found this all rather confusing to try and think out; so let it be assumed that these are just two of Maxwell's interacting current-fed circuits in which energy is conserved overall if everything is accounted for.

One important point of my argument revolves around the fact that both of these current-fed circuits are moving in the magnetic field of the other, and as such (a) both coils will experience a force from the other one, but, the solenoid being stationary in the laboratory, the free electro-magnet will be accelerated and will gain kinetic energy from the arrangement; and (b) both coils will induce an EMF (countered by the two 'extra batteries' in order to maintain constant currents) into the other coil, so these two 'extra batteries' will lose chemical energy; and since Conservation of Energy is being assumed, these energy losses from the two batteries will be exactly matched by the kinetic energy gain to the mass of the magnet; and moreover, this will not be only over a period, but pari passu, step by step at every moment of the motion. And the energy 'stored' in the two magnetic fields is assumed to be 'recoverable'. As said, all this is really just ordinary motor and 'back EMF' theory in this special case.

Now the really essential part of my non-Conservation of Energy argument is this: It is well known that a long cylindrical permanent magnet can be exactly simulated by a piece of soft iron of the same dimensions with close-wound coils around it, fed by an appropriate constant current --- i.e. an electro-magnet such as in the foregoing paragraphs; and if the two, electro and permanent magnets, were put each into a 'Black Box' it would not be possible to distinguish between them, either in their capacity to attract soft iron, or in their capacity, when moving to induce EMFs into surrounding conductors --- provided of course that the current in the electro-magnet were maintained constant against EMFs induced into it by reaction from outside.

So the final step in my argument is to replace the electro-magnet in the paragraphs above by a permanent magnet and repeat the experiment. Everything will be exactly the same, except that the permanent magnet, being self-sustaining, will not need to have energy taken from an 'extra battery' to maintain constant current as in the case of the electro-magnet. Hence, Conservation of Energy (whether true or not) having been assumed for the case of the electro-magnet, there is an energy difference here for the permanent magnet, and in fact an unbalanced energy gain. So, how can energy have been conserved in this case? I suggest that energy is not conserved here, and that there is a nett energy gain.

Finally, here is a brief account of the other similar but separate problem, about which I am not sending you details (though there is a large amount of it), parallel to the problem described above: The one above was actually the last of the four in time, and arose directly out of the one I am about to mention. But they are in fact two quite separate (though closely allied) problems on their own.

Suppose one has an electro-magnetic arrangement exactly the same as above, with a permanent magnet (or maybe it could be an electro-magnet, but let's say a permanent magnet), with as before a solenoid with a large length/diameter ratio. Now the force field formula inside the coils at the centre for such a long solenoid (theoretically an infinite one) is $\mu_o 4nI$, which is independent of the radius of the solenoid. Now, keeping everything the same, including the shape of the solenoid, i.e. its length/diameter ratio, vary the radius of the solenoid, let's say, make it larger. What will be the effect upon the EMF induced into the solenoid and opposing the battery voltage and taking energy from the battery? The formula above for the force field H acting upon the mass of the magnet and thus imparting energy gain to it is independent of radius as above. If the EMF induced into the solenoid (still the same shape), despite this increase in radius, is still the same, then the drain on the battery and consequent energy loss for a given current will also be the same as before. Then one can say that this energy loss is independent of radius, just the same as the energy gain is independent of radius, and one would have no reason to suppose that energy is not conserved. However, 'common sense' is not always right (!), and the answer is by no means clear. It is a lot more difficult than it looks. A lot of work of various kinds has been done on this (mainly by Professor Kilmister and myself, but one or two others as well), and there is as yet no conclusive proof, either way. One difficulty, a mathematical one, is the absence of exact integrals in working on the problem. I think, on all the evidence available, that energy is not strictly conserved, and that there is the possibility of an uncompensated gain in energy; but I cannot prove it absolutely. As said at the beginning, I would be very happy to send you a lot of detail about this, if you are interested to pursue it, and especially if you could advise or help in the matter. The other two problems of the total of four are related to both of the above, but are each really an independent problem, three of the total indicating the possibility of non-Conservation of Energy, the one other being simply a puzzling electromagnetic problem.

I would be most interested to hear from you, and particularly whether you can give any answer to, or throw any light upon, any of the above matters, or help in any way. Thank you for allowing your name to be passed on to me by Professor Kilmister. If in your reply you include any calculations, particularly calculus, would you please set out the steps in full, since my maths is at a rather low level, though I can often follow the simpler calculations, more or less, provided they are set out in detail. I hope I am not bothering you too much over this. No hurry, of course.

With best wishes,

Yours sincerely,

Frank F. Potter

APPENDIX B

POTTER'S FOURTH PROPOSAL: THE RECIPROCATING MAGNET ENGINE

The following is an excerpt from Frank Potter's 7th November 1993 letter to the author:

"The machine was this: A good modern permanent magnet has a close-wound coil wound around it in such a way that current can be passed in the direction opposite to that which magnetized the magnet. Standing at a short distance from one pole face of the magnet is a piece of soft iron, which is allowed to be attracted by the magnet while no current is flowing in the coil. The (potential) energy taken from the soft iron and imparted to its acceleration can be taken from it by some means, say by attachment to a crank and flywheel etc. like an old-fashioned reciprocating steam engine. When the piece of soft iron is stopped at the pole face switch on the current at a magnitude that will oppose and exactly balance the magnetism of the permanent magnet. There will be a momentary build-up of stored field energy in the coil, which can be 'recovered' later. But also, there will now be no field outside the permanent magnet and hence no magnetization of the piece of soft iron and no attractive force upon it, and in particular no loss-producing EMF induced by it into the coils by its motion if it is now drawn away from its starting position, and so no electromagnetic energy changes will take place. The mechanical energy used in accelerating it away from the pole face can be conserved by the flywheel.

So, draw the piece of soft iron away to its starting position. There will be no magnetic force restraining it and hence no expenditure of electrical energy (i.e. induced EMF) or mechanical energy (which the flywheel has taken care of) in thus moving it away again. Then switch off the opposing current when everything has returned to its starting position and recover the 'stored' energy in the field of the coils (say by discharging into a condenser or by other means), thus at the same time automatically restoring the soft iron to its original condition of being attracted by the permanent magnet. Repeat the operation continuously, using the flywheel to smooth things out mechanically. It appears that on each completed cycle there is a nett gain of energy, so energy is not conserved. Is there anything wrong with that?

I did work on this idea, both theoretically and practically, on and off many years ago in the late 1950s, in between many other calls in a very busy life. But I had to give it up, in favour of the other two ideas recorded in my earlier letter, partly due to the lack of time, but more particularly for two other reasons. The lesser of these was that I was by no means a good enough mechanical engineer to get the thing going, and doing it at home anyway. The greater reason, which was the one that really finally stopped me, at least for the time being, was that a possible theoretical and practical snag in the whole idea occurred to me, and I had not the necessarly theoretical and mathematical (particularly mathematical) ability to deal with it.

It concerns the 'recovery' of the 'stored' energy in the solenoid coils surrounding the permanent magnet, and it is this: What is the nature of the whole solenoid itself? Clearly it is not a soft iron cored solenoid, in which self-inductance L would be very much larger than that for the coils alone, because in this apparatus its core is a good modern permanent magnet, in which presumably the billions of molecular iron magnets composing it would have little if any room for motion under the influence of an applied field; and as I understand the matter it is this very freedom to move of the molecules of the soft iron that causes the great increase in self-inductance of the soft-iron cored solenoid over an air cored one. So, in effect, the coils are an air cored solenoid, because the permanent magnet inside them would be virtually unaffected by the current; or even slightly more than that, a vacuum cored one because the volume of the permanent magnet would replace the air.

What all this boils down to is that the self-inductance L of the coils would really be rather small, whereas I had I think been viewing it, more or less automatically, as quite large (like a soft-iron cored electromagnet). Now, what follows from this is the relationship of the piece of moveable soft iron into the solenoid. If it were really a soft iron cored solenoid with high L then the position of a relatively small piece of soft iron just outside it would make little difference to its large self-inductance. But in the case of the virtually vacuum-cored solenoid there might be quite a significant relative difference between its rather small self-inductance, say L_1, when the piece of iron is at the pole face, and its also small self-inductance, say L_2, when drawn away. Hence, keeping the current I constant during the whole half-cycle of withdrawal of the soft iron, and the formula for 'stored' energy of self-inductance being $\frac{1}{2}LI^2$, there would be some difference between the energy put in at the start and that recovered at the end of the second half-cycle, i.e. $\frac{1}{2}I^2(L_1 - L_2)$. So, there would actually seem to be some energy loss here, insignificant if the solenoid were really soft-iron cored (as I had been more or less assuming), but possibly significant as it actually was constructed.

So, the final question was whether it were possible and, indeed, likely that this energy loss would exactly balance out the very evident kinetic energy gain that would be obtained on the first half-cycle by the permanent magnet attracting and moving the soft iron?

I did not think the loss would be sufficient to balance out completely the gain, leaving Conservation of Energy valid; but I could not be at all sure. So the real difficulty came down to a question of theory, and in particular mathematics, in default of laboratory proof one way or the other. And I had no idea at all what the relative magnitudes were, i.e. whether the figures would be significant or not, and how this difference could be calculated, even possibly by a mathematician, let alone by myself, since obviously it would not be a very easy problem, even for an expert; and I think for many people it would come under your own "sweeping under the carpet" principle (!), assuming Conservation of Energy and thus conveniently forgetting all about it. Naturally enough really; though I would not have been happy about that, but did not know what to do. As said, much later, after a difficult period with other work etc. in my life, I went over to the other two ideas of my previous letter."

Though this led into the remark "that explains my four different ideas" this letter from Frank Potter went on for a further four pages on issues such as whether Clerk Maxwell's theories had extended to permanent magnets.

APPENDIX C

HOW CONCENTRATED FLUX DEVELOPS EMF IN AN ENCLOSING SOLENOID

One needs to explain how a magnetic flux change concentrated in a central core region of the space within a large solenoid can develop induced EMF in the solenoid.

It is not a sufficient answer in the quest to explain the nature of magnetic phenomena and induction to say that the EMF is simply the rate of change of flux $d\varphi/dt$ enclosed by each circuit loop (or winding turn) of the solenoid.

In practice, space itself is, in a sense, a 'perfect' conductor [See footnote at end of this Appendix] in that elemental regions of empty space can be said to be bounded by a closed flow path and any $d\varphi/dt$ action in that bounded region will also produce a circuital EMF.

Since there is current flow, essential to develop a field reaction, and since no I^2R energy loss is involved, we know that either R applicable to the loop is zero or something else is effective to set up a cancelling EMF in opposition in that loop of space. That 'something else' is the circuital component of an EMF set up in an adjacent loop region of space, which, for the purposes of this discussion, is deemed to be subject to its own $d\varphi/dt$ magnetic flux exchange process.

For there to be current flow in this adjacent loop and a negligible EMF driving that flow, the R factor applicable to space must be virtually zero as if it were a superconductor, and yet this is not a strict analysis because the space medium is able to sustain oscillations of electromagnetic field.

The current flow in the adjacent loop corresponds to a net zero EMF comprising a component EMF adjacent the inner loop that balances the $d\varphi/dt$-related EMF and a component EMF now in the outer section of the outer loop that keeps the balance.

In mathematical terms, imagine a sector of the space within the solenoid to be that of an arc of angle Θ bounded between inner and outer radii r and R, respectively. See Fig. 7.

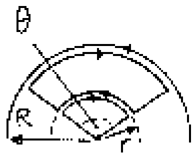

Fig. 7 Elemental arcuate sectors of a solenoidal field

The EMF induced by $d\varphi/dt$ in the central core sector with a segment of inner radius r will be:

$$(d\varphi/dt)\Theta/2\pi$$

The EMF induced in a closed loop sector between r and R is zero, because all the flux Φ is deemed to be concentrated within radius r. In order that the EMF acting within the inner core sector should not do work on the 'nothingness' of space, the outer loop responds by setting up a back EMF in the arc segment of radius r which is exactly cancelled by a forward EMF in the arc segment of radius R.

It is therefore the response of regions of vacuum space in developing circuital loop reaction currents in a non-resitive medium that is the cause of a transfer of action outwards to the winding of the solenoid by virtue of the back-to-back EMF response in contiguous sections of adjacent reaction current loops.

Once the EMF finds itself trying to develop current flow in the wire of the winding of the solenoid, then it does meet resistance and normal circuit theory applies, but the action could not occur without the buffer response of virtual current activity in the intervening space.

It is essential that this very important point should be well understood as, otherwise, we are left with experimental mathematical formulae that convey no explanation of the true energy activity involved in magnetic inductance.

The explanation here is provided because Frank Potter has questioned whether the enlargement of the solenoid radius to realms far removed from the seat of the flux change activity $d\varphi/dt$ can result in a restriction on the induced EMF, meaning the back EMF, if the power supplied to the solenoid is what causes rotation of the magnet developing the $d\varphi/dt$ flux change.

Footnote: Note that each element of a 'perfect' circuit could have inductance L and capacitance C and develop finite currents and an EMF even if resistance R were zero. Each cell of space must be regarded as a parallel-connected LC circuit and, as applied to the vacuum medium with its non-dispersive properties in wave propagation, one also needs a self-tuning resonance effect in response to rates of change of signal disturbances in transit. However, as back-up for this, there is the further property that steady reacting current flow is possible owing to the orbital motion of the vacuum charges in their quantum states. Readers interested in this should refer to the author's article 'The Ether - an Assessment', in the U.K. magazine Wireless World, 88, pp. 37-39 (1982), which discusses the self-tuning property of the vacuum medium. The steady-field reacting current flow has been discussed in ENERGY SCIENCE REPORT NO. 1.

APPENDIX D
EMF GENERATED IN A SOLENOID BY A ROTATING BAR MAGNET

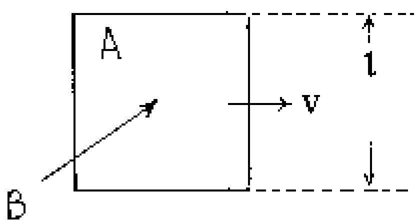

Fig. 8

Reference is made to Fig. 8. The calculation of induced EMF in a coil is based on the rate of change of magnetic flux linkage through the area of that coil. Thus, if the 'coil' is really a rectangular loop with one side of length l expanding outwards at a speed v in a plane perpendicular to a steady field B, the EMF will be proportional to Blv. Alternatively, if the loop area A is fixed so, the EMF induced will be proportional to A times the rate of change of B.

The 'linkage' is what is meant by 'mutual inductance', in the sense that, whatever circuit or source produces B, that will have a mutual inductance vis-a-vis the circuit loop of area A. Suppose, for example, that B is produced by a current I_o then the EMF induced in the loop of area A will be proportional to the time rate of change of MI_o, where M is mutual inductance.

To calculate M for a particular interaction one really is doing nothing other than working out how B produced by I_o links with an area A.

Now, there are two ways of going about this calculation. Because the action is 'mutual' it has a certain recriprocity and one can take either component of the system as the generator of a field B and work out how this links the area of the other component. Obviously, since both must give the same answer for M, by symmetry of action, it is logical to choose the easier of the two possible calculations.

In the case of a bar magnet rotating inside a solenoid it is not difficult to proceed in either way, but there is sense in taking the solenoid as the field source. The reason is that the field produced by a bar magnet is that of its two poles and is a rather complex function of magnet length and distance from the centre of the magnet, whereas the field acting on the magnet and produced by the solenoid is a uniform field in the case under analysis.

Having in mind that this Appendix is written to meet the concerns of Frank Potter, it is stressed that 'mutual inductance' means just that: the mutual action by which energy can be transferred by induced EMF between two interacting circuit elements is one that works either way with no nett gain or loss of inductance energy. Indeed, if the mutual inductance favoured one or other of the circuit components in this exchange of energy, so one could design a transformer or oscillator that would be nothing other than coils of wire in air and yet would generate electricity continuously without the aid of any external agency.

Whilst we do have in mind the issue of energy conservation with the bar magnet itself being a prospective coupling with such an external agency, the problem at hand is one of orthodox electrical engineering calculation of mutual coupling between two circuits aimed at deriving an EMF value. Hence, the logical route to finding that answer is the calculation of mutual inductance M in the problem under study and we shall do this by working out the field linkages from the solenoid to the magnet, rather than the other way around.

That said, and referring to Fig. 9, we shall now substitute the rotating bar magnet by a small coil of area A carrying current $I_o$sint so as to produce its field along the central axis of the solenoid and a similar small coil of area A carrying current $I_o$cost arranged at right angles so as to produce its field along a radius vector from the centre of the solenoid.

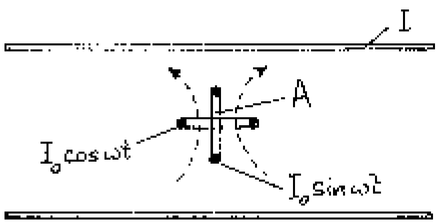

Fig. 9

Note that this represents a circuit having a magnetic moment I_oA which is chosen to equal the magnetic moment of the magnet, the latter being its pole strength times its length. The eventual EMF to be calculated will need to be expressed in terms of this magnetic moment. The action described represents a magnet rotating with an angular frequency ω.

Now, first, looking at the effect which the current $I_o$cost has in inducing an EMF in the solenoid, we can see by symmetry that this is zero, because the field diverges in opposite directions in each half of the solenoid and so the flux linkages will be such as to develop a clockwise EMF in one half of the solenoid and an anti-clockwise EMF in the other half of the solenoid and these will back against one another to sum to zero nett EMF. Therefore, that tells us that the mutual inductance for the configuration including the cost component is zero.

The task next is to calculate the field produced by the solenoid that links with the other notional coil of area A.

Let the current in the solenoid be denoted I. If the solenoid were of infinite length then, assuming vacuum permeability μ_o, the axially-directed field intensity in the solenoid is μ_oNI, where N is the number of turns per unit length of solenoid. Note that in the gaussian system of units used elsewhere in this Report the permeability would be unity with a 4π factor added.

The flux linking the area A is then A times this quantity and the flux per unit current I is simply Aμ_oN, which therefore is the value of M, the mutual inductance.

Now, by the reciprocity argument concerning the 'mutual' nature of this inductance, the same value of M applies if we regard the rotating magnet as the source inducing an EMF in the solenoid. EMF is rate of change of flux linkage or M times rate of change of $I_o$sint, which is M times $I_o\cos\omega t$.

The EMF produced in the solenoid is therefore $(AI_o)\mu_o N\cos\omega t$.

Had we assumed that the solenoid has a finite length D and a diameter *a*, then the field at the centre of the solenoid is reduced by the factor $D/(D^2+a^2)^{1/2}$, and the EMF is accordingly reduced by the same factor.

The derivation of this latter factor can be confirmed from the analysis given in section 33 above. The sine of the angle Θ is the factor just mentioned. It is unity for a solenoid of infinite length.

It follows, therefore, that if the radius of the solenoid is progressively increased to a very large value, then provided the length of the solenoid increases in proportion, so the EMF induced in it by the rotating magnet will be unchanged. However, N, which is the number of turns on the solenoid per unit length, must be the same so that the total number of turns must increase in proportion as well, otherwise the EMF will be reduced.

In effect, one is here seeing the fact that the field from a bar magnet drops inversely as the cube root of distance, whilst the area of a solenoid turn increases as the square of distance, so unless the number of turns increases in proportion to distance the flux linkage rate will not be sustained with change of scale.

Note that this Appendix is added purely to answer a question raised by Frank Potter. It has no relevance to the prospect of building a motor that can conceivably perform anomalously in energy terms, because the interaction under study is the standard interaction between a magnet and a current in a winding.

As explained elsewhere in this and other ENERGY SCIENCE REPORTS on magnetism, the prospect of generating what is termed 'free energy' is one that comes into sight where we have a magnet and a ferromagnetic core interacting under the control of a current in an external winding. That is a scenario where the third party to the action disturbs the 'mutual' reciprocal action which otherwise implies symmetry extending to energy exchange processes and it is that which brings a new dimension into energy research.

ENERGY SCIENCE REPORT No. 5

This Report was first published by the author in 1994 and was reissued later and made more generally available from Sabberton Publications as ISBN 0 085056 0217 in October 1996. It is now made available freely via this Internet facility. It concerns theory pertaining to the creation and properties of deuterons which, as present in atoms in heavy water, deuterium oxide, are involved in the experiments which gave birth to the notion of 'cold fusion'. The technology of that field is slow to develop and, though the author did plan to write a Part II Report as a sequel to this report, which is entitled *POWER FROM WATER: COLD FUSION: PART I*, this has not materialized. This Report nevertheless is an important contribution to the theory of the subject, also because it explains how the triton, the third isotope of hydrogen is created. It is worthy of study as an adjunct to the author's latest work, the book: *The Physics of Creation*, because the latter explains in updated detail how the proton itself, the primary isotope of hydrogen is created. For this reason it is given priority in updating this website by now adding progressively each of these ten Energy Science Reports as they are withdrawn from normal printed publication. It should be noted that the book just referenced is a substantial work and should not be confused with Appendix A of this Report, which has the same title. The latter featured as a 12 page Chapter 4 in the author's book *GRAVITATION*, published in 1975, which gives an early insight into what has now become a 28 year-old account of the origin of proton creation. .... Harold Aspden, 1 June 2003

ENERGY SCIENCE REPORT NO. 5

POWER FROM WATER: COLD FUSION: PART I

Contents

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POWER FROM WATER: COLD FUSION: PART I

Introduction

This Energy Science Report draws attention to the revelance of theoretical work pursued by the author over many years before the advent of the now well-known 'cold fusion' discoveries reported from Utah in 1989.

It will be followed by a Cold Fusion: Part II Report, which will be more specifically directed to the author's patented technology which is emerging from this theoretical base.

The object of this Report is to show how the 'cold fusion' scenario is destined to impact the whole field of fundamental physics, ranging from cosmology generally to the pursuit of energy generation techniques that are so fundamental that they can harness the still-latent and ever-present forces which brought about the creation of the universe.

These Energy Science Reports are all connected with that underlying groundwork in energy physics that the author has surveyed, driven by his interest in magnetism. Thus Energy Science Report No. 1 concerned 'Power from Magnetism' and described three of the author's experiments which point the way forward to what many term 'free energy'.

We are assuredly destined to see rapid strides in this technological field in the months and years ahead and we will enter the 21st century with a whole new vision of our energy future.

Only today, 15th April, 1994, as the author writes the first words of this report, a communication was received which draws attention to what is termed 'UDT' - Unidirectional Transformer - which Paul Raymond Jensen of Santa Barbara, California claims to have invented. When readers of my Energy Science Report No. 1 become aware of Jensen's 'UDT' and compare the transformer with that shown in Fig. 4 of that Report they will see how the solid-state 'free energy' ferromagnetic device can now emerge on the 'free energy' scene.

With the same prospect evolving on the magnetic reluctance motor using permanent magnets, as championed, for example, by New Zealander Robert G. Adams, this author has planned an Energy Science Report concerned with motor technology. However, here also, whilst currently in the throes of experimentation, it has come to light that a researcher named Frank F. Potter has, for many years, been urging university professors in U.K. to work on the prospect of tapping the energy field that powers a magnet. He has challenged them to do the calculations on specific field coupling involving magnets to prove the case one way or the other.

In spite of the interest engendered, the usual establishment reserve about the so-called 'perpetual motion' machine has kept the Potter issue private and not brought it into open forum. However, this author, having now heard of this, has responded to the challenge and has brought ahead of schedule 'Energy Science Report No. 4: The Potter Debate' which was completed on 10th April, 1994. That Report provides a mathematical basis which will help critics of the 'free energy' field to come to terms with what is now bound to disturb the world of those experts who know how to design electrical transformers and chokes but appear not to know how close they are to a new technology that can provide an energy bonanza.

The intervening Energy Science Reports Nos. 2 and 3 are captioned 'Power from Ice', and relate to experimental work on a thermoelectric energy converter in which the author is involved as inventor. These Reports exist only in confidential draft form at this time but that technology does spill over into something that will be said about the 'cold fusion' research, particularly in the Part II Report.

This introduction, therefore, explains how this text fits into the series of Energy Science Reports by which the author has chosen to update his published research findings prior to incorporation and consolidation in a more formal book form. The 'free energy' scene is now evolving so rapidly that it is better if such a book is written once the author has possession of his own working 'free energy' generator and can provide full test data on a practical system.

The Black Hole Syndrome

This may seem an unusual heading for a text about 'cold fusion', but the physicists who believe in 'black holes' think as do physicists who do <u>not</u> believe in 'cold fusion'. This is a very relevant comparison as one can see from the following remarks.

1. All physics is built on observation of how electrical particles behave, whether individually or in aggregation as matter. The interaction forces between such particles control their coming together, whether to form atomic nuclei, molecules, composites, crystals or stars and planets.

2. Physicists tend to extrapolate their knowledge of experimental behaviour to realms far beyond the bounds governing the conditions of their experiments. They seek to probe territory they cannot reach, but always build with confidence on the certain founding knowledge derived from experiments on what they can see or what they can explore in a laboratory.

3. The neutron as a real particle has only been detected upon creation in the free state and it has a half-lifetime measured in minutes but physicists extrapolate and create 'neutron stars' in their imagination, stars which survive far longer than a few minutes! They cannot 'see' a neutron in an atom, such as in the deuteron, but they <u>assume</u> it is there because the deuteron has two atomic units of mass and one of charge. But, surely, one could better surmise that two anti-protons plus three positive beta-particles represent two atomic units of mass having one positive unit of charge. We know that atoms decay by shedding beta-particles and what we could suspect is that, if they shed an anti-proton and a positive beta-particle, so that would manifest itself as a short-lived 'neutron'! If, on this basis, there are no neutrons in an atomic nucleus such as the deuteron, then is it really surprising to find no neutron emission when we contrive to capture those positive beta-particles by free conduction electrons in the host metal cathode of a cold fusion cell? On the contrary, physicists go the other way and make their unwarranted quantum leap by recognizing that neutrons are able to form stars that have no electrical resistance to the crushing force of gravitation - even though those free neutrons in the laboratory show a substantial <u>negative</u> magnetic moment!

4. They cannot see a 'black hole', but they can imagine matter becoming so compact, as gravitational interaction forces become so strong as to out-weigh and preclude the intervention of electric forces between those charge constituents of the neutron. They are thereby <u>assuming</u> that gravitation is a force so fundamental that it transcends and displaces electric force from a primary role that is so evident in laboratory findings from atomic physics.

5. Those physicists can see in certain remote galaxies certain effects which suggest the coming together of electrical matter, which, by all the basic rules of physics, should not occur because electric forces resist nucleation. Their evidence is a strong gravity force, abnormally related to the mass of the visible body acted upon or a substantial redshift in the optical spectrum of atoms radiating from the nearby field zone. Their assumption is that the universe was born in a Big Bang where everything was overheated and had such energy content that all physical barriers could be overcome. Anything is possible in such a vision!

6. So, if excess heat is seen to emerge from a deuterated palladium cathode in a 'cold fusion' cell, that could suggest that 'nucleation' or fusion has occurred between deuterons, overcoming their mutual electric repulsion in that metal palladium. However, those who believe in 'black holes' are not inclined to believe in 'cold fusion' because they know that the 'black-art' assumptions needed to create the 'Big Bang' and the 'black hole' are not as easy to apply inside a lump of palladium on a laboratory test bench.

7. This 'disbelieving' body of physicists has other 'disbeliefs' as well. They rely on their 'practical' knowledge of gravity and measurement of G to calculate 'black hole' properties, but do not believe that there is a real 'aether' medium, the distortion of which generates that gravitational action. They believe in mathematical extrapolation and that means reliance on equations do not 'rupture' when under excessive stress, as does real matter or real 'aether'. What, indeed, is the tensile strength or the compressive strength or the shear strength of what physicists call 4-space? What, one wonders, are its internal dimensions, the distances between its component parts? Without common ground on which to stand in talking about 'aether' or 'space-time', one cannot discuss with such physicists how it is that the 'crystal' structure of the aether itself determines the 'fine-structure constant' they use in their atomic physics. One cannot discuss with such physicists how it is that the sub-quantum motion underlying the Planck action quantum interacts with matter present to force a need for a dynamic balance, which in turn demands the presence of a discrete and unseen graviton population. One cannot therefore get such physicists to listen to the formal account by which G, the constant of gravitation, is derived in terms of that dynamic balance. And so it follows that one cannot put the case to such physicists that, where matter is very concentrated, as within an atomic nucleus in the mid-range of the periodic table, the aether is not too far from the stress limits that govern graviton creation conforming with G as measured in our laboratory.

8. It seems that there is no way in which one can lead a 'disbelieving' physics community out of their wilderness, even if one uses their own language and words with which they are familiar. All one can do is to destroy their beliefs with the mighty blow forthcoming from the reality of a technological breakthrough. Whether this comes from 'cold fusion' or from 'free energy' sourced in ferromagnetism matters not, so long as there is that technological breakthrough. What is needed is something that points to evidence of how protons and deuterons are created preliminary to their fusion to form heavier forms of matter and how Planck's action in the underlying aether spills out energy to feed that creation.

9. The 'black-hole' supergravity that can occur in very dense matter cannot be explained until one can explain gravity in normal matter and until one can further explain the factors which determine the value of the fine-structure constant. If, for

example, Planck's constant were to change in a step function as a function of the mass density thresholds in very dense matter, related to the concentration of aether energy, so that would affect the interpretation of the so-called 'black hole' evidence.

10. If, in striving to sustain a dynamic balance, the aether responds in a dual dynamic action to the passage of electromagnetic waves, so this could affect energy deployment implicit in Maxwell's wave equations and it could explain why the aether medium appears non-dispersive. These possibilities are not even considered by physicists who insist on building only on their 'past experience' without looking at the foundations to see what might have been missed. So, we advance by the accident of discovery, and, it seems, 'cold fusion' is one such accident. It remains now to convince physicists generally that there is excess heat generated in a cold fusion cell and then they can begin to think of revising their theories. This they will do in their own way, mindless of the work of record that can help them in that task.

11. Inasmuch as this author began in this field by first making the magnetic case for a real aether, then by determining the structure of that aether and deducing the fine-structure constant and going on from there to explain the connection with gravitation and proton creation, so it seems appropriate to lead from that into the subject of this Report. 'Black holes' and an 'expanding universe' conceived by physicists who were unaware of how Nature's ongoing attempts at proton creation in space can progressively reduce the frequency of electromagnetic waves in transit, plus the illusions of Einstein, have made them deaf to what this author has been saying over the years. In spite of this the author will here try once again to introduce his theory of proton creation and with it the creation of neutrons and deuterons, all to give basis to the new physics essential to our understanding of what underlies 'cold fusion' and of that deeper source of 'free energy' from which protons and deuterons are created. The author will further show how gravity features in this act.

12. One could not advance a theory on the scale provided by this author without encountering numerous obstructions where one has to pause to explain why others who claim something different have gone wrong in their own endeavours. The 'cold fusion' issue has run into such problems. However, here it has not been a question of theory. There is now too much theory and not enough fact and so it is that the author feels he can let his own theory pertaining to cold fusion stand the scrutiny of others in this contest before needing to consider its defence. No, the rival claims in the 'cold fusion' field are those of experimenters. Whilst there are the pioneers who persist experimentally in their onward research, there are the others who rely on their personal 'experience' of confirmatory tests which have failed. Thus, whilst the author makes no special claim for superior wisdom in this experimental field, he has a comment to offer on the latter topic. It is merely an observation that to get two like-polarity charges to come together in a metal conductor one needs a standing charge of opposite polarity set up in that metal. One way of creating this condition is by setting up a non-linear orthogonal configuration of the temperature gradient and the magnetic field in the metal. In attempting to use uniform temperature calorimeter test apparatus enclosing the cold fusion cell, researchers are choking off the possible catalyst temperature gradient that could well be needed to trigger deuteron fusion. That topic will be discussed in the Part II Report and, pending that, readers may see some mention of this in New Energy News: April 1994: 'Patents for Cold Fusion' pp. 3-5.

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It is hoped that the above discourse will explain why 'cold fusion' is seen by this author as offering more than a technological route to a non-polluting new source of energy. Nor is it merely something that can affect attitudes by nuclear physicists in their particular discipline. It is, in fact, a route to something of far greater consequence in that it gives us an insight into the true forces of Creation.

It is appropriate here to remind the reader that 'cold fusion' is very much concerned with whether, and if so, how, hydrogen nuclei, adsorbed into a host metal and having their atomic electrons exposed to the interplay with free conduction electrons in that metal, can fuse together to release energy. The mutual transmutations and transient behaviour of the nuclei of the hydrogen isotopes, the proton, the deuteron and the triton, is what concerns us in finding the answer to these questions.

The Triton Factor

One is not far from claiming the ultimate scientific achievement when one declares an ability to calculate the proton mass theoretically in terms of electron mass, based on showing how Nature creates that proton.

One should not then be surprised if the same theory explains other phenomena and leads to the precise derivation of other fundamental dimensionless physical constants, such as Planck's constant and the gravitation constant G.

Whilst the author has waited patiently for his work in this field to be appreciated and recognized by the world at large, to no avail so far, it has been personally satisfying to see how the same theory yields the solutions to lesser problems, such as those posed by the muon, the pion and the kaon or the neutron and the deuteron.

The key interest on which this research was founded was that of understanding the electrodynamic properties of these particles and relating the quantum of action of a real aether with the electrodynamics of the gravitons which determine the force of gravitation.

In the Appendices to this Report some of the relevant published papers are reproduced, so there is no point in discussing that work in the body of this text on 'cold fusion'. However, not reproduced elsewhere is an account presented in a book entitled 'GRAVITATION' which the author published in 1975.

The subject was that of showing how heavy electrons (the mu-mesons or muons) which account for the primary energy action in the aethereal vacuum medium come together to create particles from which evolve protons and gravitons. Their action in creating protons is fully disclosed in the paper reproduced in APPENDIX D. The paper in APPENDIX E deals with the neutron and the deuteron and particular reference is made to Table II in that paper which shows how a deuteron alternates between three states, one of which is electrically neutral with a transiently-free - particle, a state which makes it particularly vulnerable to fusion with another deuteron.

Concerning gravitation, the author could further include 'The Theory of the Gravitation Constant', as published in Physics Essays, **2**, pp. 173-179 (1989), but as that will be appended to ENERGY SCIENCE REPORT NO. 6, the reader is invited to refer to that. However, a summary introduction is presented below as APPENDIX A, reproduced from pp. 44 to 52 of the author's 1975 book entitled 'GRAVITATION'. It provides a pictorial scenario showing how particle building can occur to develop the proton into the graviton needed to explain the derivation of G, the constant of gravitation.

From the viewpoint of 'cold fusion' this is relevant because one needs to be assured that a theory developed for the proton, the neutron and the deuteron is consistent with the physics needed to explain other phenomena and, as 'black holes' and gravitation have been mentioned, the link between protons and gravitation should be of interest. Knowledge of the graviton mass is essential if one is to calculate the value of G.

The underlying theory was extremely simple in that the energy formula for two electric charges in contact is a quadratic equation having two solutions for the same energy value if one of the charge energies is a variable. This is because the energy of a charge e is inversely proportional to its bounding radius. Therefore, given two particle energy quanta, each nucleated by the standard unit of charge, one finds that a third particle form is created with no energy requirement. In an energy-active world, the separation and recombination of such particles and the ongoing regeneration of new particle forms amounts to a creation process. The question then arises as to which particle forms win in the contest for survival and it is found that only those having special secondary resonance properties can enjoy a long life span.

In this contest for survival of particles, newly created by drawing on the pool of surplus energy, there are those which are created at very nearly the same mass by two different combination sequences. This gives them a dominant advantage but the only long term survivor in real matter is the proton.

This means that the heavier particles of matter are formed by taking protons and/or antiprotons as basic building blocks and combining the -particle constituents, the electrons and positrons of the quantum-electrodynamic field background.

The deuteron has to be an electron-positron-proton-antiproton composition of some kind, whereas the triton, the third isotope of hydrogen, can be of similar composition, but of more complex form.

The reason for this is the fact that the basic graviton has a mass greater than twice the proton mass but not as great as three times the proton mass. Therefore, a closely-bound structure will constitute the deuteron, whereas the triton will need to have its mass seated in two end regions standing apart and not closely-bound by a -particle linkage.

It was on these lines, that the theory of the deuteron and triton evolved, but the key to determining their actual structure was the evidence afforded by their precise mass and by their electrodynamic response properties as known from their magnetic moments. The same applied to the neutron, which, like the triton, had a third parameter to bring in as evidence, namely a measured lifetime.

Such data, when deciphered, showed that the deuteron, for example, was exchanging states by particle and anti-particle annihilation and recreation and that in some states it had a satellite system or 'entourage' of 'free' -particles, meaning that they could migrate a very limited distance into a host metal containing such a deuteron.

For the neutron the lifetime became calculable but, as the theory evolved to build into a model of nuclear chain linkage as atoms of greater atomic number formed, so the neutron could not be seen as part of the atomic nucleus. It only exists in a free condition where it has that limited lifetime.

It is only very recently that the triton data has been deciphered and the theory has been proved very successful in interpreting the lifetime. Note that lifetimes are calculated on the basis of destructive bombardment by combinations of mu-mesons featuring in their quantum-electrodynamic dance in that aethereal field background.

The work on the triton has followed closely on the discovery that the proton and deuteron have an abundance relationship that is set by their interaction in this aethereal background field, as deuterons are primed to undergo fission to recreate protons, whilst protons merge by fusion to create deuterons.

The showing that the deuteron and the proton have a relative natural abundance that is determined by an ongoing physical process forms the subject of APPENDIX B, whereas the derivation of the lifetime of the triton is presented in APPENDIX C.

It is noted that the author has written many other papers that connect with the above theory and five, in particular, warrant mention and are commended for library reference to interested readers as they will not be included in this initial series of the author's ENERGY SCIENCE REPORTS.

They are:

(a) 'Meson Production based on Thomson Energy Correlation',

Hadronic Journal, **9**, 137-140 (1986).

(b) 'An Empricial Approach to Meson Energy Correlation',

Hadronic Journal, **9**, 153-157 (1986).

(c) 'The Physics of the Missing Atoms: Technetium and Promethium',

Hadronic Journal, **10**, 185-192 (1987).

(d) 'Conservative Hadron Interactions exemplified by the Creation of the Kaon',

Hadronic Journal, **12**, 101-108 (1989).

(e) 'A Theory of Pion Creation',

Physics Essays, **2**, 360-367 (1989).

All these papers passed the test of referee scrutiny as did many papers giving groundwork for the above developments that were published in English by the Italian Institute of Physics in their Lettere Al Nuovo Cimento series in the five or so years before that periodical terminated publication at year-end 1985.

There will be those who read this text who stand ready to criticize because there is so much in physics that can affect one's views on particle behaviour. For example, the wave nature of the neutron is not something that may seem to fit easily into the picture presented above. However, in fact, it does, because that β-particle 'entourage' already mentioned (see Table I in Appendix E) is what exhibits the wave property.

The reader who is ready to discard the substance of this text on that account should first read the author's paper 'The Theoretical Nature of the Photon in a Lattice Vacuum' to be found at pp. 345-359 in 'Quantum Uncertainties' Series B: Physics Vol.

162 (1986) in the NATO ASI Series published by Plenum Publishing Corporation, New York.

Then the reader may refer to the author's paper: 'A Causal Theory for Neutron Diffraction', Physics Letters A, **119**, pp. 105-108 (1986), before looking up those many other background papers in Lettere Al Nuovo Cimento.

Indeed, for the reader who has a cosmological inclination, half an eye on the 'missing mass' problem, and believes that steady-state equilibrium by proton creation and decay is not compatible with the redshift indication of an expanding universe, the author's paper that warrants special scrutiny is:

'The Steady-State Free-Electron Population of Free Space'
Lettere Al Nuovo Cimento, **41**, pp. 252-256 (1984).

Conclusion

This Energy Science Report on Cold Fusion, in its Part I contribution to the 'Power from Water' theme, is intended to present some of the author's relevant background theory in the scientific paper form in which it has already been published elsewhere, though the paper on the proton-deuteron abundance ratio is new to this work.

As already stated, Part II will address other aspects bearing more directly on the technology of cold fusion, but this Part I material is an essential introduction to show why it is that the deuteron by its particle entourage can be partially embroiled in the electron-positron activity of free electrons in a metal host conductor. As already mentioned, one can see from the reference in APPENDIX E the situation where the core of the deuteron sits electrically neutral and bare of charge for moments in a fluctuating environment of charge, meaning that it is vulnerable to Coulomb barrier penetration by charged deuterons, so giving chance of fusion.

Also, it is hoped that what has been said will cause some physicists to realise that existing knowledge of fundamental physics has its limitations but that 'cold fusion' research could well give us the added stimulus leading to the needed insight into the forces at work in creating the hydrogen nucleus and so understanding Creation on its universal scale.

The reprinted papers forming APPENDIX D and APPENDIX E, are copied with the kind permission from the Editors of the Hadronic Journal.

26th April 1994

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ENGLAND

APPENDIX A

[The text here in the printed version of this Energy Science Report No. 5 was copied from pages 44-51 of the author's 1975 book 'GRAVITATION']
These pages can be seen in pdf format by using the following link:

GRAVITATION pp. 44 to 51

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APPENDIX B

THE DEUTERON-PROTON RELATIVE ABUNDANCE

Introduction

We begin by asking a question:

'Bearing in mind that the chemistry, meaning the chemical-bonding affinity, of heavy water is identical to that of ordinary water, would a human being be: (a) more healthy, (b) less healthy or (c) as healthy if the water intake to the body were to be heavy water rather than ordinary water?'

As we approach the 21st century our scientific knowledge should have an answer to this question, especially as we know physicists are trying to solve our energy problems by nuclear fusion processes which utilize heavy water.

Putting the above question rather differently:

'If a wealthy man were to create an environment in which he spent most of his time with no exposure to heavy water, meaning that all deuterium oxide or hydrogen deuteroxide is removed from the ordinary water supplied to that environment, could he expect to benefit healthwise and live longer?'

Perhaps, unknown to this author, the answer to these questions is to be found somewhere on university library shelves. The author, in giving limited consideration to this question, referred to a textbook in his own possession, the third edition (1957) of 'Physical Chemistry' by Walter J. Moore, Professor of Chemistry at Indiana, published in the original American edition by Prentice-Hall Inc. of New York.

An end-of-chapter question on page 249 reads:

'A normal male subject weighing 70.8 kg was injected with 5.09 ml of water containing tritium ($9x10^9$ cpm). Equilibrium with body water was reached after 3 hr when a 1-ml sample of plasma water from the subject had an activity of $1.8x10^5$ cpm. Estimate the weight per cent of water in the human body.'

The triton is the atomic nucleus of tritium, the third isotope of the element hydrogen, so, in a sense, one can infer from the latter exercise question that the body intake of very heavy water involving tritium will make the body radioactive and that cannot be good for one's health. Yet the very fact that this exercise question appears in a university textbook does suggest that water containing a concentration of tritium can be used in clinical testing. Our interest in the health implications of deuterium is therefore warranted. Deuterium is not radioactive but we still have a valid and unanswered question in wondering if heavy water is in any way damaging to health.

Deuteron Fission and Fusion as a Natural Phenomenon

In that same 'Physical Chemistry' textbook and chapter 9, with its appended questions, we read on p. 244 about the 'energy production of stars'. Two nuclear processes are described as being alternative possibilities. One involves a process in which C^{12} and H^1 fuse to produce N^{13} which in turn decays to C^{13} with the emission of a positron before experiencing further regenerative fusion and decay iterations with hydrogen and oxygen to yield ultimately He^4. The other involves the fusion of two protons to produce a deuteron and a positron, also followed by the synthesis of He^4.

It is said that the first of these, the carbon cycle, is the source of energy in very hot stars, whilst the second involving deuterons applies to somewhat cooler stars like our sun. Amongst the steps in the stellar carbon cycle there is one in which C^{13} combines with H^1 to yield N^{14} before the latter combines with H^1 to produce O^{15}.

Now, moving back to Earth and those end-of-chapter questions we read:

'According to W. F. Libby [Science, 109, 227 (1949)] it is probable that radioactive carbon-14 (mean lifetime 5720 years) is produced in the upper atmosphere by the action of cosmic-ray neutrons on N^{14}, being thereby maintained at approximately constant concentration of 12.5 cpm per g of carbon. A sample of wood from an ancient Egyptian tomb gave an activity of 7.04 cpm per g of carbon. Estimate the age of the wood.'

The significance of this is that the physics of carbon-14 dating depends upon the transmutation of atomic nuclei and the probability of events involving exposure the atomic nuclei to bombardment by energetic stimuli. Now, in simply assigning a mean lifetime to a particular nuclear decay process the physicist can be hiding ignorance of something behind his presentation of empirical fact. He knows that there is decay and can measure the mean lifetime involved, but we are not in every case told why that decay occurs. Yes, we are told that the cosmic-ray neutrons create C^{14} from N^{14}, presumably by emission of a positron, but we are not told what it is that sporadically bombards the C^{14} once it is protected from exposure to the elements and which somehow triggers its eventual decay.

There is, quite clearly, something in our non-cosmic Earth environment that can activate nuclear fission and possibly nuclear fusion reactions. This may be that mysterious something we call the 'neutrino' but one really must wonder whether that term 'neutrino' is scientific 'mumbo jumbo' for what could be described as 'a sporadic intruding influence of an energetic interaction with an all-pervading field background'. The advancement of energy science may depend upon the development of a better understanding of that intruding influence, because it surely must account for nuclear energy transactions which can occur at normal temperatures as in that ancient piece of wood of the carbon-dating example.

It is not very satisfying to be told that, inasmuch as energy and momentum equations would not otherwise balance, there is need to recognize the existence of particles we call 'neutrinos' or the even enigmatic 'neutrons'. There was in pre-20th century science the firm belief in the existence of an aether medium which common sense suggested as that ever-present hidden underworld which could sustain electric field oscillations travelling through a vacuum. In a sense, the modern physicist has replaced that aether with a collection of imaginary particles, whether termed 'neutrinos' or described as being 'virtual' which are the unseen denizens of the vacuum state which we can refer to to 'take up the slack' created by gaps in our scientific knowledge. Yet, is the conventional picture of that virtual 'neutrino-inhabited' quantum sea correct?

Let us return to our problem and focus attention upon the transmutation of the hydrogen and deuterium nuclei, meaning the process deemed to occur in the sun by which two protons fuse with release of energy and a positron (or so-called beta-plus particle) to become a deuteron. Also meant is the reverse process by which, given the right stimulus, a deuteron can convert into two protons by emitting an electron or so-called beta-minus particle. The latter possibility as a natural process is suggested by the observation that the abundance ratio of deuterons to protons is the same for matter found in comets as it is for matter on Earth.

What universal process determines this ratio and keeps it constant? Are we, instead, to believe that the ratio is one which evolves and so changes, in which case we should try to explain why the comet presents the same ratio as the Earth. Are we to believe that there was a Big Bang in which the ratio of protons to deuterons was fixed in an atomic soup which was stirred to a uniform and final mixture before the cometary matter and the Earth condensed from that common nebulous mixture?

In the absence of verifying laboratory tests we shall never know for certain the answer to these questions, but one can say that there is more than the glimmer of a solution if the abundance ratio actually measured can be deduced in the manner and style of the solution of those end-of-chapter questions in that textbook entitled 'Physical Chemistry'.

So, we now set our sights on explaining the proton/deuteron abundance ratio ducumented at page 9-65 of the 1967 second edition of the McGraw-Hill 'Handbook of Physics' edited by Condon and Odishaw. According to this reference work, in every ten million atoms containing hydrogen and deuterium there are 9,998,508 nucleated by protons and 1,492 nucleated by deuterons.

The conditions governing the fusion and fission of these atomic particles must involve the element of chance, in that a combination of events conducive to decay must occur as a probability function, bringing about actions involving energy in a form which can materialize or dematerialize in integer quanta we associate with decay particle products (those beta particles).

Note that we speak of 'decay' both for the fission and the fusion process as if decay can be a two-way or reversible operation. This has meaning only if the real form of the proton and the deuteron is that of a system which overall exhibits the stability of single-form existence but yet which, inherently, undergoes cyclic alternations of state, as between a ground state and one of greater energy.

Much more will be said about this subject in this and later work and by reference to the author's published papers, but the reader may here consider two basic facts known to the particle physicist. These are (a) that the deuteron exhibits a nuclear magnetic moment that is about 6/7ths of that expected in relation to its spin property and (b) that the proton exhibits properties suggesting it is composed of three charges, rather than a single charge. (See APPENDIX E and the Feynman reference in APPENDIX A).

The deuteron property implies that it has a state for one seventh of the time in which its positive charge becomes that of a satellite beta-plus particle that has been transiently displaced from the mass of its core, which thereby reacts as a neutral charge in its spin response during that limited transient period.

The proton property suggests a 'quark' composition which this author prefers to see as being that of a proton charge +e aggregated with a (+e, -e) charge pair in the form of a beta-plus and a beta-minus particle or, in the alternative, an antiproton charge (-e) aggregated with two beta-plus (+e) particles.

For the actual proton this implies alternation between two states in one of which the mass-energy is slightly greater than the norm of that of a bare proton charge standing in isolation and in the other of which the mass-energy is slightly lower than that norm.

For the deuteron, there are three alternative states, (a) one of lowest energy, the ground state, in which two antiproton charges are aggregated with three beta-plus particles, (b) the neutral state, of greatest 'core' energy, where a (+e, -e) beta-particle charge pair sits between an antiproton charge and a proton charge in the near presence of a satellite (+e) beta-particle, and (c) the third energy state for which two proton charges are aggregated with an intermediate beta-minus particle with the (+e, -e) beta-particle charge pair in a satellite position.

These particle 'models' are justified on other grounds in APPENDIX E, but they serve here to give basis for our understanding that a system of protons in a suitable combination of states can serve collectively to permit a balanced energy transition involving the creation of the deuteron in its least energy state. Similarly, it is the transiently neutral state of the deuterons which permits their reaction in an energy balanced transition which regenerates the proton.

To formulate the resulting abundance ratio of H^1: H^2 we write:

$$H^1/H^2 = (S_1{}^N/(S_2{}^n)(P_1/P_2) \text{ .... } (1)$$

In the above equation:

S_1 is the factor signifying the incidence of state when a transition can occur involving the proton (this having the value 2 because there are two equally probable states).

S_2 is the factor signifying the incidence of state when a transition can occur involving the deuteron (this having the value 7 because the deuteron is in its vulnerable neutral core state for one seventh of the time).

N is the number of protons that need to be subjected simultaneously to the transition stimulus of the energy fluctuations in the environmental field background in order to secure the energy balance conditions needed to assure a transmutation.

n is the number of deuterons that need to be subjected simultaneously to the transition stimulus of the energy fluctuations in the environmental field background in order to secure the energy balance conditions needed to assure a transmutation.

P_1 is the net number of protons created by collective action in a transition event.

P_2 is the net number of deuterons created by collective action in a transition event.

The evaluation of the four parameters N, n, P_1 and P_2 will be our task below, but, to show the power of the argument being pursued, it is of interest to recite the calculated values first. They are:

N = 35 n = 8 P_1 = 18 and P_2 = 16

Putting these in equation (1) gives the result:

$$H^1 : H^2 = 6705 : 1$$

which corresponds to a deuteron abundance factor of 1491 parts per ten million compared with the observed factor of 1492.

This result is, at least in this author's opinion, a very significant scientific contribution.

It means that the physical processes that can occur in the oceans of the Earth can establish this equilibrium ratio as between the abundance of protons and deuterons to cause the heavy water content of the sea to be a natural physical quantity maintained at a constant value. One needs, of course, to apply the underlying theory to estimate the time constant of the exchanges leading to equilibrium. This is measured in thousands of years so that one can feel confident that a laboratory store of deuterium hydroxide or heavy water will not convert into normal water too readily.

More important, however, there are implications for the Big Bang theory of cosmic evolution and for energy generation by so-called 'cold-fusion' methods, if deuterons and protons can undergo mutual transmutation at the temperature of our environment. The abundance ratio could not be computed by theory in the way suggested unless such transmutations do occur and, it may be noted, none of those high energy neutrons which are deemed so important in high energy physics are involved in the processes discussed.

The Significance of the Deuteron Algorithm

The reason for terming the formulation in equation (1) as an 'algorithm' is the author's way of saying that what has been discovered is the short-cut route for solving a problem which, by orthodox methods, would otherwise involve vast amounts of computer time. That is assuming that the route to a solution by computer methods has been devised and, as concerns the proton/deuteron abundance ratio, scientists seem not, as yet, to have appreciated that the problem is amenable to solution.

It is traditional in particle physics which involve hadronic mass calculations for problems to be approached by iterative techniques which take account of a vast number of interacting factors. This will be better understood when we come to discuss what it is that determines the proton/electron mass ratio. The algorithm we will use for solving that problem is the 'jewel in the crown' amongst the arsenal already mentioned. It has devastating implications for orthodox scientific doctrine founded on so-called 'quantum chromodynamics'.

However, as the scientific world knows from the hostility and resentment aroused against the claims of Professors Fleischmann and Pons for daring to imply that deuteron cold fusion had been discovered, there is readiness to scorn progress in science that challenges cherished beliefs.

Where the only product is an intellectual accomplishment expressed as an equation which presents the numerical value of what is a very fundamental dimensionless physical constant, then the wrath of the establishment scientist can reach its zenith. The modern computer allows one, by trial an error, to probe all combinations of numbers, if one is willing to indulge in exercises that are arithmetic in character rather than physically founded. It follows, by the doctrine that if something is possible it will eventually happen, that scientists assume the trial and error arithmetic exercise is at the root of any claim to have deduced a physical constant.

They lack credulity and show no tolerance when one makes a claim to explain the numerical value of a physical constant. What, they ask, is the merit of deducing the value of a quantity having a particular meaning in physics when the value of that quantity is already known to high precision from our experimental measurements? They argue, therefore, that to find acceptance one must, before it is measured, predict a numerical value of a constant having real physical meaning, so that eventual measurement of that quantity will deservedly command attention.

This is not a logical posture, given that there are a limited number of truly dimensionless fundamental constants in physics, all of which have been already measured to very high precision. It is not a logical posture because it means that we are denied the hope of ever allowing a simple algorithmic approach to confirm to us the discovery of insight into the factors which govern the constant of gravitation, Planck's constant and that proton/electron mass ratio already mentioned. It is, however, deemed acceptable to allow the supercomputer to try to decipher the mysteries of Nature whilst feeding it with mathematically elegant instructions designed to test artistic notions of symmetry.

That said, the author challenges the reader to examine equation (1) and consider the skill needed to contrive its discovery and the choice of parameters had the author really probed the problem by exercising a computer.

Firstly, consider the simplicity of the equation and its symmetry as between the proton-deuteron transition of the numerator and the deuteron-proton transition of the denominator. Then consider the chances, with an arbitrary choice of integer numbers for S_1, S_2, N, n, P_1 and P_2 of finding the correct solution and, after choosing an appropriate combination of integers, consider the scope for devising a plausible physical model giving meaning to the integers selected. Note that the author could have put the integer 9 for P_1 and the integer 8 for P_2, if the basis of the formulation had not developed from direct physical analysis.

One may wonder what solution the trial and error computer search would have found had the objective been set for this general equation to give the right answer to within the one in thousand precision assuming any integer combination other than that presented above is to be regarded as valid. There are in fact many possibilities but then one confronts that formidable task of justifying in physical terms which combination applies and how each of the numbers chosen has a valid role in determining the proton-deuteron abundance ratio. In the absence of a tentative model to guide one's endeavours that is not a worthwhile pursuit.

Physicists are not loath to wasting time on such a project, judging by the attack on the theoretical value of the dimensionless quantity incorporating Planck's constant. This is a reference to α^{-1}, the constant we know as having the value 137.035 9895(61). In

1970 a physicist named Wyler claimed a derivation for this constant as 137.036 082 by presenting a formula including the quantity π and the integer numbers 1, 2, 4, 5, 8 and 9. As is explained by Petley in his 1985 book 'The Fundamental Physical Constants and the Frontiers of Measurement', it was in 1971 that Robertson, Roskies and Prosen brought disrepute to such work by arbitrarily sythesizing values of α^{-1} with the aid of a computer. Using a similar format to Wyler's equation, given some ground rules and arbitrary combination and choice of 11 integer numbers and further including , the computer found 6 values of α^{-1} all closer to the measured value than was Wyler's value. The integers ranged up to 19 in value and one can but deplore this 'numbers game' exercise, as a means for suppressing genuine physically based endeavour by those who seek to solve the great mysteries of physical science. The fine structure constant α concerns the action we associate with Planck's constant. It is at the very heart of the Energy Science to be discussed in these Reports.

It is with that background in mind that the author invites the reader to examine the algorithm presented in equation (1) and consider the problem of devising a physically meaningful result in such good accord with the measured value, if that accord were fortuitous.

However, for the benefit of the reader who seeks the truths of this situation, we will first summarize the process involved and then begin the analysis of the energy transactions which govern equation (1).

How is it that protons can transmute into deuterons and vice versa as an ongoing natural process, when the mass-energy of two protons exceeds that of the deuteron?

The reason is that, owing to vacuum energy fluctuations, both the proton and the deuteron are constantly experiencing changes of state in which they have slightly changed mass-energy.

It so happens that the highest energy state of the deuteron which applies for one seventh of the time is one for which the energy is higher than twice the lowest energy state of the proton. The proton ground state applies for what is virtually half of any period of time. The other half is spent in its higher energy state and it flips cyclically between the two states halting very momentarily between these two states whilst in its 'bare proton' form. The presence of beta particles when in either of the two principal energy states account for the mass differences.

Accordingly, the deuteron to proton transformation occurs when the deuteron is in its highest energy condition. Conversely, the protons cooperate in creating a deuteron by action focused on the deuteron ground state.

The analysis by which these actions can be fully understood does, therefore, require the background study of the state composition of the proton and the deuteron.

For the purpose of this Report, it suffices here to refer to APPENDIX A in which the author discusses the three-part proton and APPENDIX E, which concerns the deuteron.

As to the proton, the 'bare proton' has a definite mass that is 1836.152 times the electron mass, as calculated in APPENDIX D, but, by reference to Feynman in APPENDIX A, we saw that the proton in its normal state behaves as if its charge is spread between three centres. In fact it is alternating between states, being at times a bare proton charge and at other times having close association with an electron-positron pair and even in another state becoming an antiproton coupled to two positrons - or rather beta-particles, because physicists prefer not to think of electrons and positrons as being nuclear constituents.

In its beta-particle association it has a mass increased in one state by a value very close to 0.25 electron mass units and decreased in the other least-energy ground state by very nearly 0.25 electron mass units. For the purpose of the calculations of the deuteron-proton transmutations the time spent in the intermediate 'bare proton' state, in order to keep the overall mass-energy balance at a mean value equal to that of the 'bare proton', is quite negligible.

The reader is here reminded that particle physicists picture the proton as comprising quarks as if it has three separate fractionally charged components. This author urges the reader to think in terms of a proton which changes form between three states in each of which its component charges are unitary at all times. This author is urging the reader to keep in mind that charges can be created and annihilated in pairs and that this is a property of the beta-particles known from quantum electro-dynamics. It needs little imagination to recognize that such charge transmutations occur inside protons and deuterons and that there could even be some polarity inversion or exchanges involved between beta-particles and protons when they are so closely bound together in atomic nuclei.

Physicists who believe in fractionally charged quarks are leaping into the unknown and making unwarranted assumptions. All the evidence points instead to transmuting forms of unitary charge particles which only appear on a statistical average to be fractionally charged. They are, in fact, exchanging energy with nearby charges and participating in vacuum field effects of pair creation and annihilation activity. Therefore, they exhibit behaviour reflecting their average condition. Of course, when they emerge from their bondage in the composite particle form they must appear as unitary charges, which explains why the so-called quark has never been isolated in any experiments.

Just as the physicist assumes that there is a neutron in the deuteron, so he has assumed that there are quarks in the proton. That is ill-founded assumption which can be remedied by understanding what is offered in this text as an explanation for proton-deuteron quantities which can be measured against the theory.

We now delve into the detailed analysis leading to the prime formula specifying the natural proton:deuteron abundance ratio.

Energy-Balance Criteria

It will be argued that, for the simple particle structures involved in the deuteron and proton states, we can assume for close approximation purposes, that energy transactions between these two particle forms involve quantities corresponding to quarter units of the rest mass-energy of the electron.

Should the reader question this it may help to refer to another older textbook, this being 'Modern Physics' by Professor H. A. Wilson of the Rice Institute at Houston, Texas, reprinted in 1946 from the 1937 second edition (publishers Blackie & Son Limited, London).

It is at p. 261 in the chapter on Atomic Nuclei that Wilson begins to discuss the fact that the energy released in nuclear reactions, particularly those involving the lighter atoms, is nearly always in approximate multiples of 0.387 MeV. This is 0.757 units of electron rest-mass energy, but, for reasons that will later become apparent, we will assume that this corresponds to three of the quarter units just mentioned.

It seems quite logical, therefore, to look to the electron or the positron (that is, the beta particles associated with nuclear decay) as providing the 'glue' or binding energy holding the heavy charges (the hadrons) together in an atomic nucleus.

The deuteron when bombarded by very high energy from a radioactive gamma ray source breaks up by emitting two heavy particles, one being the proton. The other heavy particle is a neutral entity which we call the 'neutron'. The neutron is unstable and has a mean lifetime of about 15 minutes, breaking up into a proton and an electron. It follows from this that one could say that a deuteron comprises two protons and an electron. Remembering then that the proton is deemed to comprise three charged components it is not unreasonable to believe that, when it stands in isolation, it comprises a heavy positive charge in close association with an electron-positron pair or a heavy negative particle closely bound between two positrons. In this scenario the 'neutron' can be a neutral aggregation of an electron and one of these proton forms.

We come therefore back to the rather simple proposition that electrons and positrons exist in atomic nuclei and account for the binding energy which holds the protons and antiprotons together. There are no neutrons, as such, in atomic nuclei.

Now, based on Table II in APPENDIX E, it can be seen that we can state the highest and lowest energy states of the deuteron in terms of their 'proton' P unit composition and 'electron mass units' E. The latter are units of $2e^2/3a$, so that state A has energy 2P+3E-35E/8 because the deuteron, as such, incorporates three -particles. State C has energy 2P+E-18E/8, there being only one -particle in the deuteron core. The intermediate state B deuteron has an energy 2P+2E-25E/8, which is the highest. In contrast the proton has a least energy P+2E-9E/4 and a highest energy of P+2E-7E/4.

Consider now the action needed to produce ground-state deuterons from protons which have net energies of -E/4 or +E/4. The action we contemplate will involve no net energy exchange in the transmutation process, but may involve fluctuations of energy. Also, we will presume the decay of protons is conditioned at an energy level matching that at which protons are created, this is in their bare charge form with no satellite electrons or positrons. The proton input to the deuteron creation process must then involve an even number of protons involving equal participation of those with net +E/4 energies and -E/4 energies (meaning -7E/4 and -9E/4 interaction energies, respectively).

Our deuteron creation reaction will involve N three-charge protons creating x ground-state A deuterons plus y bare electrons or positrons and z residual protons in their bare charge state.

The rules governing a decay process of this kind are that the space occupancy by electron and positron charge and so their intrinsic energy content must be conserved, as must interaction energy separately and the numbers of bare proton or antiprotons.

Noting that the deuteron ground-state interaction energy is given by -35E/8 and that its electron/positron content is 3, so one can then write:

space conservation: 2N = 3(x) + y .... (2)
energy conservation: (35E/8)x = (7E/4 + 9E/4)(N/2) .... (3)
proton conservation: N = 2(x) + z .... (4)

It requires simple algebra to find the solution for minimal residue, meaning z is minimum with N finite. It may be verified that the following combination of numerical values satisfies the three equations:

(x) . (y) . (z) . (N)
16 .. 22 .. 3 .. 35
32 .. 44 .. 6 .. 70

From this one finds the unique solution, which is that a trigger event involving 35 protons produces 16 ground-state deuterons. The protons can be in either of two states and at their transition through the bare state some will be tending to increase energy and others will be tending to decrease energy. This trigger event occurs when all 35 are in the same transient increasing energy state, meaning an event probability factor, the inverse of which is proportional to the numbers of protons in the equilibrium system. The latter factor is $(2)^{35}$.

The reverse process involves a vacuum field fluctuation supplying 0.511 MeV of energy as part of the trigger event by which deuterons in their transient highest energy B state are raised to the energy level at which they can transform into proton pairs. There is a governing requirement for other transient energy input in paired units of the electron rest-mass energy quantum E = 0.511 MeV and a need for charge parity by a transformation of the C state deuteron form into the ground-state A form.

Note that a neutral B-state deuteron core without its satellite beta-plus particle has a net energy of 2E-25E/8 or -9E/8. Therefore the addition to a group of 8 such deuterons of the mass energy carried by 9 beta-plus particles will correspond to an event which brings the energy into balance with that of 16 protons, suggesting that this could be the process by which deuterons transmute into protons.

The ongoing energy fluctuations in the electron-positron field will allow the energy of those 8 satellite beta-plus particles to redeploy into electron-positron pairs in the quantum-electrodynamic background which sources the 9 beta particles, as the positive charge transfers to the proton product. On balance only one 0.511MeV unit E of field energy is needed to simulate the deuteron-proton conversion.

The action described can, therefore, on energy balance criteria, create 16 protons from those 8 deuterons, but only if there is a net unit electron rest-mass energy input and a complementary reaction which can take up the surplus unit of positive charge.

Since the net core deficit energy of the C state deuteron is E less 9E/4 or -10E/8 and that of the A state deuteron is 3E less 35E/8, which is -11E/8, the transition of 11 C state deuterons to 10 A state deuterons with the shedding of two protons will occur with no energy residue. However, in this case the reaction product requires an input of one unit of positive charge.

It follows that, at least in theory, the state transitions of the deuteron could, in the normal ongoing QED field activity, give reason for expecting protons to emerge from natural fission of deuterons but the statistics of such an event are set by the chance combination of 8 of the B-deuteron states. Then 16 protons will emerge directly from those B-state deuterons and 2 protons will emerge from the very frequent C-state to A-state transitions. The event will mean that protons are created in batches of 18 from these events.

Each deuteron is in the B-state for 1/7th of any period of time. This yields an event factor giving measure of deuteron population as $(7)^8$ since 8 deuterons collectively are the target for the primary reaction.

Combining these results one finds that S_1 and N in equation (1) are 2 and 35, respectively. Furthermore, P_1 in equation (1) is 18. Similarly, S_2 is 7 and n is 8 in equation (1) with P_2 as 16.

The overall ratio of proton to deuteron in the equilibrium state can then be expressed by the contracted quantity $9(16/7)^8$, which is 6705 as a proton to deuteron ratio or 1491 deuterons per ten million protons.

As already stated above, this compares with an experimental abundance ratio assessment of 1492 per ten million.

The General Parity Criteria

It is important to appreciate, when dealing with problems involving the background zero-point energy field, that the energy balance is the primary regulating factor. There can be energy fluctuations but, so far as the energy locked into the matter form is concerned, this is conserved in the overall picture of things.

Charge parity and the parity of space occupancy associated with electron-positron charge forms are less important to individual energy processes of the kind just described, though these too must be balanced on a collective less-local basis.

For example, an electron and positron can, together, be seen as a neutral charge entity and yet two space quanta are involved. Conversely, two space quanta can be occupied by charge of the same polarity, meaning that a given even number of space quanta can all be occupied, and then there can be a net charge out-of-balance.

If one says that 35 normal three-charge protons can transform into 16 deuterons plus 3 bare single-charge protons, there is a net charge deficit of 16 units of charge e. However, we are also saying that the reverse event can occur in which batches of 8 plus 1 deuterons convert into 18 protons. Both batch processes are occurring together in the deuteron/proton environment and so, allowing for transient leptonic (electron-positron) activity in the QED field background (see section III of APPENDIX E) the charge condition balances overall. Similarly the space occupancy condition is a self-balancing process in our stable local field environment.

Should one ask whether a litre of heavy water will be transmogrified into normal water by the processes suggested above one must answer affirmatively. The real question is that of knowing the time scale involved.

Here one can estimate the time rate of these events by noting that an event time factor of the order of 10^{-13} seconds characterizes the single electron transition in the quantum field background. It can decay at A and be recreated at B as if it jumps from A to B in that period.

The three-charge proton and state B deuteron decays discussed above centre on a pairing of two electron-sized charges in each of these particle forms. The governing frequency of the background field is that corresponding to a photon of energy equal to the rest mass energy of the electron. The chance factor for a single electron as target for an energy fluctuation is about 1 in 10^7, meaning that there are that many cycles of that electron Compton frequency in the 10^{-13} second period of the electron lifetime.

Therefore, we can estimate that every 10^{-6} seconds every proton and B state deuteron will be a candidate for transmutation. For there to be transmutation, however, the target particles have all to be in the same state and this is governed, for the proton, by that factor above of $(2)^{35}$. This means that, on average, a proton will withstand participation in the deuteron creation process for a period of $(2)^{35}$ microseconds, which is about 10 hours.

This period reduces to a few seconds for the converse process by which deuterons should transmute into protons in water that is nearly 100% deuterium oxide. It is only in the composition of the equilibrium mixture that the proton transmutation time rate applies for the reciprocal transmutations. Clearly, therefore, the question arises as to why heavy water does not convert into normal water on a time scale measured in minutes.

The answer to this is connected with the problem confronting the 'cold fusion' issue. When deuterons transmute into protons in the recognized way, energy has to be added by gamma radiation and the products are one proton plus one neutron. 'Cold fusion' has posed the question "Where are the neutrons?". It would seem that what happens in the world of very high energy collisions is not the same as events in the cool conditions of a medium at water temperature.

In the sea the process described above can occur to keep the equilibrium between the deuterium oxide D_2O, hydrogen deuteroxide HDO and hydrogen oxide H_2O. The charge imbalance is there avoided by the recriprocal transmutation but one must assume charge fluctuations involving the atomic nuclei in exchanges with the background field. Possibly this activity has connection with the many reported energy anomalies found in experiments with water, particularly those involving electrolytic action.

In high energy physics of deuteron transmutation the charge issue is avoided by the action we term the 'neutron', which this author must assume is really a proton or antiproton neutralised by an accompaniment of electron(s) and/or positron(s).

However, we still ask the question "How long will it take before a kilogram of heavy water converts to a 50% mixture of heavy water and normal water?" Note that this question is put in terms of weight because the overall volume of the water would increase as deuterons change into protons. Furthermore, unless there is neutron emission, there would be release of hydrogen gas unless oxygen were to be absorbed. The answer must lie in the understanding of the source of the added positive charge taken up by the newly created protons. If this source is sluggish in providing that charge then the transmutation rate will be retarded. It may be measured in hundreds or thousands of years under normal environmental conditions or where water is sealed in a container. Equally, it may be a matter of days only where the heavy water is absorbed into a palladium host metal carrying electric current. Accordingly, one must wonder if the charge adjustments applicable where protons convert into deuterons and vice versa affect adjustments to the natural equilibrium ratio of protons to deuterons and see how this affects the 'cold fusion' deuteron transmutation process.

This Part I Report will not enter into speculations on the technological implications of the latter issue. The main point made in this contribution is that the ratio of protons to deuterons which occurs naturally is not an arbitrary consequence of disorder in the evolution of historical events. It is a fundamental physical constant determined by the same regulating factors which fix constants such as the proton/electron mass ratio.

Footnote

In the paper which follows as APPENDIX C the deuteron features as a component of the triton and the decay of the triton is related to events by which the deuteron is itself affected by the mu-meson bombardment.

There is a fundamental difference in that action compared with the situation above. Whereas the beta-particles are really the target affected by those mu-mesons in the isolated proton and deuteron forms, when one considers these as part of larger atomic nuclei the decay action is dominated by mu-meson attack on a different and larger target which latches onto nucleons belonging to atomic nuclei having atomic mass number of 3 or more.

Though this may sound complicated, in the limited space available in this Report, the author has deemed it best to present this Appendix B and Appendix C as separate self-contained texts and it is hoped that the reader will be able to follow the logic of the separate presentations even though study of the author's other published work will be needed to fully comprehend the distinction.

The threshold between 2 and 3 nucleons has a dynamic 'gravity' balance connection with the 'graviton' mass developed in Fig. 7 as shown in APPENDIX A. The 'larger target' involved in proton creation, one larger than the electron or beta-particle, by 1843 in volume, is explained on page 40 of APPENDIX C and more fully on the second page of APPENDIX E. The relevance of the latter to the deuteron as a component of the triton is that it brings about the actual creation of a proton within the triton as a deuteron-proton composition. It is shown on pp. 42-43 that the mu-meson bombardment of that space lattice charge 'target' triggers the transient creation of a proton, on average, every 12.2 years. If this event occurs in the 3-or-more-nucleon core, so that may well involve a proton transfer and a nuclear transmutation. This is an action quite distinct from that described above where it was assumed that the two beta-particles in the proton or the B-state core deuteron were the 'target' for mu-meson attack.

APPENDIX C

[The following paper was presented at a conference held by ANPA, the Alternative Natural Philosophy Association, in Cambridge, England during 9-12 September 1993. Though the title refers to the 'model proton' the main thrust of this paper concerns the triton and theoretical derivation of its lifetime.]

THE MODEL PROTON IN A NON-COMBINATORIAL HIERARCHY

Harold Aspden

The proton, as the primary form of matter, is at the creative equilibrium interface between matter and vacuum energy. Just as there is electron-positron pair creation and annihilation activity in the vacuum field, so there may be an underlying 'heavy' lepton (muon) activity in the universal field environment. This paper explores the relationship between the muon and the proton on the simple assumption that Nature is constantly trying to create protons but is normally restrained by energy equilibrium criteria.

The author's theoretical model is of long standing record, as outlined in **Physics Today, November 1984, p. 15**, and as acknowledged for its remarkable 'classically-derived' prediction of the proton-electron mass ratio in the paper reporting its measurement by **Van Dyck et al, International Journal of Mass Spectrometry and Ion Processes, 66 (1985) 327-337.**

The advance reported in this ANPA-15 paper concerns recent developments of this model which focus upon aspects of the deuteron and the triton. In particular, the model will be tested by deriving theoretically the 12 year lifetime of tritium on the assumption that it decays owing to interaction with that same heavy lepton field environment that creates the proton. This approach then affords insight into the exposure of the deuteron to that heavy lepton field activity. The quantitative aspects of the energy transactions involved are too remarkable to be attributed to coincidence.

The advantage to humanity which such research affords is linked to the prospect of success now emerging from research on cold fusion, inasmuch as the theoretical processes envisaged explain why no neutrons result from what is deemed to be deuteron fusion. The consequences concern an alternative natural philosophy having bearing upon the forces of creation in the universe and are important in that by theorizing about the derivation of the proton mass in relation to the electron there is spin-off which can cause physicists to revise their views on nuclear theory.

1. The Triton in Focus

Tritium is the third isotope of hydrogen. It is radioactive but decays by releasing a minute amount of energy - about one thirtieth of what is needed to create an electron. Its nucleus, triton, is an enigma in physics. A portion of the energy it releases somehow vanishes without trace and this phenomenon has been the basis of the neutrino hypothesis. The fusion of hydrogen in the sun is believed to be the source of energy which powers our existence on Earth, but the supposed related neutrino emission from the sun is itself a problem. There is just not enough solar neutrino energy intercepted by our Earth to balance the energy books representing the solar hydrogen fusion hypothesis.

It is submitted that the triton is the guardian of the secrets which govern our understanding of the cold fusion process encountered when deuterium is loaded into a cathode in a Fleischmann-Pons experimental cell.

The triton has a lifetime of 12 years. That is a very important clue and it has caused this author to focus on the assumption that the triton incorporates a ground-state deuteron, which is the seat of the decay action. This means that the deuteron itself is subject to radioactive decay processes but, as will be shown, this decay action involves a proton creation followed by proton decay. What may then emerge as a cold fusion product is a tritium nucleus or the reestablishment of the deuteron in its orginal form. In other words, the deuteron appears stable, but it can develop into a triton by a natural lifetime process, albeit with very much higher probability if another deuteron in close proximity is available to sacrifice a proton.

This proposal is not hypothetical. It is based on a theme developed in the author's earlier work, published long before the Fleischmann-Pons cold fusion discovery was announced. See, for example, the American Institute of Physics journal 'Physics Today', **37**, p. 15 (1984).

There the author drew attention to the P and Q scenario where a proton of energy P was attracted to an oppositely charged partner of energy Q. If each has a charge e bounded by a sphere of radius a determined by the J. J. Thomson formula ($E = 2e^2/3a$), the total energy of the P and Q charge in surface contact is:

$$P + Q - 3PQ/2(P+Q)$$

For the binding energy term to be a maximum, P and Q must have a certain relationship. This is when 1+Q/P is the square root of 3/2. The reader may then verify that with P as 1836 the value of Q is 413, which is the combined energy of a pair of mu-mesons in electron units. Resulting from this discovery the author has advanced elsewhere a theory of proton creation which explains how protons are built from the virtual muonic energy activity in the vacuum field. Note here that electron-positron creation and annihilation are ongoing activities in the vacuum field, the basis of quantum electrodynamics, and the mu-mesons are the 'heavy electrons' which hitherto have been seen in physics as having no role or function that could justify their existence in Nature. Their role is, of course, the most important of all, that of matter creation in the form of protons!

Now, we are, in the description which follows, to see how this same process of proton creation is at work within a deuteron or a triton.

The algorithm which the reader may keep in mind in the analysis which follows is the curious mathematical fact that 4Q, meaning four mu-meson pairs, if combined with the energy released by creating two (P:Q) systems from two bare P components, will be exactly that needed to create a new proton or antiproton P.

To prove this write:

$$P = 4Q + 3PQ/(P+Q) - 2Q$$

Then rearrange algebraically as:

$$P(P+Q) = 2Q(P+Q) + 3PQ$$

or:

$$3P^2 = 2P^2 + 4PQ + 2Q^2 = 2(P+Q)^2$$

which is the above relationship between P and Q as calculated from minimization of energy potential.

It follows, therefore, that if a particle containing two P nucleons is bombarded by the mu-meson vacuum energy background there is a condition where 8 mu-mesons will create a third P. This is tantamount to a fusion process occurring at room temperature which adds a nucleon to a deuteron.

Note that the energy is 'borrowed' partially from the vacuum as a vacuum energy fluctuation and partly provided by the degeneration of two nucleons in creating the two Q dimuon components. The system will 'restore' by causing a proton elsewhere, as in a nearby deuteron, to decay, but for a transient period there will be a very active energy situation which can give basis for much that is observed in cold fusion phenomena.

The remainder of this paper will develop the above theme by reference to the triton, and the verifying key which confirms what is said above is the resulting calculation of the 12 year mean lifetime for the transmutation just mentioned. This gives insight into the energy generation rate that can be expected in the cold fusion deuteron reaction. A deuteron will experience the mu-meson transmutation described on an average that is set by the triton 12 year lifetime. Since the deuteron is in the required ground state condition 2 parts in 7 of any period of time probable deuteron transmutation lifetime by this process is 42 years. However, one cannot exclude secondary nuclear reactions triggered by the excess energy transients of the above process. [Note: the 2 part in 7 factor is derived in the author's paper *The Theoretical Nature of the Neutron and the Deuteron*, Hadronic Journal, **9** 129-136 (1986). APPENDIX E of this Energy Science Report.]

Note that the deuteron ground state is one in which the deuteron structure has two antiprotons sitting amongst three beta-plus particles, represented by $(e^+:P^-:e^+:P^-:e^+)$, and the process we are to consider is one where attack by 8 mu-mesons causes the outer beta-plus particles to become dimuon Q charges as a newly created P charge is nucleated from a nearby vacuum lattice charge. The latter will be understood from the following detailed description.

The Constant Vacuum

In the Winter 1992 issue of 21st Century one reads of an interview with Martin Fleischmann and his Italian theoretician colleague Giuliano Perparata on the eve of the Third Annual Cold Fusion Conference.

This was an interview which revealed that we could expect a backlash from the criticism levied at the pioneer work on cold fusion. It has aroused retaliation which will take the form of an attack on the weaknesses of much that has become accepted in theoretical physics. The following two quotations from that interview will serve to set the scene for the subject developed in this paper:

'There is something seriously adrift with modern theory. There is a lot of work to be done, lots more to be discovered.'

'Preparata pointed to the hyperfine structure constant, alpha, which relates the electrostatic and electro-magnetic fields and is crucial in physics. "I often ask myself," he said, not really joking, "What if the fine structure constant were like the Dow-Jones index and constantly shifted up and down? Then there could be no science and no rationality .... If it were not for constants such as the fine structure constant and the speed of light, then our universe would not exist.'

Here then is a statement that should cause physicists to wonder and reason as to why the textbooks of science do not discuss the way in which Nature determines that fine structure constant and thereby is able to build our universe. The derivation of the value 137.0359 which is α^{-1}, where α is $2\pi e^2/hc$, e being the electron electrostatic charge, h Planck's constant and c the speed of light, is crucial to everything that is fundamental in physics. Next, in order of fundamental importance, there is the understanding which can come from the theoretical derivation of β, the proton-electron mass ratio, as 1836.152.

In a 1985 book entitled 'The Fundamental Physical Constants and the Frontier of Measurement' published under the auspices of the Institute of Physics in U.K. B. W. Petley of the National Physical Laboratory describes the theoretical attempts to derive these dimensionless constants and states at page 161:

'No doubt the theoretical attempts to calculate and will continue - possibly with a Nobel prize winning success.'

Now, the reader may wonder how this concerns the triton and cold fusion. Well, perhaps Martin Fleischmann and Giuliano Preparata are unaware of the connection via this author's work, but its very essence is a vacuum medium that bombards us with action and is a seat of events that trigger photon creation, thereby determining , and proton creation which determines . The Physics Letters, **41A**, pp. 423-424 derivation of was published in 1972 and the theoretical derivation of was published by the Italian Institute of Physics under the title: 'Calculation of the Proton Mass in a Lattice Model for the Aether', in Il Nuovo Cimento, **30A**, pp. 235-238 (1975).

The first paper derived in terms of a resonance in a fluid crystal structure of the vacuum and the analysis involved knowledge of the lattice cell dimensions. The underlying research had already at that time solved the problem of gravitation and revealed that a virtual pair of mu-mesons had association with each cell and were the building blocks for hadronic matter including protons. Of particular relevance to the calculation of the proton-electron mass ratio in free space is the way in which, as a rare occasion governed by statistical chance, nine mu-mesons come together at the seat of a vacuum lattice charge to create a proton.

Here then is Nature's arsenal by which it can act, even from within our bodies, to bombard matter with mu-mesons. These are energy quanta which act in concert to strike the body blow which converts a tritium atom into helium 3 and a deuterium atom into tritium, in the process creating a new nucleon in an act seen as fusion but by promoting the decay of one elsewhere. Indeed, we confront a scenario where Nature is constantly trying to create protons throughout space but it only succeeds where the energy equilibrium as between the sub-quantum vacuum underworld and matter has become unbalanced. Generally speaking, if a new proton is created an old one somewhere nearby must decay. Therefore, if the nuclear chemistry suggests that an intruder proton moves to fuse with the deuteron so creating a tritium nucleus, the real event is probably one where the mu-meson attack on the deuteron has caused a proton to appear as a nucleon whereupon the energy equilibrium bookkeeper has 'ordered' the demise of that intruder proton.

This may seem fantasy speculation, but the reader should be mindful of the power of the author's published research by which those and constants were derived. The calculations matched the part-per-million precision of the measured values and were in exact accord.

We can, therefore, proceed to study the triton with confidence and our objective, as with corresponding published work on the neutron, for example, is no less than the aim to confirm the theory by simultaneously deriving values for the magnetic moment, the mass and the lifetime of the triton.

The reader can share in the author's pleasure of discovery by working through this exercise, because the triton, rather curiously, lends itself to straightforward analysis.

It is necessary to engage in some preamble to explain the factors involved but to keep the focus on the objective the argument will advance directly to the calculation of these three values and the reader is asked to keep in mind that the ultimate objective is the calculation of the triton lifetime. The deuteron component of the triton stands as the target and so much of what is discussed is addressed at the deuteron transmutation as if it has the same lifetime in its ground state.

The Triton's Vital Statistics

The triton has a structure supporting three units of nucleon mass presenting an overall unit of positive charge e. Its mass is slightly less than that of three protons. Indeed, we should begin by working out precisely how much the measured mass differs from that of three protons as that provides the value we need to compare with the one derived theoretically.

We will work in terms of mass expressed in terms of electron rest mass as a number ratio.

The author's data reference is the 2nd Edition of the McGraw-Hill, Condon and Odishaw Handbook of Physics (page 9.65).

Atomic mass of proton plus electron: 1.00782519
Atomic mass of triton plus electron: 3.01604971
Unit atomic mass in electron units: 1822.888

This latter value was found by dividing the first atomic mass into 1837.152..., which is the proton mass incremented by one electron unit.

If we now multiply the first-listed atomic mass by 3 and subtract the second-listed atomic mass, the result is 0.007426 and multiplication by the unit atomic mass in electron units gives 13.54. This, therefore, is the measured mass difference as between 3 protons plus two electrons and the triton.

It follows that the triton has a mass that is 11.54 electron mass units below the combined mass of three protons. Our task is to find the model form of the triton which allows us to calculate this mass discrepancy.

The other items of data we need to extract from the same data source (page 9.93) is (a) the triton lifetime of 12 years, (b) the half-spin unit of angular momentum (presumed to be same as the proton) and (c) the magnetic moment stated in nuclear magnetons to be 2.9789.

It is, however, better for us to avoid reliance on data that is based on indirect measurement and take note of the direct measure of the triton nuclear magnetic moment presented as a ratio in terms of the proton magnetic moment effective in the same reacting environment. This ratio, as quoted from the Dover 1966 text of 'Atomic Physics' by Harnwell & Stevens, is:

$$1.06666$$

The task ahead is then to guide the reader through the analysis by which the three measured numerical dimensionless values just presented as the triton's credentials are duly derived by pure theory.

The Magnetic Moment of the Triton

It is appropriate here to refer to the author's paper entitled *'The Theory of the Proton Constants'*, Hadronic Journal, **11**, pp. 169-176, 1988.

On page 174 of this paper the gyromagnetic ratio of the proton is deduced theoretically as being 2.792847367, which compares with the measured value of 2.792847386(63) and so is quite precise, it being computed from a proton modelled on a structured resonant state.

This, in effect, is the proton's own magnetic moment expressed in terms of nuclear magnetons and so one can see that the 2.9789 triton magnetic moment above is derived from the measure 1.06666 and the independent measure of the proton's gyromagnetic properties.

Now, when we have regard to the fact that the triton's magnetic moment is measured as a frequency ratio as between the reaction of a triton and a proton in the same magnetic field, there is the curious feature that the two frequencies have what appears to be a perfect integer ratio, namely 16:15, which is the near-unity ratio factor 1.06666.

This causes one to wonder whether the interfering wave modulation which would develop harmonic interactions somehow locks the response of the triton onto a condition that is exactly set by this 16/15 ratio, even though the true triton magnetic moment with no proton reaction present is virtually that of three nuclear magnetons.

With this doubt, there is little purpose in trying to derive the precise quantity 2.9789 and it suffices for our purposes to justify, if only as an approximation, the triton magnetic moment as being 3 nuclear magnetons.

The interesting point to then take into account is that amongst all atomic nuclei the triton is unique as having by far the largest magnetic moment in relation to its nuclear angular momentum. The ratio is 6:1, whereas Ag^{108}, which sits between the two stable isotopes of silver, has a half-life of 2.4 minutes and comes closest with an exceptionally high ratio factor of magnetic moment to angular momentum of 4.2.

What is it, therefore, that gives the triton the magnetic moment of 3 nuclear magnetons based on a single half-spin unit of angular momentum?

The simple answer which is now suggested is that the triton comprises three nucleons two of which are protons and one of which is an antiproton. They all react magnetically in opposition to a magnetic field and so the two protons 'spin' one way and the antiproton spins the opposite way. The magnetic moments add to 3 units and the 'spins' add to a single half-spin unit of angular momentum.

This then explains the magnetic moment property and, further, we have now an insight into the structure of the triton.

The Structure of the Triton

Once the structure of the triton has been pictured in our minds then we can proceed with the confirming analysis by calculating the triton's mass discrepancy and its lifetime.

The interesting feature seen already is that we have not pictured the triton as comprising one proton plus two neutrons. Keep in mind the no-neutron syndrome of cold fusion! Three protons will not hold together even in a quasi-stable aggregation. This is why physicists have taken the easy course and assumed that it consists on two neutrons plus one proton with some kind of glue that introduces a negative mass binding energy.

Such assumption has led them down a blind alley. We need to add something such as beta-minus or beta-plus particles or be bold enough to imagine a stable entity including antiprotons. The truth can only be found by discovering the structure which gives the right answers for the three measured parameters presented above.

Discovery in this pursuit needs inspiration and intuitive analysis and it is here that the author must lead the reader directly to the solution and then show how the calculated properties prove that it has to be the correct structure of the triton.

The triton does, in fact, comprise two protons plus one antiproton, and our only concern now is to understand the 'binding' that holds the three nucleons together but keep the proton and antiproton far enough apart so that they do not fuse and mutually annihilate one another.

Now, here we are guided by the fact that independent analysis of the nature of the deuteron has shown that in its prevalent state it comprises two protons bound together by an intermediate beta-minus particle, otherwise termed a positron. This is fully explained in the previous reference, the author's paper *'The Theoretical Nature of the Neutron and the Deuteron'*, Hadronic Journal, **9**, pp. 129-136 (1986). The less prevalent ground state comprises an in-line configuration of three positive beta particles separated by two antiprotons.

We may be further guided by earlier work reported by the author in his book *'Physics without Einstein'*, published in 1969 by the author under the trade name Sabberton Publications. On pages 147-152 of that work there is a description of nuclear bonds, which the author termed chains, which took the form of an alternating sequence of beta-plus and beta-minus particles and which linked adjacent hole-cum-charge sites in the vacuum lattice which locked onto the atomic nucleus and caused it to form a shell structure. Indeed, this theme was further elaborated in the author's paper entitled *'The Chain Structure of the Nucleus'*, published in 1974, also by same publisher.

The data there presented show that a charged meson can attach itself to a charged nucleon to release sufficient energy to account for its own mass-energy and further the total energy of a chain spanning between two vacuum lattice hole-cum-charge sites. Furthermore, there is a balance of mass-energy or mass deficit which one calculates as being some 12 electron mass units.

In these circumstances, and having regard to the fact that we are trying to account for a triton mass deficit of 11.54 electron units, the author sees no point in going further than the assertion that the triton has a single beta particle chain linking the antiproton and the proton pair, the latter regarded as being seated at an adjacent lattice site in the vacuum lattice system.

The beta particle chains are deemed to be very much a part of the structure of large atomic nuclei. Each chain has up to 170 such particles corresponding to the fact that the vacuum lattice spacing is 108 times the beta particle radius. There are two of the author's papers of easy reference as background to this subject. They are: *'Aether Theory and the Fine Structure Constant*, Physics Letters, **41A**, pp. 423-424, (1972) and *'Theoretical Evaluation of the Fine Structure Constant'*, Physics Letters, **110A**, pp. 113-115 (1985).

As will be seen from those papers there is a factor 1843 derived from a resonance closest to a zero potential condition and representing the volume of a vacuum lattice charge in relation to a beta particle. Indeed, the derived value of the fine structure constant was given in the form:

$$\alpha^{-1} = 108\pi(8/1843)^{1/6} = 137.0359$$

The fact that the space occupied by the vacuum lattice charge can, given enough energy input, develop into 1843 beta particles from which a proton form can condense is crucial to the creation of the nuclear chains, but the action of creation of a proton depends primarily upon the mu-mesons that do the work.

The concept of space conservation in charge particle transmutations is consistent with energy conservation, bearing mind that the pressure or energy density within the charge of the vacuum lattice particle is in equilibrium with the 'gas-type' pressure set up by the mu-meson pairs that, on average, populate each cubic lattice cell of side dimension 108 beta-particle radii. Thus the number of beta particle charge volumes that equals this cube volume is a measure of a factor N which is relevant to the inverse chance of a 'hit' as the annihilation and random position recreation of a mu-meson recycles at the standard (Compton electron) frequency associated with vacuum energy charge pair creation activity.

To evaluate some numbers, note that the lattice charge has a Thomson radius that is larger than the beta particle charge radius by a factor 12.26, which is the cube root of 1843. The energy of the lattice charge is therefore 1/(12.26) or 0.08156 electron units. The number of electron charge volumes in the unit cubic cell of the vacuum is $(108)^3$ divided by 4/3 and so is 9,324,644. Dividing this by 1843 we find that there are 5059.49 lattice charge volumes of energy 0.08156 electron units in each cubic cell of the vacuum, which is 412.666 electron mass units of energy. This is double a mass energy a little below 207, thereby representing the combined mass energy of a virtual mu-meson pair that is the energy in each cell.

The fundamental derivation of the 108 cell dimension parameter and the 1843 factor, the subject of the author's primary analysis of vacuum energy discussed in the above-referenced 1972 Physics Letters paper, therefore leads to the theoretical derivation of the mu-meson energy quantum. It tells us the energy content of the vacuum state.

The triton, when created, lives amongst this activity and its rather special structure makes it vulnerable to decay owing to the bombardment by those mu-mesons. The core target for that bombardment is not the antiproton or the two proton nucleons in its composition. The target is the vacuum lattice charge to which the triton is attached. The deuteron, however, is also subject to such attack and here, too, the real target is a lattice particle in its near vicinity.

An isolated proton or a deuteron does not need to develop a fixed association with a lattice charge because its mass has not exceeded a critical level above which the dynamic quantum 'Zitterbewegung' behaviour needs a collective balance by a graviton system. The phenomenon of gravitation is dependent upon the inertial reaction of vacuum particles in the form of gravitons which have a mass-energy of 2.587 GeV, an energy value having an effective mass between two and three proton masses. This is fully explained in the author's works. See, for example, *'The Theory of the Gravitation Constant'*, Physics Essays, **2**, pp. 360-367 (1989).

However, when the proton or deuteron is part of a water molecule the nuclear chain structure of the oxygen atoms will provide the lattice location in the vacuum field system. This is why the cold fusion events we see with free deuterons in a palladium host metal are not, so far as we can judge, occurring in water.

When atomic nuclei exceed the mass of two protons they do, of necessity, share in a collective action requiring dynamic balance by a multiple graviton system and that action requires that their combination as a structured nuclear entity spreads itself over a multiplicity of vacuum lattice sites. The triton, therefore, has to have a nuclear beta particle chain able to bridge two lattice sites and it probably has two protons in close proximity that straddle the lattice charge of one site whereas the antiproton nucleon constituent is seated at the other lattice charge site. Tritium is, of course, radioactive whether in the molecular stucture of water or not and so it warrants respect and caution from a health viewpoint.

The Triton Lifetime

This structure already discussed now leads us to the calculation of the decay property of the triton. To proceed we restate part of the commentary in the introduction.

In order to set up the nuclear bond in the form of a chain of beta particles a meson charge has to develop as a charge attracted to the proton. This meson charge is termed a Q charge and its energy is that of the unit cell energy, approximately 413 electrons as already explained. Two opposite polarity charges e, having energy E in electron units represented by P and Q and conforming with the J. J. Thomson formula:

$$E = 2e^2/3a,$$

where a is charge radius, will, when attracted so as to be in surface contact at their charge radii, have a combined energy E' which is given by:

$$E' = P + Q - 3PQ/2(P+Q)$$

This formula is basic to proton creation and was mentioned by the author in Physics Today, **37**, p. 15 (1984), so we are not introducing something new at this stage in developing the theory of the triton.

In fact P and Q are in equilibrium as an optimum energy condition for which the negative term is a maximum when P is 1836 and Q is 413.

The point of interest is that E' can be calculated to be 92.7 electron mass units below the value of P.

In other words, given that there are two protons well separated by the diameter of the vacuum lattice charge (or a beta particle in the case of a deuteron), we can see how such a system, which features in the triton composition, can deploy twice the energy of 92.7 electron mass units to assist in a nuclear transmutation. This sums to 185.4 electron mass units.

We then note that the stimulus of 4 pairs of virtual mu-mesons, each of 412.7 electron mass units will suffice with the 185.4 electron mass units to create a proton of 1836 electron mass units. In fact, the energy equation is rigorous in providing exactly the amount of energy needed, which is why the decay of a triton yields so little energy that the result has remained a puzzle to scientists.

The scenario of interest is then the action by which the triton can be the seat of a process by which a proton is created within the triton itself so as to force a transmutation.

The condition we are considering is a coincidence event when 8 mu-mesons hit the lattice charge in the same vacuum cycle. If the result is the creation of a proton then the recovery of the equilibrium of the vacuum/matter interaction will involve the demise of a proton in matter nearby.

The task in determining triton lifetime is simply that of determining proton creation probability in a vacuum lattice site charge within matter.

Proton Creation Probability

As already shown, it takes 8 virtual muons to trigger the action leading to the creation of a proton. The question is how to bring 8 muons together for this purpose. There is an active virtual muon pair in each cell of the vacuum medium, that is for each lattice charge (-e), the latter being neutralized, so far as we can sense in our matter frame, by a positive continuum background.

If the positive virtual muon μ^+ enters the lattice charge it will momentarily, in the relevant action cycle, render that charge neutral by converting it to some neutral paired charge form. Therefore, to get 8 muon energy quanta to combine in some way, we need to have 8 lattice charges in close proximity in a state in which either all are transiently neutral or, alternatively, 7 are neutral and one is charged to a double unit level, as by being transiently primed by the addition of μ^-.

Now, the chances of one lattice charge being primed by either muon in its cell are 2 in 5059. There are 256 combinations of chance simultaneous priming of 8 such lattice charges in each action cycle. The follwing tabulation shows the virtual muon polarity combinations as distributed amongst the various mixed states.

Only the first two entries under S in this table represent states that can satisfy the merger requirements by creating neutral energy quanta with a single nucleating charge. Thus there are 9 chances in the 256 for the conditions to meet the proton creation trigger requirement. In other words, in every action cycle at the Compton electron frequency we have 9 chances in $(5059)^8$ of proton creation referenced on a particular lattice charge.

S	μ^+	μ^-
1	8	0
8	7	1
28	6	2
56	5	3
70	4	4
56	3	5
28	2	6
8	1	7
1	0	8

This gives us a 'lifetime' in the sense that the attempt to create a proton can influence a decay process which sheds a proton, as already explained.

That lifetime is:

$$(5059)^8/9(1.235\text{x}10^{20}) \text{ seconds or } 12.2 \text{ years}$$

The mean lifetime reported for the triton is 12 years and so this result is a quite remarkable application of the author's theory.

Discussion

Given the above solution to the mysteries of triton decay, it needs little imagination to probe the possibility that a deuteron, in its prevalent state, as two protons sitting on diametrically opposed sides of a central beta-minus particle, could become subject to the stability of a nearby vacuum lattice charge and experience similar proton infusion. In this case, the deuteron would become a triton, whereas in the triton the proton infusion into the two-proton component destroys the beta particle nuclear chain and severs the link with the antiproton component, which thereby becomes involved in a decay which replenishes the virtual mu-meson population of the vacuum.

The deuteron proton infusion process would be accompanied by the demise of a proton elsewhere, but what we would see with two deuterons in close proximity would appear to be one deuteron shedding a proton and a beta minus particle and the other deuteron acquiring a proton and shedding a beta plus particle, which overall amounts to an act of fusion. Two deuterons merge to create a proton and a triton by shedding energy as the two beta particles annihilate one another.

To account for the nucleation of the Q charge forms the less prevalent deuteron ground state composition having five component charges is the best basis for the transmutation under discussion. The central beta particle binds the two proton forms whilst the outer beta particles transform into Q charges to release the extra energy needed to convert the 8 mu-mesons entering the lattice charge target into a proton.

One can develop this theme by investigating the expected excess heat generation rate that could come from the 12 year decay rate for the deuteron ground state and one may further wonder how that process might be accelerated.

However, the main conclusion reached in this work is that there is basis for understanding the cold fusion reaction and the focal issue here is the interpretation of the process by which the triton is naturally radioactive at room temperatures. It is believed that the account presented here will help with that understanding.

APPENDIX D

[This is the author's paper *The Theory of the Proton Constants* which can be seen as reference 1988b on this website.

APPENDIX E

[This is the author's paper *The Neutron and the Deuteron* which can be seen as reference 1986d on this website.]

ENERGY SCIENCE REPORT NO. 6

POWER FROM SPACE: INERTIA AND GRAVITATION

Contents

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POWER FROM SPACE: INERTIA AND GRAVITATION

Introduction

This Energy Science Report is one of a series concerned with new energy technology and the fundamental energy science that is involved. Much of that science is of record in published papers that lay dormant on the shelves of those university libraries that have kept abreast of the source tributaries that might eventually flow into mainstream physics.

However, for some mysterious reason that science historians will one day need to explain, the physics community has built a dam which blocks much that could flow more rapidly into the knowledge stream. In particular it stands aloof and ignores evidence which tells us there is energy in abundance in a real space medium that regulates the quantum world. Those few scientists that have become aware of the enormous energy resource pervading the universe and extending into our immediate environment have, in the main, failed to see its technological potential.

Being a pioneer who has researched this subject for more than forty years, and published comprehensive theoretical accounts of the way in which the vacuum field energy governs gravitation, inertia and determines all the fundamental constants of physics, this author has become well accustomed to 'peer review' rejection. Institutional interests fend off the intruder who does not want to build on their sinking foundations and who points to better ground on which to build. And so, those who profess to be the scientific establishment hold firm in their beliefs, not expecting the Earth to shake in any way which may force them to rebuild on a new base.

This somewhat cynical introduction is presented in the hope that it will make readers pay more attention and cause them to help in bringing the world to its senses on just a few points about physics, before we are swept along by a tidal wave of technological change involving us in 'free energy'.

The author, some time ago decided to arrest the research on his theory, realising that no one really cared and that the only way forward was for that research to await the emergence of a related technological breakthrough which could help mankind generally.

Mankind has been made well aware of the genius of Albert Einstein and the importance of the relativistic equation $E = Mc^2$, which says that energy E has mass M provided one is able to 'see', with the constant speed c of light referenced on one's own self, what it is that has that mass. There are those who know why $E = Mc^2$ is relevant to nuclear power, but the scientific genius of those 'expert' even in that field has not yet solved the mysteries of the true causal nature of gravitation and the property of inertia.

Occasionally, of course, there are those who claim to understand inertia and confront us from time to time with their interpretation of their solution to that great mystery. Yet, always it seems, the opinions which penetrate the 'peer review' are those which 'conform' to tradition and go out of their way to comply with what is termed 'Lorentz invariance', which fits too closely in the Einstein mould and accounts for his failed attempts to explain inertia.

It is because a group of scientists (Haisch, Rueda and Puthoff: Physical Review A **49** pp. 678-694, 1994) have now claimed attention by asserting a new Lorentz-invariant account of inertia in terms of the universal energy background and implying prospect for tapping that energy resource that this author feels obliged to write this Report.

Why is Inertia Important?

Inertia is the property which relates mass and motion, just as gravity is the property by which mass is drawn to other bodies by a force of mutual attraction. Ignoring the imaginary 'quarks', electricity is a property possessed by all truly fundamental particles of matter, in equal measure, represented by a universal unit of charge e, and we know that like polarity charges interact by mutual repulsion, whereas opposite polarity charges interact by mutual attraction.

Inertia, gravitation and electricity are properties that are absolutely basic in Nature. They are the manifestation of energy that has suffered disturbance and is in search of equilibrium, whether seeking to avoid redeployment or seeking to become redeployed.

One can always start with Einstein's ideas, but then do remember that he tried and failed to discover the unifying links between electricity, inertia and gravitation.

One can heed what is said about the inertial theory of Haisch, Rueda and Puthoff by Robert Matthews writing in Science, vol. **263**, pp. 612-613, 4 February 1994 under the title: 'Inertia: Does Empty Space Put Up the Resistance?'. Matthews discusses Einstein's failure in this quest and goes on to say:

> "Now three researchers think they have found the source of inertia - and it turns out to be much closer to home. Inertia, they say, comes from the apparently empty space that surrounds us all - or rather, from the buzz of activity that, according to quantum theory, fills even a perfect vacuum, where sub-atomic particles are being created and annihilated in the blink of an eye. It is this ever-present sea of energy that the researchers believe resists the acceleration of mass, and so creates inertia."

So, we have our attention drawn to the notion that that sub-quantum sea of energy in space is the underlying essential activity that endows a particle with its inertia.

One has to imagine a particle, when accelerated, being pushed and shoved by that sea of energy in space with the result that it exhibits a property of preserving its motion and evidences inertial 'resistance' when accelerated.

Now, it is this author's experience, based on the development of his own theory, that Nature prefers the simple life and does not, as it were, ever 'put the cart before the horse'. Whatever fills that empty space with energy will, at least so far as simple physics requires, have itself to comprise component particles. It is no use talking about 'radiation' when one does not understand 'energy' and one can hardly preach knowledge concerning 'energy' without nucleating that energy on a 'particle'. Remember, we are talking about 'motion' and, to say something moves, that something has to have a position and an existence. 'Fields' are expressed as mathematical symbols and exist in man's thoughts, but Nature has no way of knowing what we mean by a 'field'. Nature builds on particles and their motion and that then leads us to recognize what we call 'energy'.

So, how can we really expect the particle to derive its inertial property from a background that is nothing other than other particles?

No, the inertial nature of a particle has to be something intrinsic to that particle!

What else is intrinsic to that particle? It has an electrical charge. We then can argue that the particle has form and is bounded so that that electric charge is confined into a limited volume of space centred on the particle. That gives it a measure of intrinsic energy, by the teachings of electrostatics, without us yet having spoken about motion.

The word 'motion' if expressing speed or velocity is meaningless unless we can refer to a frame of reference. Such a frame, as an electromagnetic reference frame, is not intrinsic to the particle. If the 'motion' is an acceleration, a rate of change of velocity, then, and only then do we have a property intrinsic to that particle, because that electric charge in its confined state suffers internal disturbances as its electrical energy adapts to the accelerated motion. Such disturbances, as measured within the body form of the particle, are undoubtedly propagated within that body at a finite speed, which we denote c, and so, still intrinsic to the particle, we have energy E and speed c.

We need something else to take our understanding forward and so we ask the question of how we would ourselves respond if Nature made us a single particle in a mystery environment that we could not see or sense.

The answer, or at least this author's answer, is that we would do everything possible to resist our destruction. In short, we would conserve our energy. Nature must prescribe, therefore, that the third and governing element affecting that particle under normal conditions is that it will conserve its energy unless physically transmuted, as by breaking into three particles and sharing energy with a newly created particle pair.

What does that particle have to do to conserve its intrinsic energy, as opposed to the other energy we think it has because it is moving relative to some external frame of reference? (This latter energy is 'kinetic energy').

The answer is that it must not shed energy by radiating disturbances through the empty space surrounding it.

We now begin to see the link with quantum theory, not one where quantum theory explains the inertial property, but one where the particle's own conservative property can explain quantum theory, the latter being a feature imparted to the particle population constituting at least some of that background sea of energy in space.

Physicists will now tell you that Larmor derived a formula which 'proved' that an electron when accelerated must radiate energy. Yet, if those wise physicists read up on the subject they will see that there is no 'proof' because the derivation is based on unproven assumptions. There are two assumptions. One is that energy is, in fact, capable of being 'radiated' as a wave or 'field' disturbance. Note that we now think of energy transfer in terms of particles (photons). The other assumption is that the particle is 'accelerated' by unspecified means or means, which if specified, are promptly eliminated from the analysis by relying on the energy supposedly radiated to the remote wave zone where the accelerating cause is not to be seen. The latter puts even further emphasis on the first assumption.

Now, what this means is that we, in looking for the real truths, have substituted for the Larmor assumptions the simple attribute of 'energy conservation' and so denied the energy 'radiation' possibility. We can then rework Larmor's analysis and keep in place the influence of other charge which has to be present and influential in promoting the acceleration of the particle under study.

Readers who perform this calculation (see Appendix A) using the correct formula relating electric energy E (proportional to e^2) and the particle radius confining that charge e, find that there need be no energy transfer across that boundary of charge confinement. There is, however, a condition which emerges from the analysis. This is that the accelerating force, as known from the local action of the accelerating field, necessarily factored into the field energy equations, must be 'resisted' by the particle in a measure formulated by an expression in which E/c^2 relates force and acceleration.

Mass becomes a <u>derived</u> inertial property as does the formula $E = Mc^2$, and both stem from the simple fact that Nature allows each and every particle in the universe to act conservatively in preserving its existence by denying radiation of energy.

So, inertia is understood in the simplest possible way and $E = Mc^2$ owes nothing to Einstein's imagination and everything to energy conservation principles. The background sea of space energy is <u>not</u> a party essential to give account of this basic property. The latter only features in the collective actions and particle collision processes as energy is pooled by electrodynamic activity.

Concerning the latter, note that collections of charged particles sharing oscillations, as in a radio antenna, involve mutual effects. For N charges e, accelerated together, the intrinsic conserved energy accounting for the mass of N particles relates to Ne, whereas the mutual interaction in electrical energy terms, given an overall confining space for the cluster of charge, is proportional to $(Ne)^2$. It follows, therefore, that since we do not think in terms of the mass properties of mutual interactions, or 'mutual acceleration energy', we confront three prospects:

(a) The radio antenna can be a transmitter of energy as a function of charge acceleration, but only in proportion to N(N-1) and <u>not</u> in proportion to N^2. However, since N is measured in countless billions, this poses no practical problem and shows why one can dare to challenge the Larmor formula without upsetting the radio physicists.

(b) The 'mutual acceleration energy' of a cluster of like polarity charges must add to the inertia of that cluster, but note that the particles have a very small radius whereas the cluster is relatively very large, which diminishes the inertial contribution.

(c) When particles are part of a vast sea of action characteristic of space, in a neutral mix of positive and negative polarities, they must involve energy that one might classify as 'mutual acceleration energy' subject to fluctuation and yet, somehow, form part of a system in which equilibrium is preserved. Given that inertia is dependent upon action intrinsic to a particle, one can then contemplate mutual actions as giving a base frame for collective reference of electric actions. In other words it seems probable that the locally applicable frame of electromagnetic reference is that set in a frame associated with the collective energy activity of a local sea of vacuum particles, otherwise known as the 'zero-point background field'.

In summary, the property of inertia is not dependent upon interaction with the vacuum field and the energy in space as suggested by Haisch, Rueda and Puthoff. That space energy background is, however, likely to play its role in determining the frame of reference for the energy of motion (speed) of a particle. This becomes a probability when one brings to bear the argument that the energy added to a particle owing to its motion is energy added in creating its satellite companions in the nearby field. This activity takes the form of a statistical presence of created particle pairs, leptons, typically electrons and positrons, which can become quite prolific and add enormous supplementary mass as a core particle acquires a speed close to that of light. The so-called 'relativistic mass' increase with speed then becomes an attribute of inertia possessed not by the core particle or by the zero-point energy background but by its satellite companions in their individual form.

From a practical energy viewpoint, the author sees no route to tapping 'free energy' by this link between the inertial property of particles and the sea of energy in space. The only link which can give access to that energy is via the quantum coupling of that medium, its so-called 'Zitterbewegung' or jitter motion, with electrons in atomic orbits and particularly with ferromagnetism. The latter is the subject of the 'Power from Magnetism' studies in this Energy Science Report series.

Creation of Matter

The fact that the basic particles, protons and electrons, which form matter exist and have inertia and mass in compliance with $E = Mc^2$ means that Nature has its own way of giving up energy to create those particles.

Is this really a one way process? The proton and the electron are not listed in particle data as having a finite lifetime. Do they really live for ever? If so, then one can think of the universe being created once and only once and not existing in a background seething with energy that keeps some kind of equilibrium with matter whilst fluctuating transiently to shed and recapture energy as some of that matter is created and annihilated.

Given that we can 'see' that when matter is created it comes to us in two 'stable' forms of different charge polarity, the electron and the proton, of greater mass by a factor of 1836, we have the clear evidence that Nature sheds energy which is seen to materialize in these particular forms, presumably only because they have the longer chance of survival than the myriad of other particle forms that one could conceive.

It is only logical, and involves very little thought, to recognize that if the proton and the electron were to decay and return their mass energy to the background activity in space, so, in immediately reasserting energy equilibrium as between matter and that background, those particles would be recreated. They may not be created in the first instance as a proton-electron pair, but they could develop from a kind of chemistry of reactions involving leptons in various forms, and particularly muons, and in the end the stable particle forms of proton and electron must emerge.

In short, one must accept that the proton and the electron do have their own characteristic lifetimes. They need not be created and annihilated in paired relationship because the electron will undoubtedly decay and be recreated numerous times between events involving proton creation.

Given that this is the case, the question of energy radiation by an accelerated electron might seem to be of no importance and merely an academic issue. One then finds, using the Larmor formula already mentioned, that if it were applicable to the electron in orbit in an atomic electron shell and if the intrinsic self-energy of the electron were to be radiated, the lifetime of the electron would be of microsecond order. Yet the electron lifetime is most certainly of the order of 10^{-13} seconds, as can be inferred from its ability to 'tunnel' through potential barriers as if such a time factor has meaning. It 'tunnels' through that barrier by the expedient of decaying on one side of the barrier and finding it desirable energy-wise to reappear by creation on the other side of the barrier.

However, if we use this argument to discount the need for challenging the derivation of the Larmor formula, so we lose that physical basis for understanding inertia as expressed by $E = Mc^2$. It is a trap we must avoid falling into, because understanding inertia is so important as it is the stepping stone for the onward understanding of the physical connection with gravitation.

In particular, by deriving the property of inertia as having a 'first principle' dependence upon the energy conservation response of a discrete electric particle when subjected to external influence, we know that all such discrete charge forms, if truly fundamental, will exhibit a mass property.

It follows that the background sea of energy in space must have mass and yet we cannot sense that mass directly in the usual way, which is by its weight. The energy in free space has, therefore, some unusual properties in a gravitational sense.

A factor in this is the consideration of form. A body having weight we can measure in a laboratory has shape and is bounded in some way. It has a centre of gravity that can be identified. Boundary conditions are important when calculating gravitational interactions. As with an electric charge within a uniform continuum of charge, the forces exerted on that charge when displaced a unit distance depend not just upon the charge density of that charge but upon the shape of whatever it is that limits its boundaries. A charge displacement in a spherically bounded charge continuum is subject to one third of the restoring force rate of a charge bounded between two planar surfaces of virtually infinite extent. Who, however, is ready to say how that background continuum of the world of zero-point energy is bounded?

It does matter, because a 19th century theorem bearing the name Earnshaw has well established the fact that the aether cannot comprise electrical particles in a neutral combination whilst exibiting any stable form that could define a structure. Yet, the latter is needed to give basis for determining the universal constants and particularly the fine-structure constant. The one form that eludes Earnshaw's theorem is that for which the particles in the structure all have like polarity and are set in a background continuum charge of opposite polarity.

The boundary conditions limiting the space energy are, in this author's opinion, planar and each such plane defines the separation between domains of 'space' and 'anti-space' in the sense that protons and electrons predominate on one side, whereas positrons and antiprotons predominate on the other side.

Proceeding, from this we need to understand how gravity comes into the picture, but our starting point is that there is a mass property throughout empty space and, for some reason, we cannot sense the linear momentum property. It is almost as if one is dealing with a perfectly incompressible fluid in which energy can be stored by motion but transfer to matter of a net linear momentum is impossible, though spin of a spherical body of the fluid can occur with energy storage and angular momentum.

What is the Cause of Gravity?

It is extremely easy for the author to carry on in this style and give account of the nature of gravity but there is little point in rewriting what is of record in refereed and published scientific periodicals.

Suffice it to say that, just as no mechanic could contemplate building a machine which failed to take account of dynamic balance, so Nature in providing a dynamic sea of energy subject to that 'Zitterbewegung' oscillation could not possibly avoid also providing the counterbalance feature.

That counterbalance feature is provided by a population of particles dedicated to that objective. The quasi-stable structured background of space gives the firm basis on which Nature builds to determine the fundamental constant of action we name after Max Planck, but that is merely a catalyst regulating the interplay between the background space energy and matter. The space energy is mainly seated in mu-mesons, which are quite distinct from the particle system that defines the vacuum structure. However, the third essential part of this space 'machine' system is the graviton population which provides that dynamic balance in a way that involves minimal distortion of that lattice structure.

That 'distortion' is small because the gravitons have greater mass than protons and so displace only a minute amount of continuum charge, but as they have motion spaced away from the main lattice, the latter determining the frame of electromagnetic reference, so, in measure related to the mass they balance dynamically, they give rise to forces of mutual electrodynamic attraction, namely a 'force of gravitation'.

This is an extremely simple account of the nature of gravitation, the real challenge being that of showing how the precise value of the Constant of Gravitation G can be derived to conform with the theory. Of course, one could not come to this picture of the underworld of space without thinking as a mechanic with some electrical skills. The mathematicians who dominate physical theory and seek to develop equations displaying properties of symmetry and having aesthetic properties are not thinking of a real world in which the 'balance' is inertial and not necessarily symmetrical.

One has only to take note of the blind reliance which mathematicians place upon Maxwell's wave equations to realise how easy they have found it to wander away from and out of the real world. How can an electric wave displacement propagate through space by its lateral oscillations if the field has energy and so mass and yet do this without that <u>counterbalance</u>? Where in the Maxwell equations do we see the formulation of the dynamic counter-balance, the wave which must accompany the propagating primary wave as an anti-phase partner?

If one says it is not necessary then one is not thinking in terms of a real physical environment but indulging in fantasy by presenting a form of mathematics which may seem to work in some limited situations but yet fails to give that physical account needed to understand why it is that the universe holds together. Without the dynamic balance in energy transfer across space and in energy storage in space and, indeed, without the consequent property of gravitation, the violent universe, like any violent out-of-balance machine, would break up into chaos devoid of form. As it is the universe gives us Planck's constant and the Constant of Gravitation and these are very easily explained and derived, once we have found the secret of why a particle has inertia.

At least, this author has found that task somewhat easy, in the formal analytical sense. What has been enormously frustrating and excessively difficult has been the obstructive effect of the Einstein doctrine and the related disbelief in the existence of a aether.

It is, to this author, quite remarkable to see so many errors perpetuated by so many scientists who live in the belief that the vacuum is empty of energy, that Maxwell's wave equations have sufficient meaning without there being something missing to explain dynamic balance and go even further in thinking that a photon can convey energy at the speed of light, when a particle travelling at the speed of light has infinite energy!

It is incredible that the scientific community has been willing to tolerate the so-called 'wave-particle duality' problem, thereby giving up on resolving why it is that waves promote energy transfer in a sea of energy, <u>as if</u> carried by a particle travelling with the wave through space from A to B. Surely everyone should realize that the wave disturbance is all that 'travels', whereas the energy background absorbs energy quanta at A and sheds energy quanta at B, as if that energy has moved at the speed of light.

If one takes away the energy background, the aether, and then finds that particles of photon energy have to travel at the speed of light one has immediately been inconsistent in ignoring the fact that mass energy becomes infinite at that speed. On the other hand, if one thinks of a wave as a <u>disturbance</u> of the energy in space but not as a transporter of energy, so the photon becomes an event in demise at A and an event in creation at B, and the question of the Larmor radiation of an accelerated charge is solved ab initio. There is no energy radiation and the $E = Mc^2$ expression for inertia then emerges as a derived expression based on energy conservation, which was our starting point.

A discerning reader might see the 'mechanic' as being in trouble in building his model of the vacuum energy machine with three major components, a structured electrical particle array moving inertially in counterbalance with a graviton system and an intermediate virtual mu-meson system occupying the inertial intermediate position. How can there be electrodynamic interaction from the gravitons and not from the charged structure? Well, the answer to that is again simple. The inertial frame is that in the intermediate position and the frame of reference having physical effect is that determined by the <u>moving</u> charged structure.

In physics we have <u>assumed</u> that the inertial frame and the electromagnetic frame are one and the same, but we have not proved it. On the contrary, though experience on a macroscopic scale and Einstein doctrine tell us that there is something in common between these two frames, there is other evidence linked to Heisenberg's Uncertainty

Principle and quantum theory. This has been interpreted as a situation where the motion and position are both uncertain but they relate in a manner connected with Planck's constant. Imagine the 'structure', which we take to be the frame we sense electromagnetically, to move in a quantum orbit around the inertial centre, dynamically in balance with that graviton system. The 'structure' has a position that is uncertain in measure related to that orbital radius and a momentum that is uncertain in measure related to speed in orbit. That speed and that radius when multiplied together is a finite and fixed quantity; it is certain, yet position and momentum are uncertain! The 'mechanic' knew this when he built the machine and Heisenberg suspected the design 'principle' without realising that this very point is the real clue to the nature of gravitation!

The 'mechanic' can also be seen to have built a universal timekeeper in that the orbital motion has to be one that is synchronous on a universal scale, as otherwise the structure that is moving will be distorted and will break up. Therefore, time itself is woven into the fabric of the space energy background and, again, one wonders how it is that 'time dilation' based on different observers in relative motion can be tolerated in physical theory and why Lorentz invariance has become a law unto itself.

The author can but hope the reader will research this subject in his or her own way, beginning by reference to the few of the author's papers appended to this report. Whether or not the reader accepts what is said is of little consequence, provided, however, that the reader has at least seen a glimmer from that raging quantum inferno of energy that is there in our immediate space environment. Such a reader will, it is hoped, then be ready to be attentive to claims made by those now working in the 'free energy' field when they come to declare 'Eureka'.

Personal Footnote by the Author

The above account about the Haisch, Rueda and Puthoff inertia theory began by referring to the article in 'Science' by Robert Matthews who writes for the Sunday Telegraph in London, England. It was of interest to me to read in that article:

> "Their argument draws on a curious quantum vacuum phenomenon first described by the British physicist Paul Davies (now at the University of Adelaide in Australia) and William Unruh of the University of British Columbia in the mid-1970s. If you move at a constant speed through the quantum sea of virtual particles, it looks the same in all directions. But as soon as you start to accelerate through it, theory predicts that the vacuum gives the appearance of being a tepid 'sea' of heat radiation."

> "Cosmologist Paul Wesson of the University of Waterloo, Canada, an authority on the links between the subatomic and cosmic worlds, is 'glad that someone is trying to return to the question of inertia again'. But he is concerned about 'the astrophysical and cosmological implications of the work'. Wesson's concern centres on the cosmological constant, best known as the add-on to Einstein's

equations of general relativity that endows free space with extra energy and gives it a gravitational effect."

So here we have two authorities on the subject, one declaring that the energy of the vacuum appears hotter 'from the viewpoint of a particle' simply because that particle accelerates, and the other who is 'concerned' and is 'glad' that someone is trying to explain inertia.

Much of what I have described in the above Report is the subject of my 1972 book 'MODERN AETHER SCIENCE'. It was Paul Davies, I believe, who at that time was called upon to review that book, branding it as 'Physics in Fairyland'. Yet I would say that it would indeed be a 'fairyland universe' if it were seen to glow with heat when someone sitting on an accelerated particle is looking at it but yet appear to cool suddenly if that acceleration ceases. If Davies is right it would seem that all we need to do to extract heat by allowing the vacuum medium to shed energy by cooling is to cause matter to oscillate and become a receiver of energy!

This I do not believe, but I do believe, as I have explained on page 116 of 'MODERN AETHER SCIENCE' that "when a charge is set in motion it will have to find its own equilibrium via the catalytic action of the aether, exchanging energy with other free charge present ... the net effect being that the catalytic action can transfer kinetic energy between the charges, a phenomenon we well know from the behaviour of the electrical transformer."

It is my contention that before we waste time trying to understand imagined apparitions of heat deployment in space, we should first explain how, in the laboratory, energy devoid of the independent observer as a local carrier of the action, finds its way from an electrical circuit into the vacuum medium as electrical inductance and then comes back again when we switch off the current.

There is no point in scientists thinking they can explain the cosmology of the universe when, as is blatant fact, they cannot explain the nature of the energy processes involved in electrical inductance. The explanations on offer are empirical, just as if there were no such thing as 'cosmology' but only observation of stellar objects. If inductance requires acceptance of a real aether medium and not just a mathematical four-space formulation, so much of cosmology, with its reliance on symmetry and invariance, is open to question. One needs, as said above, to avoid forcing an argument forward by putting 'the cart before the horse'.

Paul Wesson, I remember as a young scientist who had read about my theory and came to my home to discuss it even before beginning his graduate research study. I recall that he was impressed by my account of gravitation and tried to pursuade his academic supervisors at Cambridge to allow him to pursue the theory as his Ph.D. thesis subject, a request which was firmly denied!

So, should Paul Wesson come to read the above account, having stated that he is "glad that someone is trying to return to the question of inertia again", I send my greetings and invite him to look up and reread my account of inertia that was in my 1966 book 'THE THEORY OF GRAVITATION'. It is still the same, 28 years on, as a theory which says that an accelerated charge does not radiate energy, leading, as equation (1.18) on page 15 of that book, to:

$$\text{Electric field energy} = \text{mass of the field times } c^2$$

followed immediately by the words: "The realization that an electric field has the property of inertia is fully supported by the derivation of that equation".

I have provided in Appendix A an extract from pages 80 - 84 of my 1980 book 'PHYSICS UNIFIED' to show the reader the formal analysis by which $E = Mc^2$ is derived as an account of inertia based on energy conservation by accelerated charge.

I have in APPENDIX B, by my paper 'A Theory of Proton Creation': Physics Essays, **1**, 72-76 (1988), shown how the mu-meson energy sea in space is active in creating the proton.

Similarly in APPENDIX C, by my paper 'The Theory of the Gravitation Constant': Physics Essays, **2**, 173-179 (1989), I show how G is determined by the space energy medium.

Then, to round off the subject of this Report, I present by APPENDIX D, my paper 'Instantaneous Electrodynamic Potential with Retarded Energy Transfer': Hadronic Journal, **11**, 169-176 (1988).

This latter paper solves a problem I struggled with for many years as I sought to deduce the full physical basis for steady-state electrodynamic interaction and explain how there could be balance of action and reaction forces in the electrodynamics that connects with gravitation. The propagation of action at the speed of light with all the mystery of the retarded 'solutions', the mathematical equations which confound textbooks on the subject and are never applied in practice, is clarified by this paper.

Written in 1988 the paper complements my efforts to advance my earlier research into hadron electrodynamics, meaning my interest in the anomalous energy behaviour of heavy ions in electric discharges.

However, for the general reader I commend study of the paper, having in mind the age-old question about action-at-a-distance forces and Newtonian interaction versus the propagated action that features in Einstein's theory.

The action is summed up in the title of the paper. There is instantaneous action-at-a-distance with spontaneous energy transfer both at the action source and at the seat of the distant reaction, but that action is with the local space energy medium and is followed by a retarded adjustment of energy in the zero-point energy background as equilibrium of that sea of energy takes its time to recover.

I conclude by thanking the Editors of Physics Essays and Hadronic Journal for permission to reproduce the appended papers.

26th April 1994

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APPENDIX A

The Energy-Mass Formula

In the printed version of this Energy Science Report No. 6, published in 1994, this Appendix comprised a copy of a section of text between pages 80 and 84 of the author's 1980 book 'PHYSICS UNIFIED' published by Sabberton Publications, the distributers of this Report. It begins with a four-line quote from Einstein's 1905 basic paper. However, in this 2003 PDF version of the Report, it suffices to provide a link to those book pages as they are of record, also in PDF form, on the author’s website. To see those five pages use the link below:

http://www.aspden.org/books/Pu/pupp80to84.pdf

APPENDIX B

'A Theory of Proton Creation'

In the printed version of this Energy Science Report No. 6, published in 1994, this Appendix comprised a copy of a paper printed in the Canadian periodical 'Physics Essays'. This paper, published in 1988, presented the updated version of one of the primary themes of the author's theoretical work. Understanding the creation of the proton in the onward progress of our understanding of the physics which governs our universe. It is a key feature now included as Chapter 4 in the author's new work: 'The Physics of Creation', which now (June 2003) appears in full on the author's website www.aspden.org. However, here the object is to provide, for the record, a copy of Energy Science Report No. 6 and this Appendix, to be complete, requires access to that 'Physics Essays' paper.

To see that paper in PDF format use the link below:

http://www.aspden.org/books/Asp/1988c.pdf

APPENDIX C

'The Theory of the Gravitation Constant'

In the printed version of this Energy Science Report No. 6, published in 1994, this Appendix comprised a copy of a paper printed in the Canadian periodical 'Physics Essays'. A mention of 'energy in transit' in the copy of this paper that was included in that printed version of Report No. was marked with an asterisk drawing attention to an added footnote. This footnote was:
[* 'Energy in transit' has to be seen as a ripple in a large pool of energy. Just as a ripple in a pool of water travels at the wave velocity, so the energy ripple travels at the speed of light, but neither the water in the pool nor any energy moves at that wave velocity.]

This related to the discussion of the electrodynamic action in the context of its relevance to gravitation, it being essential for energy to deploy in the field medium, which, absent an aether as such, requires energy to travel at the speed of light, whereas matter travelling at that speed would need to have infinite mass. The presence of the aether as an energy medium is essential if one is to interpret the empirical evidence in a way that makes sense in physical terms.

To see that paper in PDF format use the link below:

http://www.aspden.org/books/Asp/1989b.pdf

APPENDIX D

'Instantaneous Electrodynamic Potential with Retarded Energy Transfer'

In the printed version of this Energy Science Report No. 6, published in 1994, this Appendix comprised a copy of a paper printed in the U.S. periodical 'Hadronic Journal'. At the time this paper was written, it was deemed by the author that understanding electrodynamic interaction as between particles of matter and their associated graviton accompaniment was vital to an in-depth understanding of the true nature of gravitational force. Although the author has, in the new book 'The Physics of Creation' mentioned in Appendix B above, given reason for modifying his opinion on the role of electrodynamics in gravitational action, this paper warrants consideration and needs to stand on the published record of the author's work. Note also that it was written at a time when the author had been distracted by some fascinating observations by E. W. Silvertooth (now deceased) who had claimed to sense motion through the aether. This was mentioned on pp. 312 and 313 of that paper, but, nevertheless, in presenting the paper as Appendix D of Report No. 6, the author had reason to include the following footnote as an addition at the end of that paper:

[* Although the author has anxiously waited for the Silvertooth Experiment to be confirmed or disproved, there has been no final clarification reported. Therefore, at the time of writing this Report (April, 1994), the author has decided to consolidate his theory, adhering to the position expressed on the EM (electromagnetic) reference frame in his book 'Physics Unified']

The latter book is now of record in PDF form on the author's website www.aspden.org whereas the paper, the subject of this Appendix, can also be seen in PDF form by using the following link:

http://www.aspden.org/books/Asp/1988a.pdf

ENERGY SCIENCE REPORT NO. 7

POWER FROM MAGNETISM: THE TRANSVERSE RELUCTANCE MOTOR

by

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Contents

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POWER FROM MAGNETISM: THE TRANSVERSE RELUCTANCE MOTOR

Introduction

This Energy Science Report is Part I of a research report documenting progress on a project funded by the U.K. Department of Trade and Industry as a Stage I SMART AWARD*. This was awarded in August 1994 to Thermodynamics Limited in an open competition based on an invention submission by the author. The object of the research is to establish whether or not a magnetic reluctance motor can derive any of its power by tapping the thermodynamic field background and the proposal suggested a novel form of motor construction with this objective.

At this interim report stage (May, 1995) tests on an experimental machine give a preliminary indication that such thermal effects, which involve magnetocaloric cooling, do exist and account for the enhanced efficiency anomalies observed. This machine, which has technological features hitherto unexplored and which meant that its design is somewhat of an exploratory nature, provides the evidence needed to design a viable prototype demonstration machine system. The latter should now progress on a much shorter time scale and will be the basis of the Part II report.

The content of this report will not relate to the many problems that beset this project in its initial period, nor to the spin-off research findings, which also have a special interest, nor to the different machine constructions explored en route. What will be disclosed is:

(a) The author's original reasons for expecting a thermodynamic power gain in the pursuit of this project,

(b) The experimental evidence supporting the above proposition as derived from detailed analysis of one set of test results on the primary machine and

(c) The constructional features of that machine which will also be the basis of the onward design of the prototype to be tested for the next Report.

The tentative conclusion emerging from what is here reported is that we can hope to see a way forward to magnetic reluctance motor development which brings in sight the possibility of generating electrical power by tapping the ambient thermodynamic field background. Success in such a venture would bring with it a much-needed new non-polluting energy resource.

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* "Small Firms Merit Award for Research and Technology.

Basic Energy Anomaly

It is hoped that technical specialists reading this report will not prejudge the findings by believing, inappropriately, that the Second Law of Thermodynamics applies to this particular technology. This preliminary section gives a background introduction to the scientific principles underlying the work, including comment on its thermodynamic principles.

The magnetic reluctance motor differs in operating principle from normal d.c. or a.c. motors in that it relies upon magnetic induction, a process which involves storing energy in gaps between magnetic poles. The more familiar electromagnetic machine operates by passing current through windings which are acted upon by magnetic poles to set up the drive force causing machine rotation. In the reluctance motor it is the release of energy from the pole gaps as they close that feeds the drive power to the machine.

When we consider how a d.c. voltage power supply is used to feed that priming induction energy to the reluctance motor the equivalent circuit is seen to be one having winding resistance R and inductance L connected in series to a supply providing an EMF E resulting in a current I.

By applying standard electrical theory it is an easy task to calculate the proportion of energy input that goes into the I^2R losses and the proportion $LI^2/2$ that is stored by inductance. Their ratio changes as the current builds up and would become extremely large if the flow were allowed to continue long enough in its effort to reach the ultimate value I_o of E/R.

However, as in the reluctance motor, we commutate the flow, allowing just enough inductance energy into the machine to give it the drive power before switching the current off. The time period involved need not therefore be any greater than 25% of the period of the magnetic flux cycle resulting from successive pole gap closure and separation, this being determined by the synchronous frequency of the machine. For the 8-pole machine test reported later this becomes 1/200 second at 50 Hz and 375 rpm. At 1500 rpm the 25% duty cycle would be of 1/800 second duration.

Even though these time periods are short, the design of the machine has to be such that a sufficient input energy can reach that inductance in that short time and that means that the winding resistance has to be low.

However, a design compromise is needed here. It might seem reasonable to require operation for which that charging time period is of the same order as the time constant of that inductive circuit, namely L/R seconds, thinking that if this were not so then the full inductance of the machine would not be harnessed to give the machine its best power rating.

The question at issue, is the amount of the loss in the resistance in relation to the energy fed to inductance.

For an ongoing power input rate simple calculation (see Appendix) gives this ratio as a function of time as:

$$e^{Rt/L} - 1 \qquad (1)$$

which at the end of the period θ defined by the time constant L/R becomes e-1 or 1.718. This means that only 37% of the power input at the end of this period can be finding its way into the drive of the machine, because 63% is being lost.

As shown in the Appendix if the cumulative energy input during that time period L/R is calculated, based on a linear inductance assumption, then 54% finds its way into the power drive and 46% is lost in that resistance R.

Of course, if, as is the case, the inductance increases as the poles of the machine close this will progressively shorten the relevant time period in (1) and reduce the proportion representing loss, but it would still seem surprising that there could be a reduction of an overall loss percentage to 10% or even 20%.

Yet, as is well established, magnetic reluctance motors can operate in the 80-90% efficiency range, even taking into account magnetization losses in their core structures.

This can be explained by the design expedient of putting a strong input EMF on the motor winding so that the input pulses develop a rapid rate of change of the magnetic flux accounting for the inductive energy input. This develops a back EMF which leaves little potential drop across the low resistance of the winding. The pulse period must then be much shorter than the time constant L/R, so that the current is switched off before the magnetic circuit begins to saturate. This is tantamount also to using a very low resistance winding, an awkward design constraint if the coils forming that winding have to fit on salient poles.

Modern electronic switching technology, which in itself brings with it another form of loss, has progressed to the point where the expense of the current pulsing makes the magnetic reluctance motor a viable alternative to the normal a.c. induction motor. Evenso, we need to look at ways of developing the reluctance motor further, not only with that winding resistance and the L/R factor in mind but also with regard to the following argument concerning a thermodynamic factor.

Given the high efficiencies obtained by reluctance motors and accepting that designers will know precisely where the loss occurs, there is really no fully justifiable basis for suggesting that existing magnetic reluctance motor technology may be already deriving benefit from a magnetocaloric energy regeneration effect. However, this author does wonder if, marginally at least, such an effect is already assisting motor performance.

If a pulse duration period commensurate with the circuit time constant L/R were to be used and the I^2R losses were 50% of motor input power, then to regain the 90% level of efficiency the inductance energy would need to be augmented by the equivalent of 40% of motor input from the quantum field background. The latter governs the atomic electron quantization in the ferromagnetic state in iron and plays a key role in magnetocaloric cooling.

In this case, the flux recovery cycle of the machine would result in environmental cooling within that field system and this would draw on the heat generated in the resistance to gave the overall appearance of an efficient motor. So here might be an important technological phenomenon that we may, in some small measure, be using unknowingly in our reluctance motors, but one we could use to much more advantage if it were researched and well understood.

The author, therefore, has had occasion to examine more closely what is of record in university teaching concerning how energy is stored in an air gap in a magnetic circuit.

The author's Ph.D. thesis had concerned anomalous energy losses in iron based on research (1950-1953) in Professor E.B. Moullin's Department of Electrical Engineering at Cambridge and one needs to look no further than a textbook by Professor Moullin. On pages 172-174 of his 'Principles of Electromagnetism', (Clarendon Press, Oxford, 1955), an experiment is reported which describes the inexplicable aspects of apparent magnetic flux linkage between two magnetic cores separated by an air gap. The teaching conclusion was that leakage flux defies calculation when one tries to theorize about experimental results.

This author, having developed suspicions about the thermodynamic aspects discussed above, has come, many years later to see the Moullin experiment with new eyes. The evidence is clearly there indicating that the energy in the air gap is greater than the energy supplied as inductive input to the magnetizing winding, greater by a factor that increases with increasing magnetic flux density.

This led the author, in the first of these Energy Science Reports, to describe and report findings on an experiment based on that performed by Professor Moullin, in order to confirm this position. That experiment involved a sequence of tests on static cores with successively different air gap spacings and has been reported by this author to a conference on the new energy topic held in Denver, Colorado. It has since been repeated independently by others, all of whom confirm that there is a significant energy gain.

The magnetic reluctance motor is the device one turns to if one wishes to use that excess energy before it is recaptured by the magnetic core system during the reset period. It was this background that inspired the inventive concepts which are now under test in this SMART AWARD project.

To end this introductory section, and before moving on to present test data on the experimental motor, a few words concerning the Second Law of Thermodynamics are appropriate.

This law is based on the doctrine of the impossible, namely that one cannot take heat from a source and convert it into useful power in a machine unless that source sheds heat to an absorbing medium at lower temperature. Now, in a magnetic core, or in an air gap between magnetic poles, there is an activity that accounts for energy storage by inductance. That activity involves electric charge in motion and reacting to the applied field. That reacting charge is kept active by thermal motion, whether this be mere thermal noise in the magnetic circuit seated in conduction electrons or whether, as applies in the vacuum gap, that 'noise' is and the quantum activity known to physicists as 'zero-point' field energy. If energy is fed by machine excitation into that inductance then the energy supplied, whether driven by current in a magnetizing winding or augmented by the ferromagnetic core it embraces, must be pooled with that thermal energy. It is shed as heat. Then, when the demagnetization process occurs or the pole gap closes to reduce the inductive energy stored, so there is cooling as energy is used to do work. The latter may be by setting up an EMF in the magnetizing winding or by mechanical work derived from the force action between the poles, but this thermodynamic activity is an ongoing and essential part of the physical property we describe as inductance. Its return is not by a random heat diffusion process, simply because the applied magnetic field set up by current in a winding brings order into the reacting charge motion and orientates its vector in readiness for an eventual collapse directed into the winding as a back EMF.

Electrical science does not ascribe temperature to the field energy stored by induction. Accordingly, scientists reading this will not be familiar with this summary description. However, no reasonable scientist could assert that this process is in any way restrained by a need to comply with the Second Law of Thermodynamics. The latter only concerns true heat engines that operate between set temperature limits and not to machines which know only one temperature, the ambient temperature, and in which magnetism is the catalyst converting heat into electricity.

This latter statement needs just a little qualification because MHD technology is subject to the Carnot efficiency limitations, MHD being the magnetohydrodynamic technology of the 1960 period, in which ionized gas passes through a transverse magnetic field which cools the gas to develop an EMF producing electrical output in the mutually orthogonal direction.

Here, the heat is that of ions in a gas and the gas emerges at a lower temperature than at entry. If we consider instead the energy associated with the motion of free electrons in metals or the charges that sustain displacement currents in the field medium of space, then that temperature property, so far as it concerns the hidden charge reacting to the inductive field becomes at best something that is notional and unrelated to the temperature of a machine proper. That hidden charge, whether in the system of free electrons or in the zero-point field of the vacuum medium, becomes the 'prime mover' reacting to shed heat energy to sustain the EMFs regenerating useful power from inductance and recovers heat by cooling the surrounding atoms in the machine structure.

To use the Second Law of Thermodynamics to argue against this, one must contend that there are two temperatures and assign a temperature to the 'prime mover' that differs from the ambient temperature of the machine. The 'prime mover', however, in iron, for example, is the free electron population and one is told in physics that such electrons have very high Fermi velocities and so are, notionally, kept at very high temperatures. If such temperatures are so high, they are higher both for inward transfer of inductive energy and the later return of that energy. The Second Law of Thermodynamics can only apply to one way energy transfer but inductance is a two-way phenomenon, as we well know from the highly tuned resonant oscillatory conditions that can be established in inductive circuits.

Even by normal equipartition of energy rules concerning particle collisions within the iron core, the free electrons we need to account for electrical conduction are kept in motion at higher effective temperatures than the surrounding atoms.

One can, therefore, argue that the Second Law of Thermodynamics has to be confined to the machines such as steam engines and internal combustion engines and not applied to the inductive properties of the reluctance motor. This is in spite of the fact that the latter do involve thermodynamic energy processes.

Unquestionably, however, the doctrinaire attitude of academic physicists on this question of the Second Law of Thermodynamics has precluded acceptance of this author's long standing explanation of electromagnetic induction and related gyromagnetic reaction phenomena.

Enough has been said for the moment on this scientific debate and this Report need not take the argument further. What matters is the experimental evidence reported in the next section. The real purpose of this Part I introductory discourse has been to argue that the thermodynamic foundations of the invention to be described are on very firm ground and can be traced by survey of this author's work of published record in scientific periodicals and books.

A Test Result from the Experimental Motor

The design and construction of the motor will form the subject of a following section. Here it suffices to state that the motor has two magnetizing windings which are inductively coupled, the excitation of which can switch the magnetism of a permanent magnet between a path through the pole gaps to develop drive torque or a leakage path where no torque is developed. The intention is that the magnets will do the work needed to drive the motor, buffering energy through inductance, and absorbing ambient heat to replenish that shed by the magnets, with applied electrical input power serving essentially to control flux switching.

As will be seen the design precludes any torque reaction from normal electrodynamic effects between current in the magnetizing windings and magnetic flux in the machine, thereby restricting any motor drive to a true magnetic reluctance action seated in the inductive field energy. The reason is that all conductor turns on the windings, to the extent that they are linked by magnetic leakage flux, can only assert forces in directions that are radial with respect to the machine axis.

As a summary statement, the test to be described gives reason to believe that the thermodynamic efficiency gain predicted as a basis for the project has been confirmed. It remains now to build a prototype machine and a new control system designed to a more effective specification which can now be formulated from the data provided by this test.

Note that, so far as this test result is concerned, emphasis is placed upon the establishment of the principle that a magnetic reluctance motor can operate with an efficiency enhanced by magnetocaloric cooling, the ultimate hope being to secure evidence of 'over-unity' performance. By 'over-unity' is meant a mechanical output power exceeding the electrical input power owing to thermodynamic input involving environmental cooling.

The dominant pursuit, the focus of the SMART AWARD, has however been the less ambitious aim at a modest efficiency improvement by investigating the possibility of self-commutation by a 'shaded-pole' construction of unusual design which has similar thermodynamic implications.

Both technical objectives have been served by the same test machine. Note particularly that this 'self-commutation' objective explains why the machine has no conventional commutator, a feature which has made the broader scope of the research testing of the machine particularly difficult.

The test reported here was a no-load test in the sense that the only mechanical function was that of running both a drive motor and the test machine as a mechanically-coupled system. The task is the assessment of the inherent operational electrical and mechanical characteristics of the test machine. This latter has a very special and unusual design configuration which has made it impossible to use standard electrical engineering knowledge to make a reliable prediction of its response to applied power.

Besides this, as can be seen from the opening text of this section, there are certain complexities in the magnetic circuit form, which includes permanent magnets, and the pole gap configuration as well as end effects, not to mention eddy-current reactions. All these pose unusual design considerations, involving non-linear characteristics and non-harmonic time characteristics, and so are best explored empirically.

The Equivalent Circuit of the Test Configuration

This is shown in Fig. 1 where the two machines are depicted by the broken line as having mechanically coupled shafts and each machine has its own circuit powered by a stabilized d.c. voltage supply.

The d.c. drive motor has a permanent magnet stator system and rotor windings fed as a single input through a commutator incorporated in the machine. It has a high torque and a maximum speed rating of 5,100 rpm when driven by a 12 volt d.c. supply, its maximum power rating being 65 watts.

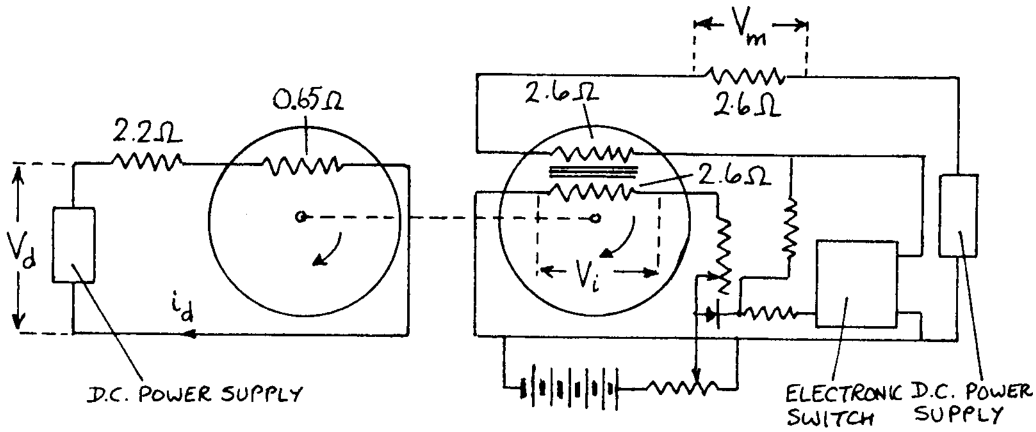

Fig. 1

[Note that as the research developed, the 'shaded-pole' feature was implemented by providing laminated stator cores, which were mounted in the motor in a 'transverse' sense and were tilted in the forward direction of rotor spin. The word 'transverse' means that they were arranged to act in a cross-wise direction. This explains the title of this Report.]

It was chosen because the cogging effect owing to the the stepping action of the pole structure of the test machine showed the need for a good drive torque, but evenso the system had to be given a hand-start by bringing the poles out-of-register when the d.c. motor was started up. This requirement will be avoided in the onward construction of the prototype machine.

V_m was measured by a digital voltmeter (d.c. scale) and its waveform observed on an oscilloscope.

V_i was also observed as a waveform on an oscilloscope.

The machine speed was measured using an optical tachometer.

The 2.2Ω and 2.6Ω external resistors were included as load devices to buffer potential drop and, in the case of the d.c. motor, to allow its power supply to remain unadjusted whilst the motor changed speed during the test.

The 0.65Ω resistance was the measured internal resistance of the d.c. drive motor winding, whereas the windings on the test machine had a 2.6Ω resistance.

Test Machine not Excited

The drive motor was run coupled to the test machine at 800 rpm and i_d was found to be 1.03 amps with V_d of 5.5V.

Total power input:	(5.5)(1.03)	5.665 watts
Power in 2.2Ω load:	$(2.2)(1.03)^2$	2.334 watts
Power supplied to motor:		3.331 watts
Loss in 1.2Ω winding:	$(0.65)(1.03)^2$	0.690 watts
Drive power to system:		2.641 watts

After the system had been operated with the above voltage input but with the test machine excited the following further measurement at higher input voltage with the test machine non-excited was performed at higher speed.

The drive motor was run coupled to the test machine at 1350 rpm and i_d was found to be 1.15 amps with V_d of 7.1V.

Total power input:	(7.1)(1.15)	8.165 watts
Power in 2.2Ω load:	$(2.2)(1.15)^2$	2.910 watts
Power supplied to motor:		5.255 watts
Loss in 0.65Ω winding:	$(0.65)(1.15)^2$	0.860 watts
Drive power to system:		4.395 watts

Test Machine Excited

V_d was held at 5.5V and the test machine now powered by adjusting a regulating potentiometer controlling a power transistor used as a switch, avoiding an oscillation mode, to result in a V_m waveform of the form shown in Fig. 2. The d.c. supply voltage to the transistor circuit was 12.26V.

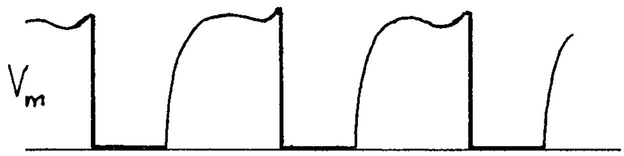

Fig. 2

Note that the trace showed an upward surge just before the current ceased. This will be explained later, but for the immediate purpose we will interpret the waveform as being a rectangular pulse with an initial exponential transient, such as one expects from switching a d.c. step voltage into an inductance. Note that V_m as a voltage is really a measure of current in a 2.6Ω load resistor.

The measured d.c. average of this voltage waveform was 1.31V and the machine ran on this setting at 1350 rpm with the drive motor current i_d having reduced to 0.64 amps.

From the waveform it was estimated that the switched-on duty cycle of the test machine was 60% and it was clear that the exponential rise in the signal represented the inductive power input needed to sustain magnetization loss and the true drive power fed to the test machine, whereas most of the power was dissipated in the I^2R loss of the load resistance and the machine winding as well as by potential drop in the power transistor used for this test.

This 60% duty cycle was longer than had been intended but it did serve to give a result as control settings providing such pulse duration were found more effective than the shorter pulses obtained by biasing the control. However, this is most certainly only because the timing of pulse onset was not optimally set owing to a weakness in the electronic circuit design used and this, too, will be overcome once the main prototype machine system is built. Such redesisgn will avoid reliance on the close magnetic coupling of the power input winding and the winding used to produce the commutating control signal.

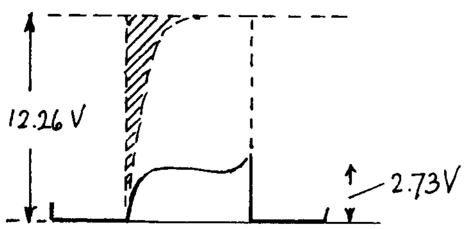

Fig. 3

In a sense, therefore, the test result presented is a good example from the data obtained by varying several control parameters but a 'worst case' example from the I^2R loss point of view, owing to the long duty cycle of the pulse.

Note that without the inductance effect the power input to the machine plus load resistor would be a step voltage waveform of rectangular form applied across a resistance of 5.2Ω, the 2.6Ω winding plus the 2.6Ω series resistor. The shaded area in Fig. 3 is the portion signifying the time variation of the inductance voltage component driving the machine.

It was estimated by inspection of the waveform that approximately 20% of the rectangular outline form was a measure of the time period corresponding to the inductive input. Bear in mind that an exponential build-up of current combines with an exponential decay of induced EMF to give an inductive energy input of half that expected from a multiplication of current amplitude, voltage amplitude and the time duration. This means that only 10% of the power represented by a volt-amp measure of d.c. power input is deployed into inductance.

Of the 12.26V input to the transistor circuit some voltage drop would occur across the transistor even during the inductive transient period, though a much greater potential drop, involving loss in the transistor, occurs as the inductive transition ends.

Proceeding on this basis the 1.31V measured across 2.6Ω converts to a measure of V_s, the voltage across the load resistor during the non-transient portion of the rectangular pulse form, given by:

$$(0.6V_s)(1\text{-}0.2) = (1.31)$$

from which V_s is found to be 2.73 volts. This, when doubled to account for the identical drop in the winding resistance, was consistent with the estimated operating load potential delivered in the on-state of the power transistor used as the switch.

The inductive drive power will involve a back EMF diminishing from 12.26V and we need to calculate the resistance losses not only in the 2.6Ω machine winding but also in the transistor and in the 2.6Ω external load resistor.

Total power input:	(12.26)(1.31)/(2.6)	6.177 watts
Power loss in load resistor:		
	80% of (2.73)(1.31)/(2.6)	1.100 watts
Power loss in winding:	as above	1.100 watts
Inductive drive power:		
	half of 20% of total input of 6.177	0.618 watts
Power loss in transistor:	balance of above	3.359 watts

Ignoring the power transferred to the load resistor and the loss in the transistor (which can be reduced to negligible proportions by suitable design) the deployment of power by the machine combination operating at 1350 rpm was found to be:

Test machine input:	1.718 watts
Power loss in winding:	1.100 watts
Inductive drive power:	0.618 watts
Power supplied to drive motor:	
(0.64)(5.5-[(0.64)(2.2)])	2.618 watts
Loss in 0.65Ω winding: $(0.65)(0.64)^2$	0.266 watts
Drive motor power to system:	2.352 watts
Total power (other than I^2R loss) needed to drive the system at 1350 rpm:	2.970 watts

This 2.970 watts at 1350 rpm compares with 2.641 watts needed at 800 rpm and 4.395 watts at 1350 rpm when the test machine was not on power.

The reason that I^2R losses are excluded from this comparison is that, owing to specific design characteristics, the test machine losses can be reduced very substantially by using a winding conductor of larger cross-sectional are and much lower resistance, whereas this is not feasible for the d.c. motor which already uses winding space to maximum advantage.

The real gain in performance is that evident from the inductive power drive, which involves the magnetization losses in the system. What we see here is a power reduction of 1.425 watts from a base value of 4.395 watts. Yet we are activating more magnetic excitation in the test machine when excited than was present for simple non-excited drive by the motor alone.

We have excluded the I^2R loss and there must be more magnetic loss for the system running with both motor and test machine excited, but yet the overall power intake has reduced by 32%.

This can only be ascribed to the regenerative effect of magnetocaloric cooling which the machine design aimed to explore.

If such cooling does accompany the enhancement of the magnetic pole action in driving the motor then the magnetization losses of the expected order can occur to generate heat in the normal way, but overall the machine must be operating with an exceptional efficiency.

The test, as interpreted above, does establish that there is an anomalous excess power phenomenon at work.

Test Result Significance

The tests were made with the test machine rotating clockwise, which was the direction corresponding to the shaded-pole construction of the stator pole pieces. Anticlockwise rotation for the same input power conditions gave speeds some 10% below those measured for clockwise rotation.

Therefore this feature, in aiding commutation, is contributing to machine performance and will now be accentuated further in the onward construction of the prototype machine.

This prototype version of the machine will be designed to overcome the test difficulties encountered in the pulse control of the machine as tested above. The tests suffered from the problem of correctly timing the onset of the pulse current and its duration. When the design parameters of such a control could be ascertained from the tests it became apparent that the best way forward was to design instead a machine having a dual excitation so as to avoid the inductive coupling of the single excitation which set up unwanted oscillations and so limited scope for full power testing.

The machine had a size and weight commensurate with a normal motor of several hundred watts rating and yet was tested at 1350 rpm, taking a coupled d.c. motor up to that speed from a base speed of 800 rpm, with only 0.329 watts of additional input drive power! This excludes the power needed to sustain I^2R losses in the windings of the two machines, but the corresponding increment in such power was only 0.676 watts. The above data show 0.690 watts as drive motor winding loss at 800 rpm, 1.100 watts as loss in the test machine winding at 1350 rpm and 0.266 watts loss in the drive motor winding under combined operational conditions at the latter speed.

As is explained below, the latter losses can be very substantially reduced but the prime attention has to focus first upon the thermodynamic implications to clarify a very basic issue.

The question at issue is whether one can be 100% sure that the machine is acting regeneratively in a thermodynamic sense. There is every indication that it is, but there is one open question that is crucial to scaling up the design to a high power machine.

The answer to the question will decide whether this research is leading to a new machine technology of highly efficient motors, which can, as it were, feed on the heat they generate and so come close to being 100% efficient or whether it can lead to a technology breakthrough of far greater importance.

There is good reason, by reference to the Moullin-type of experiment already mentioned, to suspect that we can draw on energy feeding the underlying quantum field that powers the atomic spins in a ferromagnet. If this is so then the magnetocaloric cooling process has much more to offer than the near-to-100% efficient electric motor. In sight comes the possibility of building a new form of power generator.

In other tests on the same machine system as that discussed above it was found that increased current input to the test machine could reduce the d.c. drive motor current to 0.2 amp, less than 20% of its normal value, but it was not possible with the particular test rig used to run the system with only the test machine on power.

The objective there was to see if one might reach a stage where the d.c. motor current reversed as it became a generator. Then one could explore the degree to which magnetocaloric cooling can be exploited in a power generation mode.

Clarification of this issue will be the objective of the Part II Report which will follow from tests on the prototype machine now under construction.

In the meantime, the following technical points emerging from the above test findings are to be noted:

(a) The I^2R losses attributable to the test machine winding can be reduced by a factor of 5 at least, because it should be possible to limit the inductive power input to less than 40% of the pulse period used in the test and because a single winding of 2.6Ω was used instead of two such windings in series driven at half current. The second winding was deployed, contrary to original design intention, to provide the commutating signal control for the electronic switch and the pulse period was longer than it should have been and its onset poorly timed owing to control settings adjusted to avoid feedback-induced oscillations. The latter problems can easily be eliminated with a dual test machine combination. The machine design would allow the winding resistance to be reduced very substantially if the weight and cost of the copper could be justified by the efficiency gain.

(b) The use of only 4 magnets in the test machine may mean that end effects which weaken the operation owing to magnetic leakage can be present. These can be reduced relatively by using more magnets and a longer rotor axis. The latter was accepted as a limitation in the design of the first machine, dictated by availability of stator pole pioece laminations, but the findings now warrant building the longer machine. More magnets on a longer stator with the pole gap spacing halved should give power enhancement by a factor of 3 or more, without appreciably changing the overall size of the machine.

(c) The magnets used in the machine tested above developed a flux density in the stator having an a.c. RMS value of between 600 and 800 gauss, which implies a unidirectional polarization of 1700 to 2260 gauss. By using stronger magnets or, in a large machine, electromagnetic excitation of a soft iron rotor core by input of current to a rotor winding, this could be increased to 10,000 gauss, meaning a power rating enhancement by a factor of 20 to 35. The latter increases as the square of flux density.

(d) Concerning the I^2R losses, these can also reduce further as a function of scale so as to become negligible in a larger machine. For a machine of the same 3-dimensional proportions, the power rating increases as the cube of the base length whereas the I^2R losses increase as the square of the base length. Therefore, in a large machine such losses can be dscounted to leave the machine performance at efficiency levels tested by reference to the inductive power and magnetization losses.

(e) Possibly also a higher power rating can be obtained by running the machine at higher speeds than those used in the above tests. In one set of tests using an excitation control circuit different from that used for the above data, it was found that the machine had to run above 2,300 rpm to avoid oscillations in the power circuit, but the system did operate to relieve the power input to the d.c. drive motor quite substantially at that speed.

(f) Finally, and of considerable importance, there was an observation not discussed above and this was an indication of a return of inductive power by the test machine. In several of the tests the transient increase of pulse current was accompanied by a transient on pulse switch-off. What was observed was an increase in current to a peak, a kind of one-sided spike that could nearly be double the current just before it switched off. Even in the test reported, the duration of the pulse exceeded the controlled on-state of the transistor* and this meant that the inductance of the machine was forcing current flow even though the transistor should have switched off. The fact that the current was sustained as the reverse induced voltage transient occurred is sufficient to indicate that there was power feedback not allowed for in the above calculations. This promises an even greater efficiency in the onward development. The hidden promise here can be understood immediately, once it is recognized that the inductive input voltage pulse occurs as current builds up, whereas the inductive reverse voltage pulse accompanying flux collapse occurs as current increases further. Since the time-integral of voltage has to be the same for flux change in either direction, this can only mean that more inductive energy is being returned as flux collapses than was supplied during flux build-up. The reasons for this and the source of power, the magnetocaloric cooling, are now well understood by the author and, so having seen the evidence in the performance data of the test machine, this will be the focus of attention in onward development.

[* The control was by an inhibit signal, and would not base current sustained by inductive feedback]

Overall, therefore, in the expectation that a machine modelled on the one tested above could, with a higher speed, convert that small power gain to a 5 watt gain, there could be as much as a 60-100 fold gain by using a better magnet structure. This implies a 0.3 kw to 0.5 kw rating for a machine having a base length of 125 mm, of about the right order expected with conventional motor technology, but we are here considering a machine that could be a thermodynamically powered generator.

If such a performance proves feasible, then by scaling up the machine size to a 10 metre base, that power rating becomes 150-250 Mw, which is of power generation station capacity.

As will now be seen from the onward description of the constructional features of the test machine, its mechanical structure and assembly are eminently suited to scaling to large size. It is a salient pole machine but there are no windings on those individual poles and this is very important from the point of view of dynamic balance. Furthermore, where the rotor magnetization is excited electromagnetically by a rotor-mounted winding, that winding could comprise a simple superconducting coil system coaxial with the rotor axis or a coaxial solenoidal coil system neatly mounted between the rotor pole pieces.

It is a particular feature of the design of the machine discussed in this report, which has a permanent magnet rotor, that the single magnetizing winding is an externally mounted solenoid which can be made without need to restrict the cross-section of the winding. Therefore, the winding resistance can be very low and related losses commensurately reduced, an important power saving feature for a motor.

Regardless, therefore, of the thermodynamic implications and their effect upon machine efficiency, the fact that a motor having this special single winding design works at all is something that gives this project merit.

The following machine description represents a form of construction that should prove interesting in its own right and in connection with a motor development on conventional lines, devoid of the shaded-pole and themodynamic factors, but where high powered magnets are incorporated in the rotor.

Test Machine Description

The test machine incorporated four 60 mm diameter ring magnets of anisotropic ferrite. Their thickness was 8mm and they had a 24 mm diameter central hole. They were mounted with spacer hubs on a 19 mm diameter brass spindle separating five rotor pole sections comprising 90 mm diameter laser-cut disc laminations having perimeter teeth forming 8 salient poles. They were cut from electrical sheet steel of 0.5 mm thickness. The magnets were very inexpensive standard loudspeaker-type magnets having no special properties and a relatively low power of about 3 MGOe. They were chosen because their size as available of-the-shelf stock items suited the needs of the test machine. There are commercially-available magnets of sintered neodymium-iron-boron with a power of 10 or more times this. High speed operation is certainly possible with cast Alnico magnets which have a 5.6 MGOe rating, but the onward prospect on the horizon is a new type of magnet developed in Japan which is said to have an enormous BH_{max} rating of several hundred MGOe.

The design technology implicit in the motor described below has, therefore, to be viewed in the context of such development and the 100-fold prospect of power enhancement suggested in the previous section of this report is then realistic even where magnets are used to polarize the rotor.

To spare effort and demands on the author's time during this onward research phase, the following description is not presented in research report style, but is, apart from the following illustrations in Fig. 4, 5 and 6 simply the text written for a patent application covering the machine.

Accordingly the figure numbering sequence following those three figures is that of the separate figure number sequence of the patent specification and the excerpts taken from the patent specification are incorporated at the end of this Report as Appendix II.

As will be seen, the magnets produce a magnetic field directed along the axis of the machine, but this field develops magnetic flux which is diverted laterally through the laminar rotor discs and then, after passage through the pole gaps, diverted again in a return direction parallel with the machine axis to pass through the bridging stator laminations. All this occurs within the confines of a solenoidal magnetizing winding and, to the extent that the fluctuations of magnetic flux from the magnts are confined to the pole gaps and the magnetic circuit including the rotor and stator, there can, in principle, be no back EMF opposing the action of the magnetizing winding.

Yet, the pulsating current in that winding has been found to operate the motor. There is, of course, some leakage flux which contributes to the inductance of the magnetizing winding but there is reason to expect much of the inductance energy input to be recovered, whilst the magnets actually do work and generate power solely owing to the control effect of that inductance.

The following supplementary commentary provides some further information and may explain why the author is encouraged by these findings and is anxious to know the outcome of tests on the dual machine system which is described in the latter part of the appended patent description.

As indicated above, a Part II Report will be prepared as soon as tests on the dual machine system are completed.

Supplementary Commentary

The above test data is subject to some modification which can best be explained by first explaining that the first test on the machine was a test using half-wave rectified 50Hz a.c.

This meant running the machine at low speed (375 rpm), not enough to test the shaded-pole feature, which was the dominant interest owing to the funding arrangements. These tests were therefore of a cursory nature just to see if half-wave current pulses did affect the machine in the manner expected, but more particularly to get a measure of the induced back EMF and so the level of flux activity across the pole gaps and to see how such pulse input relieved load on the drive motor.

It proved extremely difficult to get the adjustments of the controls just right with the motor running at 375 rpm for the expected sychronisation to establish itself. Then, and only then, was it possible to reduce slowly, stage by stage, the current input to the d.c. drive motor while holding that 375 rpm speed. In spite of this, several such tests were performed and the a.c. magnetizing current and voltage was measured as the power input to the d.c. motor progressively reduced.

Each such test proved very satisfying, because the saving in d.c. power input to the drive motor far outweighed the a.c. input as measured in VA (volt-amps), without regard to power factor. Effort was made to take run the system with the test machine driving the d.c. motor as a generator, but with the test system used the system lost the 50Hz synchronism once the d.c. input current had reduced to about one third of its original value.

The problem here arose because the d.c.power suply used was a stabilized voltage supply and it could not drop below a 4.5 volts, which is why a load resistor had been put in series with the motor. Although some time was spent in effort to overcome this, the author was more anxious to develop a control system for running the machine at much higher speed and so these 50 Hz tests were abandoned.

One important aspect of the test was, however, the monitoring of both the current waveform as supplied to one test machine winding in relation to the voltage waveform induced in the unloaded magnetically-coupled and near identical second winding. Together these waveforms gave an insight into the inductive power fed in and returned from the machine over the cyclic period of pole closure and separation.

It was then very evident that the power factor governing the a.c. power input was such as to indicate a quite significant excess power, even assuming that the d.c. drive motor was only 50% efficient. Ostensibly, it seemed that the test machine had to be operating above 100% efficiency by drawing on thermal heat input.

The most important observation, however, apart from finding that a pulse amplitude of about 0.8 amps in the single test winding was needed in the test, was that very nearly all of the inductive power input to the machine was being returned by the a.c. circuit. The volt-amp product reversed polarity as the half-wave current decreased. It could do this because the rectifier diode used could sustain current flow by the winding generating a forward EMF.

Now, here was a feature that was important. With the machine driven by the permanent magnet system the inductive power fed in to secure flux switching was not all used in adding power to the machine drive and even in these 50 Hz tests, where current was reducing as flux collapsed, most was, it seems, recoverable. This had been anticipated, or at least hoped for, in developing the machine design because of the relative configuration of the source magnets and the stator pole pieces, but it was gratifying to see this confirmation.

This then became a reason for examining the prospect of building or procuring an a.c. power source that could operate efficiently at 250-400 Hz to power an inductive load regeneratively through a diode. The attendant problem was also that of assuring sufficient frequency stability to be compliant with the synchronous operation of a motor not receiving its power drive as such from that supply.

This pursuit tended to runaway with the time available for the project, with partially successful results using the same test machine. Eventually, to move the project forward, the author decided to use a simple electronic power drive where one machine winding signalled the control timing needed to put power on the other winding. A pnp power transistor was connected so as to deliver its collector-base current to one winding in its ON-state, and inhibited so as to be in the OFF-state when the other winding delivered a positive polarity signal to the base.

With such a control system the test results of this Report were obtained, but any inductive power returned from the machine winding is necessarily dissipated and detracts from the possible efficiency of the machine. This is because the forward EMF set up by that return of energy causes unwanted current spike at the end of the cycle. There was the problem with the system under such test that it could very easily be set with its magnetic pole gap flux wasting power in oscillations.

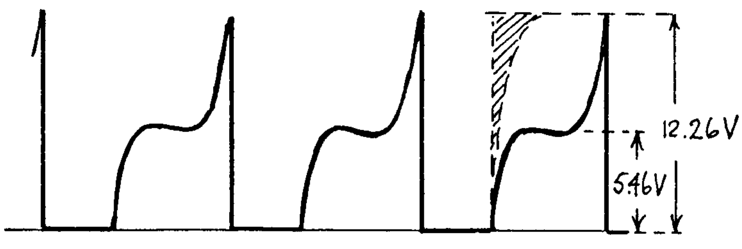

Fig. 4

Had a capacitor been incorporated without informed design based on test performance then that too could have aided oscillation, rather than helping to suppress such effects whilst storing energy for use in the next machine cycle.

With only slight adjustment of the bias controls a V_m waveform corresponding to Fig. 4 corresponding to Fig. 2 on page 9 was obtained. The exponential rise of current peaks before dropping a little and then rising again to end in a upward surge which, in some tests, was so narrow that only its amplitude could be validly measured.

This waveform shows that the input current, which is really what this voltage waveform represents, owing to it being the potential drop in a series 2.6Ω resistor, builds up as in a normal LC circuit. The pole gap flux is therefore changing so as to set up a back EMF acting against the supply EMF. Then the flux levels off and begins to reverse the back EMF, owing to machine rotation changing the pole gap spacing. Once this occurs the back EMF becomes a forward EMF increasing in its effect the supply voltage feeding the collector of the transistor and so overriding the inhibit signal set up by the bias and enhancing current flow in its ON-state.

Now, to interpret Fig. 4 in terms of energy one needs to take note that the supply EMF to the transistor circuit has to be strong enough to overcome the maximum back EMF induced in the magnetizing winding.

Note then that a magnetic reluctance motor works in one of two ways. In both the inductive energy fed into the machine, as measured by $\int(V_iI)\delta t$, far outweighs the return energy expressed when this quantity becomes negative. One way of assuring this is to switch I off at the point when the motor poles are in register. Thus I is zero during the reset stage and, since the net flux change has to be the same but opposite in sign for the two stages, $\int V_i.\delta t$ is equal in magnitude for the two stages.

In the first mode of operation, the inductive input power augments the magnetic flux to strength the pull between poles during the pole closure phase, so that the energy added in this way goes directly into the mechanical power drive during that phase.

In the second mode of operation, the inductive power input is used to suppress the magnetic attraction between poles during their separation and the energy is deployed as in compressing a spring to recharge the magnetic energy potential of pole gap without that recharge drawing on the inertial power of the motor. Then, during pole closure, with current off, the energy in the gap does the necessary work. In this case the machine would normally include permanent magnets.

However, what we see in Fig. 4 is something quite different from either of these situations. Drawing the waveform in the manner shown in Fig. With the voltages now corresponding to a current drop in 5.2Ω, the total test machine circuit resistance, the 5.46V line represents a norm in the transistor ON-state set when the inductive effect is zero. The full line represents current or voltage across the 5.2Ω resistance. Above this line the voltage difference to the 12.26V level represents voltage drop across inductance or in the power transistor, the intermediate broken curve showing a demarcation between the two. The latter when multiplied by current is the heat loss in the power transistor.

12.26V is the supply voltage fed to the transistor circuit. The determination of the input $IV_i\delta t$ quantity is then represented by the voltage drop in the shaded section in the upper right portion of the rectangular boundary shown.

Consider now the return of inductive energy. Of necessity, $IV_i\delta t$ has to be the same in magnitude for input and output, and the question at issue is how much of the latter change occurs with I on, as seen in Fig. and how much occurs with I turned off. Certainly, the showing is that the current is greater, much greater, on average during the return transient.

Guided, however, by the observations at 50 Hz already mentioned, the author tends to the view that most of the input inductive energy is returned and is in this transistor-powered test shed in I^2R loss in the circuit resistance. This means that the underestimate of the input inductive power is compensated by the return of inductive power and becomes an entry in the energy balance sheet as excess heat developed in the load resistance.

Certainly, it is clear that the inductive energy put into the system has not been wholly used to power the motor. Much of the energy is returned but precisely how much energy is difficult to ascertain.

These observations do not detract from the validity of the conclusions reached in the main sections of this Report, but what has been discussed here becomes a factor in designing the onward prototype machine system and particularly its control circuit.

The machine system to be built next will present few design problems because it will be a cross-coupled dual combination of the single test machine already tested, the cross-coupling bringing the machine flywheel action into play as a regulator avoiding parasitic flux oscillations caused by the close-coupling of the windings of the single test machine.

The control system needed will be researched in exploratory stages, beginning with transistors in the form of power MOSFETs, but attention will focus on the inductive energy recovery and that may dictate the need for other control techniques for powering the system.

APPENDIX I

LC Circuit Loss Analysis

Before calculating the resistance loss portion of the power input transient supplied to an inductive circuit, it is instructive to study first the capacitative situation.

Consider a step voltage E applied to a resistor connected in series with a capacitor. Such a circuit (resistance R, capacitance C) has a time constant RC, verifed as follows. The current at any instant is denoted I and I_o is E/R.

$$E = IR + (1/C) \int I.\delta t \tag{1}$$

where the integration is from t = 0 to t = T.

Write:
$$I = I_o e^{-t/RC} \tag{2}$$

and substitute in (1) followed by performing the integration:

$$E = I_o[Re^{-T/RC} + (1/C)(RC-RCe^{-T/RC})] \tag{3}$$

which reduces to:
$$E = I_o R \tag{4}$$

verifying the assumed time variation of I expressed in equation (2).

The I^2R loss is then:

$$W_R = I_o^2 R \int (e^{-2t/RC})\delta t \tag{5}$$

which integrates to give at time T:

$$W_R = I_o^2 R(RC/2)(1 - e^{-2T/RC}) \tag{6}$$

and the corresponding energy stored in the capacitance is:

$$W_C = EI_o \int (e^{-t/RC})\delta t - W_R \tag{7}$$

which is:
$$W_C = EI_o RC(1 - e^{-T/RC}) - W_R \tag{8}$$

It follows, therefore, that if θ is infinite W_R is $I_o^2R^2C/2$ and W_C is EI_oRC less W_R. From (7) W_R becomes $E^2C/2$ and is equal to W_C. In other words, for every unit of energy stored in the capacitance exactly this same amount of energy is lost in the resistance R.

In the initial stages of the transient energy is lost at a greater rate than it is being stored and the situation reverses as charging proceeds.

With an inductive circuit, on the other hand, this situation reverses as the energy stored in inductance outweighs the loss initially but then the situation reverses with passage of time and the energy stored settles at a final level whilst there is an ongoing steady resistance loss.

The relevant equations with inductance L and resistance R are:

$$E = IR + LdI/dt \qquad (9)$$

where:

$$I = I_o(1 - e^{-(R/L)t}) \qquad (10)$$

and:

$$E = I_oR \qquad (11)$$

The total resistance loss to time T is given by evaluating the following expression over the range of integration from t = 0:

$$W_R = I_o^2R \int (1 - 2e^{-(R/L)t} + e^{-2(R/L)t})\delta t \qquad (12)$$

which is:

$$W_R = I_o^2R[\theta + 2(L/R)e^{-(R/L)T} - (L/2R)e^{-2(R/L)T} - (3/2)(L/R)] \qquad (13)$$

If T is L/R then W_R becomes $(LI_o^2)(1 + 2/e - 1/2e^2 - 3/2)$ or $(0.168)LI_o^2$.

In contrast, the inductance energy stored at that time T is found by evaluating $LI^2/2$ from equation (13).

It is simply $LI_o^2/2$ times $1 - 2/e + 1/e^2$ or $(0.200)LI_o^2$.

One sees from this that at time θ the inductance has stored 54% of the energy input, this being the proportion 0.200 of (0.200 + 0.168).

Concerning the rate at which energy is apportioned between the resistance loss and inductance this is the ratio of I^2R to $ILdI/dt$ or, from (13), $(R/L)(1 - e^{-(R/L)t})/(R/L)(e^{-(R/L)t})$, or simply:

$$e^{(R/L)t} - 1 \qquad (14)$$

so one sees that at time T, which is L/R, the proportion of loss to energy being stored has become e - 1 or 2.718 - 1 or 63% of power input.

This Appendix therefore guides the design to determine a value of L/R which is high, meaning that R has to be as low as possible, and then driving a voltage pulse into the winding using a sufficient, but not excessive, input EMF of adequate duration to block unwanted magnetic flux oscillations.

The technology suggested by this Report using a single solenoidal magnetizing winding allows R to be very small whilst providing for some power regeneration sourced in I^2R heat generated.

APPENDIX II

Test Machine Description

This text is extracted from pages 1, 2 and 5 to 26 of the description in a patent specification relating to the test machine. The 4 sheets of drawings containing 16 figures in the patent specification are numbered as 35 to 38 of this Report. The application was filed at the U.K. Patent Office on July 7th 1995. [Official publication date February 12, 1997 as GB 2,303,255].

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MAGNETIC RELUCTANCE MOTOR

FIELD OF INVENTION

This invention relates to magnetic reluctance motors, which are motors having salient poles which drive the motor by magnetic attraction rather than interaction of a magnetic field with current in a winding.

Such motors can operate by applying current which strengthens the magnetic polarization as stator and rotor poles come into register as the rotor rotates or which weakens the magnetic polarization as the poles separate from the in-register position.

Magnetic reluctance motors are known to have high efficiency and could well become a dominant type of motor now that the cost of the semiconductor circuitry needed to control such machines has reduced to the level at which they can prove commercially more attractive than the induction motor.

This invention is concerned with an improvement in the basic structure of the reluctance motor, which increases efficiency even further by a technique which harnesses a physical property known as 'magnetocaloric cooling'. This property is intimately connected with the manner in which the energy in an iron-cored inductance is stored in the core.

The field of this invention is therefore primarily concerned with thermodynamic power input to a reluctance motor, which is, in fact, a new field having a very limited technical background.

BACKGROUND OF INVENTION

The background relevant to this invention, so far as it is known to the Applicant, will be described in the following specification, by reference to the drawings. At this stage it suffices to make simple bibliographical reference to the following patents which are discussed in this specification. These are:

GB Patent No. 2,234,863 corresponding to U.S. Patent No. 4,975,608, GB Patent Application No. 2,267,995 corresponding to U.S. Patent No. 5,376,184, and GB Patent Application No. 2,282,708, the first four of these having the same applicant as applies to the subject invention and the latter having additionally, as co-applicant, Robert George Adams of New Zealand. GB Patent No. 547,668 granted to Stanley Isaiah Hitchcock.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 to 5 show schematically the form of five different prior art permanent magnet reluctance motor constructions, which serve as background relevant to the invention.

Fig. 6 shows a test core configuration used to verify a magnetic flux switching feature that is applied in the invention.

Figs. 7 and 8 show, respectively, a side elevation sectional view and an end elevation sectional view of a motor constructed according to the invention.

Fig. 9 shows the magnetic flux paths in a part-section of the structure shown in Fig. 7.

Figs. 10, 11 and 12 show different interacting stator and rotor pole arrangements in a magnetic reluctance motor, Figs. 11 and 12 pertaining to the invention and Fig. 10 to a prior art form.

Fig. 13 shows a design variant of the motor construction presented in Fig. 8, the rotor poles being tilted in the forward direction of rotation.

Fig. 14 shows a machine system incorporating two reluctance motors coupled in an anti-phase pole configuration, with a cross-connected magnetizing winding arrangement for coordinated power input pulse regulation.

Fig. 15 shows a B-H magnetization curve applicable to the stator cores in the reluctance motor according to the invention, illustrating how the field excitation, in interacting with reluctance changes as the motor poles close and open, causes flux density changes in a loop direction which represents power generation rather than loss.

Fig. 16 shows the rotor of a reluctance motor having provision for rotor magnetization by current in rotor windings on ferromagnetic soft iron cores mounted between laminated rotor sections.

DETAILED DESCRIPTION OF THE INVENTION

At the end of this specification there is an Appendix which shows, by technical analysis, using formulae familiar to experts in electrical science, the physical basis on which this invention relies. What is described and claimed has been established by experiment, but inasmuch as it will surprise many experts in the art to learn that thermodynamic effects can contribute to the improved efficiency of an electric motor, the Applicant has deemed it prudent to give the formal scientific basis for the research which underlies this invention.

The essential point made is that, if one can feed power into an inductance L having a high value by supplying a current of strength I, the energy then stored being $LI^2/2$, and then cause L to reduce substantially before reducing the current, one must gain electrical energy.

The Applicant's research extending over 40 years has recognized that inductive energy is stored by the partial ordering of the thermal state of a reacting field medium, which means that upon the recovery of inductance energy there has to be a cooling of the reacting medium to assure energy balance, just as there is heating upon energization.

In spite of this awareness for so many years, it is only now that the Applicant, owing to this invention emerging from experimental research funded by the U.K. Department of Trade and Industry by their SMART AWARD programme, has been able to bring this knowledge to fruition in a technological application.

The essential considerations, as applied to the reluctance motor, can best be described by first examining how energy is deployed in the motor. Suppose that the motor incorporates magnets and the stator and rotor poles begin in the out-of-register position. Without feeding in any external power, the magnets can serve to pull the poles together and so put drive torque into the machine. At the in-register position the magnetic circuit through the poles has its highest inductance as seen by windings on those poles. It is at this position that a current of strength I is supplied in the direction that aids the action of the magnets. As the current builds up L holds its high value. The current will do no work other than sustain some I^2R loss and store energy $LI^2/2$ in that inductance. If the current is then kept on at the level I as the poles separate, by the time they have reached their out-of-register position the poles gaps formed will have virtually reduced the inductance to near zero. The current can then be switched off without the return of any energy at that final stage. However, during the phase when the poles were moving apart, L was reducing at constant current I and this means that, since the power delivered is $I\delta(LI)/\delta t$ or $I^2\delta L/\delta t$, one has an overall electrical output in energy terms of I^2 times the change of inductance, which is L. In other words, one gets twice as much electrical power back as was fed in when the current was switched on.

Of course, there is some ohmic heating loss, but there is also that cooling already mentioned. Also, one can rightly assume that the current I strengthens the magnetic pull between the poles as they separate so that more mechanical work is needed to pull them apart against the action of the magnets than was delivered from their mutual attraction during pole closure.

This may, therefore, seem normal and unsurprising, even though electrical power is generated, because mechanical work has been added and because standard science in dealing with such problems applies what is known as 'the principle of virtual work' which assumes an answer based on energy conservation. If the heat exchanges are not factored into the analysis, use of this principle becomes a misleading exercise.

Now consider the situation where that same current I is applied in the opposite direction to weaken the magnetic flux between the poles when they are fully in register. The current experiences a back EMF in the windings and only senses flux rate of change; it has no knowledge of the biasing magnetic field set up by the magnets. There will be inductance energy supplied as input amounting to $LI^2/2$ as before. In this case the poles can separate without there being any strong magnetic attraction demanding mechanical energy, because the magnetic flux has been biased to a zero value. As the poles separate the current can reduce progressively to keep the zero flux condition and no exchange of inductive power occurs. The overall result is that the energy input $LI^2/2$ has been spent and mechanical energy gained from the magnet during the pole closure phase. These two energies can be presumed to be equal, but if the motor has the design described below, it is found that the mechanical drive power of the machine exceeds the inductive power input. It is then a matter of design to reduce the I^2R heating loss so as to gain overall enhancement of motor efficiency by the magnetocaloric cooling thus evidenced.

The reluctance motor which has variable pole gaps complicates the situation represented in the Appendix, the more so if magnets are involved, and it should be explained that using the magnetizing current to divert flux from the magnet and along a leakage path will set up demagnetization effects which effectively reduce the inductance L. This allows the value of the current I and the angular position of the rotor in adjusting the pole gaps to combine as a control determining LI.

As one then sees from the Appendix, the root principle of the power gain argument is that if one can contrive to reduce LI of a circuit whilst it carries constant current I, then the inductance will deliver more energy output than was supplied and there will be commensurate cooling in the inductor core. By suitable positioning of magnets or magnetizing windings in a reluctance motor, this becomes feasible technologically.

The essential design factor in this is the positioning of the magnets or windings which govern the inductance at positions not directly linked by a magnetic field to the seat of the inductive action. Here 'magnetic field' is used in the context of ampere-turns and is distinct from the magnetic flux which necessarily provides the inductive linkage. The magnets or windings can be placed in positions offset from the pole gaps in a reluctance motor or positioned with axes orthogonally angled with respect to the flux direction in the pole gaps.

Referring to Figs. 1 to 6, the background applicable to this invention will now be described.

In each of these figures the components marked with arrows represent magnets, the arrow pointing from south to north poles so as to represent their field action and magnetic flux direction. In Figs. 1, 3 and 5, the spindles 1 support two rotor sections 2 each comprising an assembly of electrical sheet steel laminar rotor discs having a set of salient poles. In each of Figs. 1 to 5 the cross-shaded components 3 are stator windings, each of which has a stator core 4. These cores are of solid soft-iron form in Figs. 2 and 4, but otherwise in Figs. 1, 3 and 5, they consist of an assembly of electrical sheet steel laminations. Each stator core in Figs. 1 and 3 provides a pair of stator poles, interacting respectively with the rotor poles of the separate rotor sections.

Fig. 1 shows a prior art reluctance motor disclosed by this Applicant in GB Patent No. 2,234,863, corresponding to US Patent No. 4,975,608. In principle the motor there disclosed has magnetizing windings 3 which, when energized, block the through-passage of magnetic flux sourced in the magnets, forcing diversion around a path through outer bridging yokes 5 to the poles on stators 3 and corresponding poles of the two rotor sections 2. These rotor sections serve, according to the angular position of the spindle 1, to open or close pole gaps between the rotor and stator so that flux from one pair of magnets in one stator core can return as flux through another pair of magnets on an adjacent stator core. There is an even number of such stator cores and the magnets of adjacent stator cores are arranged with opposite polarization directions to assure this.

By pulsing current through the windings 3 at times when the poles are closing, this allows the magnets to drive the motor. As the poles separate the current is switched off and the magnetic flux diverts through the stator 4, the path of least reluctance, leaving the poles free to separate.

The relevance of this prior art disclosure is its showing of magnetizing windings that are mounted parallel with the spindle axis and so are orthogonal with respect to the flux direction across the pole gap.

In the invention, the subject of this patent application, a superior construction incorporating the magnets in the body of the rotor is disclosed. It has been found easier to exclude from the pole gaps the flux sourced in the magnets if the latter are rotor-mounted, as opposed to stator mounted.

Fig. 2 shows a motor structure which became public knowledge from the publicity in Australia relating to a motor construction by Robert G. Adams of New Zealand. The Adams' motor has all poles of the same polarity bonded together at a collar 6 on the spindle 1, leaving the end poles at the free ends all also of the same polarity. Each such pole sweeps in turn past a stator pole and is attracted to the soft iron of the stator core 4. As it passes the in-register position, the magnetizing winding is energized to act in opposition to the flux then linking the core from the magnet. This expels the flux and allows the magnet to move on until attracted by the next stator core.

The Adams' disclosure shows that, by using powerful magnets, accepting flux leakage and by using short stator cores as controlling electromagnets, a motor can be constructed which, according to test reports by Adams, is said to have a quite exceptional performance of the kind contemplated in the above preamble.

This Applicant opened a liaison with Robert Adams and proposed cooperation to find then that we had developed our ideas on common ground in conceiving a motor version with rotor-mounted magnets disposed parallel with the spindle axis. This led to the filing of GB Patent Application No. 2,282,708 relating to a motor having the construction shown in Fig. 3. Adams had built and tested a machine of the form shown in Fig. 4. In both machine designs the separate bar magnets 7 all rotate together so that all their poles at one end of the machine are of N polarity and all the poles at the other end are of S polarity. This avoids flux reversal in the stator cores which would develop extra loss, bearing in mind that the motor is driven by flux changing in amplitude rather than in direction.

The Fig. 4 machine operates in a manner analogous to that of the Fig. 2 machine, whereas in the Fig. 3 machine the flux from the magnet is diverted through rotor laminations to traverse poles gaps to the stator in a radial direction.

The U.K. Patent Office cited GB Patent No. 547,668 (inventor Stanley Isaiah Hitchcock) against the patent application corresponding to the arrangement shown in Fig. 3 and this citation is a disclosure of a motor of the form shown in Fig. 5. Here the design is much the same as that of Fig. 3 except for the vital differences in Fig. 3, (a) that the stator magnetizing windings and the magnets, which together control the flux acting across the pole gaps, are both orthogonal with respect to the flux direction across those gaps and (b) the flux closure path is through separate bridging stator cores rather than into annular stator cores having salient poles. The latter avoids problems of flux closure, as through a casing 8 (shown in in Fig. 5 in broken outline), by using the stator core members to support windings 3 located in the magnetic flux circuit between the rotor sections 2.

From the viewpoint of the subject invention, the weakness of the Hitchcock disclosure is the use of short-length stator coils mounted very close to the operative pole gaps. This provides such close field coupling that none of the power gain from flux domain rotation, as discussed in the specification of GB Patent Application No. 2,282,708 (the Fig. 3 machine), is available from the magnetizing action. Also, with the need to minimize I^2R ohmic heating loss as a paramount consideration, if high efficiency is to be achieved, the contraint on space available for the stator magnetizing windings poses problems which are avoided by the following invention.

Referring to Fig. 6 it is noted that a test on a static assembly of the form shown, comprising a magnet 9, a laminated ferromagnetic core 10 having a magnetizing winding 11 with laminated core members 12 linking the two revealed that a quite moderate current was sufficient to break the magnetic holding force between the core and the magnet. In principle this served to demonstrate that a current in the winding directed to oppose the action of the magnet will sense the core 10 as having very nearly its normal high magnetic permeability μ, whereas the stray action of the direct magnetic field from the magnet will have little effect. Accordingly, the magnetic flux, which the magnet would normally drive around leakage paths between its poles, but which it transmits at a magnetic flux density B through a bridging yoke if one is present, is effective in the core 10 as a field B/μ. It needs very little current in the magnetizing winding to obstruct passage of flux from the magnet in such a case.

There are some additional field effects from the laminated core members 12, but the general point holds, namely that if one wishes to improve efficiency and gain power in a reluctance motor there are distinct advantages in putting the field-generating sources in positions around the ferromagnetic circuit orthogonally directed with respect to the gap orientation.

Figs. 7 and 8 show different views of a motor construction incorporating the invention. The rotor has a spindle 1 which is of a non-ferromagnetic metal, such as brass or stainless steel. It is mounted in ball bearings 13 set in end frame members 14 which are of a tough electrical insulating material, a rigid polyurethane product being used in experimental versions of the machine. These are connected between their corners by stainless steel studding 15. The object is to minimize stray magnetic field effects and, so far as possible, confine the magnetic flux produced by the machine to the space within the bounds of solenoidal winding 16 located on and enclosing 8 stator core members 17. These stator members 17 are formed from I-section transformer laminations and are located on shoulders formed as part of the end frame members. They are disposed parallel with respect to the central axis of the spindle, this axis being also the central axis of the solenoidal winding. Each set of I-section transformer laminations forming stator core members 17 is bolted between rigid polyurethane supports of triangular section (not shown in the drawings). These hold the laminations in a tilted position, at a 45^{o} angle as depicted in Fig. 8. In a test machine of this form the solenoidal magnetizing winding comprised two coils, each of 220 turns.

The rotor, in the representation shown, which is that of one machine constructed, comprises four barium ferrite ring magnets 18 of the kind used in loudspeakers. These magnets have a thickness of 8 mm and an outer diameter of 60 mm. Five rotor core sections 19, each comprising an assembly of 0.5 mm thick disc laminations of electrically sheet steel having 8 teeth at its perimeter to form salient poles, are mounted on the motor spindle 1, separated by the four magnets 18. The end rotor core sections had a thickness of 4mm and the three intervening sections had a thickness of 8mm. The magnets were mounted on the spindle, with their polarizations all in the same direction, as shown in Fig. 9.

The principle of operation of the motor will now be explained by first commenting on Figs. 10, 11 and 12.

A conventional design of a magnetic reluctance motor has a salient pole rotor 20 with no magnets in its structure. Its poles interact with salient poles on a laminated ring stator 21, these having individual windings 22 to control the magnetic flux across the interpole gaps. When the magnetizing winding is energized the rotor and stator poles moving into register as the rotor turns develop a magnetic flux across the pole gap with flux lines tilted forward as indicated by the arrow. If these flux lines were perfectly radial as applies to electrostatic field action, should that analogy be contemplated, the pull between the poles would not develop torque on the motor spindle. By symmetry, when the poles are in perfect register (Fig. 11), the magnetic field in the gap is radial and the torque produced is then zero. It then serves no purpose to maintain the energization of the winding. Indeed, the current must then be terminated in order that pole separation should not develop a brake torque.

Fig. 11 shows the stator core 21 as formed with its laminations lying in planes transverse to those applicable to the stator in Fig. 10. Thus, whereas the magnetic flux in the conventional stator of Fig. 10 has to find a path to an adjacent pole through a stator lamination coplanar with a rotor lamination, the stator form shown in Fig. 11 guides the flux between mutually orthogonal laminations to a pole on a separate rotor core section at a position further along the spindle.

This latter construction then allows tilting as shown in Fig. 12, the object of this being two-fold. Firstly, in some small measure, the tilt assists in conforming with the inclination of the flux and so the force action across the pole gap. Secondly, the flux, having been established, has to be precluded from developing a tilt in the backward direction corresponding to a retarding torque action. As already indicated, if the flux is set up by a magnetizing field, then the commutation is less of a problem. It is just a matter of terminating the current pulse at the right moment. However, if the magnetic flux is developed by magnets, as in the machine shown in Figs. 7 and 8, then the commutation task involves setting up an action opposing the magnets as the poles separate. Given then that in the Fig. 12 position, the magnets cause flux to cross the pole gaps and enter the planes of the stator laminations, the action of pole separation requires either that the flux should break whilst still tilted forward, at least in the stator, or that the flux must be pulled through the full planar faces of the laminations on the forward side of the stator cores. This will induce eddy-currents which oppose this action. However, it is important to realise that what is opposed is not the reduction of magnetic flux already present, but rather the build-up of magnetic flux in passage through the planar faces of the laminations. This therefore can but aid commutation and ease the task of using control circuit means to set up the currents opposing the action of the magnets.

In summary, therefore, there is purpose in tilting the stator laminations as shown, and this is not an available option with the conventional ring-type stator lamination.

In the operation of the motor shown in Figs. 7 and 8, the control involves pulsing the current in the solenoidal winding to set up a magnetic field directly in the stator cores directed in the same orientation as the polarization of the magnets.

Notwithstanding the fact that all magnets face the same way and are separated only by good ferromagnetic material, the magnets do not seek a common flux path along the axis and through to the open pole regions near the motor bearings. Because the rotor laminations have projecting teeth which extend 15mm from the outer perimeter of the magnets, the rotor lamination discs being 90 mm in diameter, these guide the flux to the stator region. Therefore, if the rotor and stator poles are in register the magnet sends its flux around a closed loop across the pole faces and through the sections of stator cores located at corresponding axial positions.

When current is applied in a direction which supports the magnet, this developing a magnetic field H as shown in Fig. 9, this opposes and blocks flux passage in those stator sections and forces the magnet to seek a leakage route for its flux. Much of the diminished strength of the magnet is then deployed away from the pole gap and much of the flux finds a return leakage path within the confines of the cylindrical boundary set by the solenoidal winding.

This means that the current pulses fed to that winding can serve to control the action of the magnets in driving the reluctance motor, but the actual change of flux involved does not all link that winding inductively. Such flux as does link the winding will be a measure of the inductance of the winding and some of the power supplied as inductive energy will be recovered during a complete pulse period. The former factor means that in some measure the motor will be driven by the magnets without drawing commensurately on input electrical power and that can only mean that there has to be magnetocaloric cooling of some kind to provide that excess power from a heat source.

In Fig. 13 a modification of the motor depicted in Fig. 8 is presented. It uses rotor laminations 23 which have the pole-forming teeth angled in the direction of forward rotation of the motor to complement the tilt of the stator laminations. In this figure the arrows on rotor lamination 23 show the magnetic flux lines sourced from the magnets entering the rotor disc and being guided by the angled teeth to track along a path to the pole gaps.

The construction of a machine of the general form shown in Figs. 8 or 13 can prove difficult if it is attempted to assemble a unitary stator core with winding and a rotor separately and then bring the two together. The powerful magnetic attraction between the rotor and the stator then make it virtually impossible to mount the rotor inside the stator and support it in its end bearings.

A solution to this difficulty was found by adopting an assembly process by which the rotor was first mounted in its end bearings with the linking studding 15 bolted in position. Then each stator lamination component is inserted and secured in position, this providing sufficient bonding to hold the end frame mambers 14 in place when the studding is temporarily removed to allow the solenoid to be wound. The innovation involved here is the use of the end frame mambers 14 as side flanges of a bobbin form for that winding.

With this construction the motor can operate with one single solenoidal winding by suitable current pulsing, but it is foreseen that the ultimate benefits of the thermodynamic features of the machine render it adaptable for use as a power regenerator or in a coupled motor configuration which has a pilot drive motor as a starter motor.

In this case, by reference to Fig. 14, a solenoidal winding 24 on one of two machines 25, 26 having the form shown in Figs. 7 and 8, is used to control the timing of power input to a solenoidal winding 27 on the other machine. The stator core system of each machine is depicted in Fig. 14 as incorporating a core 28 which inductively couples two windings 24 and 27. The inductance of the core depends upon the pole gaps in the associated machine, because the core is formed by the magnetic path through the rotor and stator core system.

In Fig. 14 the d.c. motor 29, which has a power supply not shown, is used as starter motor and it serves during normal operation at speed to regulate the speed of the machine combination. It can also be used as a d.c. power generator feeding on the drive power generated by the machine system, thereby serving to recharge batteries used as an energy source on start-up.

In the cross-connection between the solenoidal windings 24 and 27 on the two machines there are power amplifiers 30 serving to boost the power exchanged between the machines and these power amplifiers are supplied with electrical power from an external power supply system when the regenerative action of the machine system is inadequate.

To understand the regenerative action, refer now to Fig. 15. This shows a B-H relationship between flux density B and magnetic field H in a stator core of the machines. When B is low, the rotor and stator poles are out-of-register and no field current is supplied to the magnetizing winding. The pulse timing governed by the power amplifier or the biasing arrangement through an electronic coupling including diodes assures that no significant current flows in the winding until the pole gaps have closed. The machine has periods during rotor rotation where the gap spacing changes very little over a range of rotor movement. It is during this period that the circuit control allows current to flow to a level determined by the input voltage.

The state of magnetism of the stator core then shifts from X to Y in Fig. 15. Since this is a range involving high inductance, commensurate with the effective permeability of the stator core being of the order of 1,000 times that of a non-magnetic material, this action needs very little current, meaning a low field strength H.

At Y, even though the poles, though beginning to separate, are still in near-register, the current reaches a level where it has succeeded in driving the flux sourced in the rotor magnets from the closed paths through the stator core and thereafter with increased current obliges that flux to seek a leakage path to find a closure route. It is then found from tests on such a machine that one route adopted, besides leakage within the confines of the solenoidal winding, is that through the open ends of the stator cores, which means that these free ends develop poles which set up a demagnetizing effect. This demagnetization, although principally set up by the flux from the magnets in the rotor, has a direct action opposing the onward build-up of field by the current in the magnetizing winding.

Accordingly, the transit from X to Y occurs at high inductance, but the transit from Y to Z occurs at a rate subject to a very small incremental magnetic permeability, even though the motor poles are still virtually closed. During this Y to Z phase there is the need to feed in substantial current and substantial inductance energy to take the flux density B to the value at Z. The B-H area between YZ and the B ordinate is a measure of this input energy.

At Z, the current input pulse having peaked, the motor pole gaps begin to open rapidly and since the current is sustained the action of the motor inertia in forcing the pole separation operates to deliver a return of inductance energy to the magnetizing winding. The energy returned is that represented by the B-H area between ZX and B ordinate in Fig. 15.

Overall, the area of the B-H loop formed is a measure of the energy excess that has been fed back by this induction process, by drawing on magnetocaloric cooling. Note that the loop is described clockwise, whereas in conventional magnetic systems such as transformers, the B-H loop is always described anticlockwise, in which case the B-H loop represents magnetization loss. Such magnetization loss as does occur in the motor will therefore detract from the B-H loop area and so be accounted for in the overall gain.

To maximize this power gain the machine must be able to act virtually as a magnetic reluctance switch with the motor function serving only to open and close pole gaps. If the motor system is not loaded as a mechanical power drive, its reluctance function, especially that attributable to the magnets in the rotor, will serve to assist rotation during pole closure and that will nearly balance their braking action during pole separation. Inasmuch, however, as there is a magnetocaloric input of power there is scope for dividing that power output between motor drive and electrical power regeneration.

Indeed, it is essential if this technology is to be exploited to the full, that the inductive power regenerated has to be deployed usefully in assisting the system operation, rather than spent on resistance loss in the electronic power source. This is why a back-to-back coupling of two machines has merit, in that as one machine is operating over the XZ range requiring power input, so the other is phased in its operation to be operating over the ZX range. This phasing is incorporated in the machine system by adjusting the angular setting of the mechanical coupling between the spindles of the two machines.

The induced EMFs in windings 24 are anti-phase signals so that by suitable electronics, or simply diode interposition, they can be used to cross-feed power between the machines when set with the appropriate pole position phasing.

A typical test on one machine system using the structure shown in Figs. 7 and 8 has shown that more inductive energy is returned in each flux cycle than is supplied as input, even though the d.c. starter motor itself drew a reduced power whilst the whole system increased in speed from 800 rpm to 1350 rpm. In this case the inductive power gain, though positive, was marginal in comparison with the mechanical power gain, but the findings were a very clear indication that the theoretical basis of this invention, with its reliance on a magnetocaloric cooling as a source of excess electrical power input, is soundly based.

Although the invention has been described in its form as implemented in a test prototype, which used permanent magnets, it is to be understood that the essential component is the ferromagnetic core in the system, which need not be of permanent magnet material.

In its technological application, the optimum design based on this invention depends upon the scale of the machine. A large machine system can employ rotor and stator structures which are simply electromagnetic in form, provided the core is ferromagnetic. The key feature of the invention is the way in which the reluctance of the core effective in the magnetizing winding can be switched from a high inductance state to a low inductance state by means not directly coupled to that magnetizing winding. The specific design of the reluctance motor by which the pole closure and pole separation design serve this reluctance switching functions is the attribute which brings about the enhanced efficiency condition. The permanent magnets are not essential and, indeed, a rotor built with a soft iron ring cores 31 to replace the magnets with rotor windings 32 such as is shown in Fig. 16 could serve quite well functionally and in fact better in cost terms in a large machine.

The rotor winding, supplied through slip rings, would merely carry a steady d.c. current and the flux changes resulting from the pole opening and closing would set up eddy-currents which involve a moderate loss. However, these currents would have limited core penetration and would tend to sustain a steady magnetic flux condition in the body of the rotor. As with the coercive force action of a permanent magnet, these would help to force the leakage flux action that is part of the functional operation of the machine as described.

The importance of the enveloping solenoidal winding as the primary magnetizing winding governing motor operation can be seen when it is realized that, if individual windings are used on each stator core, these would need to be segmented along the core length so as not to obstruct the pole gaps. The enveloping solenoidal winding has therefore several advantages, namely its low resistance because of its unrestricted outer diameter, its ease of assembly and its continuity along the body of the machine.

In machines constructed by the Applicant to test this invention, the motor end frame members were of electrically insulating material because some pulsating magnetic flux leaks from the open ends of the stator core members. This leakage seems essential if provision of a return flux path through a ferromagnetic casing is to be avoided.

However, the end frame members could be metal castings of spider-like construction which, with the axial studding 15, provide no closed circuit linked by the changing magnetic flux. The eddy-current losses in the end frame members would then be reduced to those set up by a small amount of flux penetration into the thin spider limbs connecting the studding and the central hubs supporting the motor bearings.

APPENDIX OF THE PATENT SPECIFICATION

Ferromagnetic Inductor Energy Analysis

The energy stored in an inductance L formed by a magnetizing winding mounted on a ferromagnetic core is the integral:

$$\int I[\delta(LI)/\delta t]\delta t \quad (1)$$

evaluated over the range from zero current I to the applicable level of current.

This can be written as:

$$\int [L\delta I/\delta t + I^2\delta L/\delta t]\delta t \quad (2)$$

which is $I^2\Delta L+LI^2/2$ where ΔL is the change of inductance, assuming this occurs at the level of current I.

It follows from this that if L is reduced when I is high and increased when I is low, the inductance can deliver more energy during the current reduction phase than is supplied to it during the current input phase. This may sound anomalous but it is consistent with basic physical principles, because the process by which an inductance stores energy involves heating and cooling. Heat is shed when the inductance is energized, because the electromagnetic induction polarizes the reacting field in the manner described in the Appendix of the published specification of GB Patent Application No. 2,267,995 or that in U.S. Patent No. 5,376,184. Conversely, there is cooling, known in physics as magnetocaloric cooling, upon deenergization. There the energy balance is attributable to thermal effects which are not formulated in the above expression.

To prove that more energy can be extracted from an inductance than is supplied to it, suppose that the inductance has a high value L as the current increases and a progressively lower value L-ΔL as the current is sustained at a high level, the current not being switched off until the inductance is very low.

The energy input during the current increase phase is then given by:

$$L(I)^2/2 \quad (3)$$

and the energy output at the transition when L reduces is given by:

$$\Delta L(I)^2 \quad (4)$$

with further energy output during the current decrease phase:

$$(L-\Delta L)(I)^2/2 \quad (5)$$

Since there is no current when the transition to increased inductance occurs, these three energy components are all we need consider. Together they show a net gain of electrical energy of half the expression (4).

This assumes that the inductance can be changed without expending energy equal to that gained and this is not possible for an air-cored inductance. It is possible by using a ferromagnetic core, for example, by adjusting an air gap in the core, assuming the gap is positioned somewhere in the core not directly field-coupled with the magnetizing winding. Here the word 'field' (H as used in Fig. 15) has a meaning distinct from magnetic flux (B) which necessarily does couple the air gap with the magnetizing winding.

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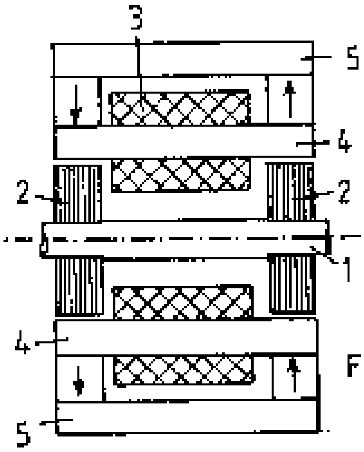

FIG. 1

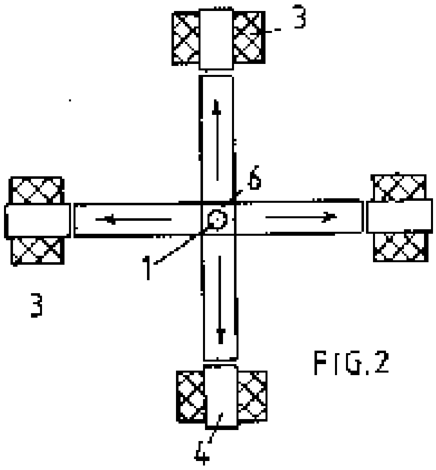

FIG. 2

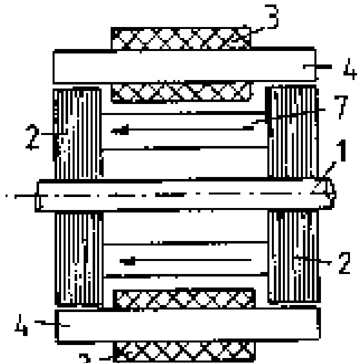

FIG. 3

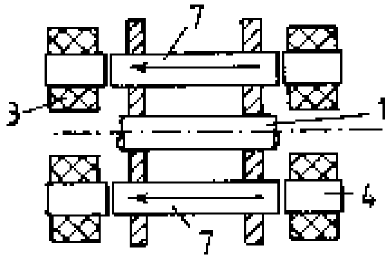

FIG. 4

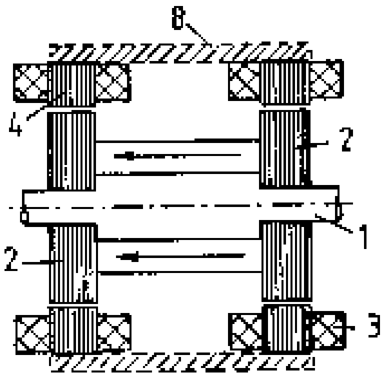

FIG. 5

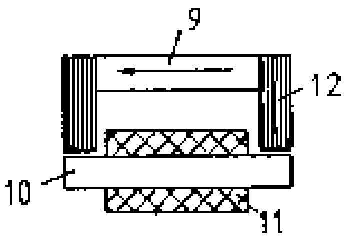

FIG. 6

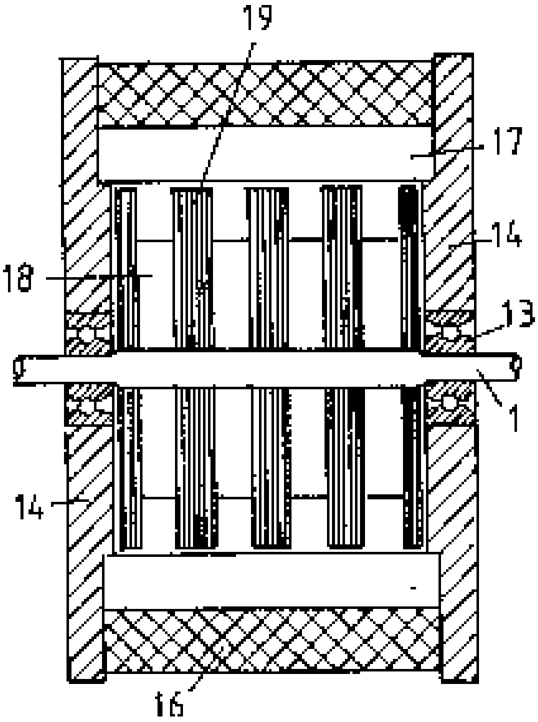

FIG. 7

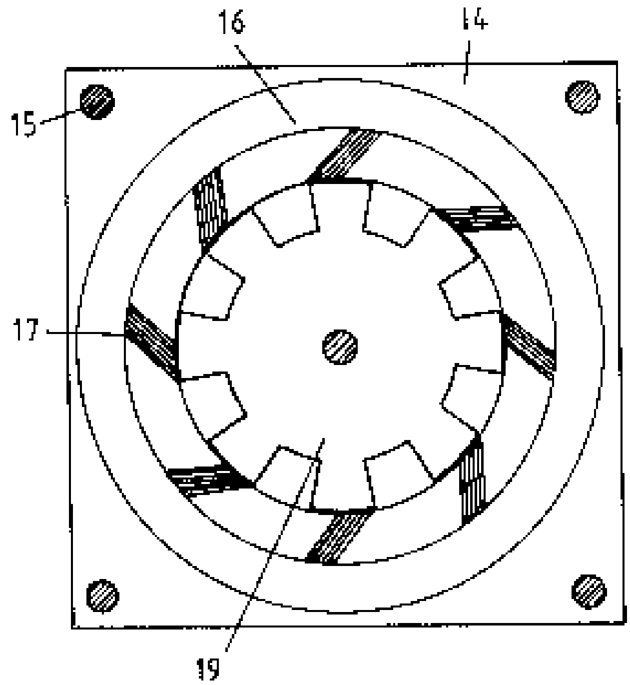

FIG. 8

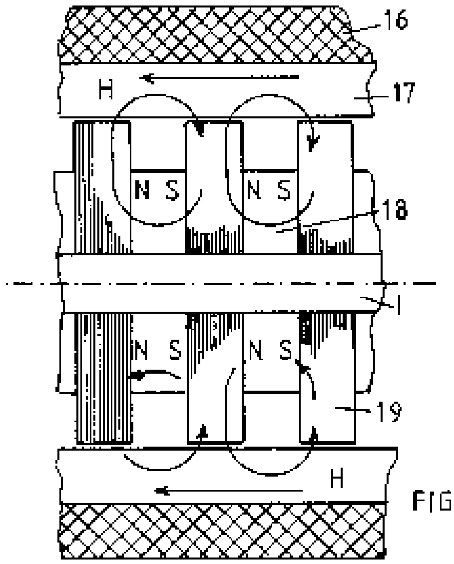

FIG.9

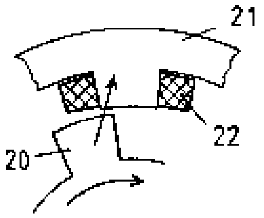

FIG.10

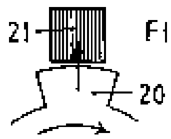

FIG.11

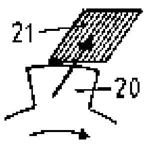

FIG.12

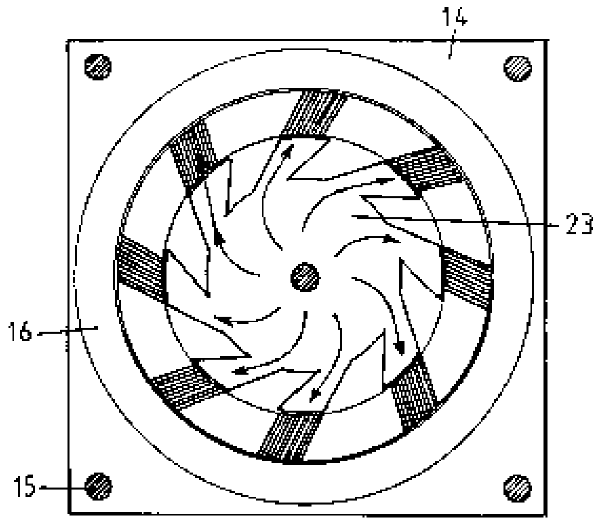

FIG.13

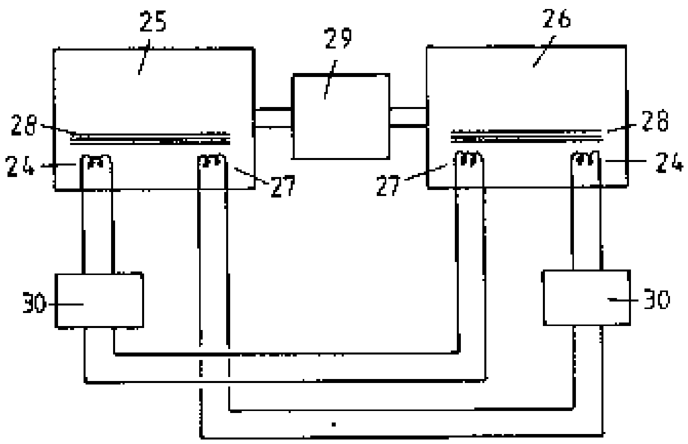

FIG.14

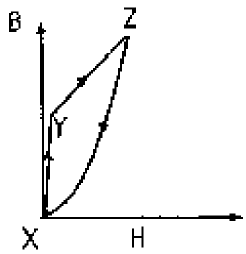

FIG.15

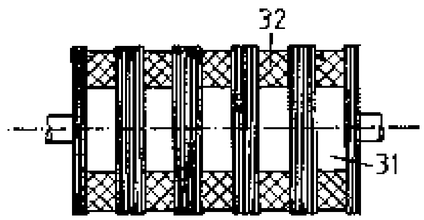

FIG.16

ENERGY SCIENCE REPORT NO. 8

POWER FROM SPACE: THE CORREA INVENTION

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Contents

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POWER FROM SPACE: THE CORREA INVENTION

Introduction

This Energy Science Report is one of a series concerned with new energy technology and the fundamental energy science that is involved. It is devoted exclusively to the research findings of Dr. Paulo Correa and Mrs. Alexandra Correa of Concord, Ontario, Canada and seeks to explain the fundamental physics underlying their remarkable experimental discovery.

The Correa technology pioneers one of the four routes now opening up and promising to give us access to a plentiful and abundant source of what is coming to be termed `free energy'. These all can contribute in their various ways to an energy future free from pollution, but all, at this time, trespass on forbidden territory, as judged by orthodox physicists and so are not attracting mainstream scientific interest. This leaves the field open for exploration and exploitation by the few who do have the needed technical competence, the inspiration and an independence of spirit.

The four avenues can be classified as (1) cold fusion, (2) ferromagnetism (3) vacuum spin and (4) electrodynamics. Each involves a mysterious input source of excess energy and each is destined to impact the world of technology in the near future.

It is debatable at this time whether events will confirm true nuclear 'cold fusion' as the source of heat in the well publicized pioneer work of Fleischmann and Pons. It may in fact be another manifestation of the 'vacuum spin' phenomenon, by creating in an aqueous electrolyte, or even in the cathode itself, conditions somewhat analogous to those prevailing in the Correa apparatus. Indeed, there seems to be no doubt that the Correa technology itself bridges two of the above 'excess energy' categories, electrodynamics and vacuum spin. The Correa method is probably the most advanced of these emerging new energy technologies, being fully reproducible, well researched with its test findings well documented in and protected by granted U.S. patents. It already allows us to tap energy from space itself, or rather the vacuum field activity that fills space, and in contrast with the alternative methods it offers what may prove to be a mobile light-weight power source compared with the heavy apparatus needed where magnets and rotating machinery are involved. Unlike 'cold fusion' which generates low grade heat output, the Correa technology generates electricity at power voltage levels.

The physics involved in understanding the source of energy in the Correa discharge tube is as basic as that required to understand the energy source which sets up the force of gravity. Both are seated in an electrodynamic action involving, in the main, heavy ions and, indeed, the electrodynamics of the interactions between heavy ions are not well understood by scientists. This is why they have failed to solve the mysteries of gravitation and the problem of field unification and why they have missed seeing the way forward to the new energy technology which we are about to discuss in this Report.

Below we will come to describe the operating principles of the Correa invention and the action by which energy is extracted from the aether. The reader who is impatient and curious to learn some details about the technology may wish to jump ahead to read the section between pp. 6 and 8 and then from p. 17 before coming back to read what immediately follows. The sceptical scientist who does not expect to believe what is evidently being claimed will be served best by following the discourse as it now develops.

Preliminary Remarks

Having just stated that "the electrodynamics of the interactions between heavy ions are not well understood by scientists" I see it as important to justify this statement before I venture to criticize other aspects of basic physical theory relevant to the new energy field. I will simply quote a few passages from the published specification of British patent application GB 2,002,953 which I, as inventor, applied for in 1978. The title of the patent application was 'Ion accelerators and energy transfer processes'. Textbook doctrine on the subject has not progressed since that time.

"Electrical engineering has developed using the simplest formula (for electrodynamic interaction between electric charges in motion) and few today would concede that there is any question about the universal validity of this formula, the so-called Lorentz formula. More informed teachers of electrical engineering have kept the problem in mind and express caution. Professor E. B. Moullin, who was President of the Institution of Electrical Engineers and Professor of Electrical Engineering at Cambridge University at a time when the applicant was engaged on Ph.D. research in electromagnetism (1950-1953), wrote in the 1955 edition of his 'Principles of Electromagnetism':

'It is useless to speculate about the effects of electricity moving in a particular piece of circuit until we have discovered further laws of electromagnetism'

This appears at page 26 of this Oxford University Press publication."

"In a book by A. Von Engel entitled 'Ionized Gases', 1965 Edition also by Oxford University Press, there is the statement at page 285:

'There is no final answer to the question of whether the primary electrons find in the plasma an artifice which without extracting too much energy is able to transform the more or less uniform electron energy into an energy distribution which is needed to satisfy ion production in the gas. In fact it has been suggested, as a result of certain probe measurements, that there is a strong positive space charge accumulated in front of the cathode, so intense that the space potential is considerably higher than the discharge voltage and at least higher than the lowest excitation potential. How this space charge develops and how electrons have random energies sufficient to overcome the retardation in the negative field between the space charge and the anode is still an open question.'

Earlier on page 273 he wrote:

'One of the most puzzling problems of the arc discharge is the functioning of the cathode of the cold arc. Cathodes of Cu, Ag, liquid Hg, and many other metals are examples of this type. It can be stated from the very outset that no final solution of this problem has yet been found.'

Berneryd et al (Direct Current, vol. 6, 1961, pp. 81-85) studied instabilities of discharges and found positive ions to have energies very much higher than suggested by theory. Benford et al (New Scientist, vol. 56, 1972, pp. 514-516), writing about electron beams in relation to fusion, declared that a 1.3 MeV electron system accelerated gas ions to energies as high as 20 MeV. They said that the origin of the fields was a subject of speculation. Stock (Journal of Physics D, vol. 6, 1973, p. 988) found that ionization current calculated from electron energies were up to one thousand times smaller than those observed."

Now, in quoting the above I have added the underlining to the marked passages to emphasize my point that the scientific `experts' in the field do not understand the reason for these energy anomalies produced by electrical discharges through ionized gas. The scenario giving these problems is one where the discharge involves a predominant presence of heavy ions rather than the mere arc discharge of electrons freed as by thermionic emission. It applies to current in what are termed 'cold cathode' discharge tubes.

The passages quoted above should be kept in mind when reading about the technological breakthrough disclosed by the Correa inventions. The phenomenon involved has been turned to account by generating electrical power output far in excess of the input power used and so it is no longer a question of scientists declaring, as they do regularly, that they understand so much about the laws of thermodynamics that they can deny this possibility without even considering the evidence. They do not understand their own experimental findings of clear record in this particular technical field and so are in no position to say that excess power generation is impossible by virtue of a 'law' prescribed by past 'authority' in ignorance of the experimental facts just quoted.

We have here to confront the reality of this situation, namely that energy from a mystery source can be harnessed technologically, and this Report aims to explain this as well as pointing to the source of that energy and showing where accepted physics stands in need of correction.

To appreciate in full measure of what this Report is about it is recommended that the reader should procure copies of the three U.S. Patents granted to Dr. Paulo N. Correa and Mrs. Alexandra N. Correa: U.S. Patent No. 5,416,391 (issued May 16, 1995), U.S. Patent No. 5,449,989 (issued September 12, 1995) and U.S. Patent No. 5,502,354 (issued March 26, 1996). The disclosure in the specifications contains experimental facts presented in a form which amounts to an academic dissertation or degree thesis and, as I see it, the disclosure in these patents cannot now be ignored owing to their clear showing that we already have access to the hidden energy source which one can presume powered the creation of the universe.

I can also interject here a note added since the main body of this text was written to advise that a full description of the Correa project together with a copy of the specification of U.S. Patent 5,416,391 has been published in the Vol. 2, No. 7, 1996 issue of Infinitie Energy (ISSN 1081-6372), Editor-in-Chief and Publisher Eugene F. Mallove Sc.D. and that publication warrants the fullest attention.

Still as part of these preliminary remarks I further draw attention to the fact that my paper: 'The Law of Electrodynamics', appeared 27 years ago in the Journal of the Franklin Institute, <u>287</u>, 171-183 (1969). It explained how one could justify, by simple dynamic analysis based on empirical data, the fact that in an electrical discharge through heavy ions there is an axial electrodynamic force acting on the ions that is $(M/m)i^2$, where M/m is the ratio of ion mass to electron mass and i is the current carried by the heavy ions.

I stated that many authors had found anomalous cathode reaction forces in discharge studies and quoted E. Kobel, Physical Review, 36, p.1636 (1930) as measuring that anomalous cathode reaction force and showing that it was proportional to the square of current and far greater than any value one could compute from a pinch pressure in the discharge filament.

Later, in 1977, my paper: 'Electrodynamic Anomalies in Arc Discharge Phenomena', appeared in IEEE Transactions of Plasma Science, PS-5, 159-163 (1977). Here I had in mind the subject of my patent application as referenced above. See the quoted text on its p. 161 and the last five lines on p. 163, where the action was deemed to accelerate ions into the cathode as a means for generating heat. I had by then become aware of the possibility that we could tap vacuum field energy and generate heat anomalously by harnessing the electrodynamic forces set up in an axial discharge involving heavy ions. However, my circumstances did not allow me to take the proposition forward experimentally. The invention, the subject of that patent, was aimed at tapping the zero-point field energy to produce 'excess energy' heat by the electrodynamic ion discharge action which sustains a positive space charge adjacent the cathode. In contrast, as we shall see below, the Correa invention is able to produce electrical power directly by discharging that positive charge in pulses drawn through a secondary output circuit. The energy source in both cases is the same, as is the principle for setting up the positively ionized plasma and holding it transiently stable.

By 1985 a new kind of discharge anomaly had been reported as a result of passing very high current through water. I showed a simple derivation of my version of the law of electrodynamics and commented on this anomaly in my paper: 'A New Perspective on the Law of Electrodynamics', Physics Letters, 111A, 22-24 (1985). This referred to the incomprehensible enormous explosive effects found from pulsed ion discharges in pure water and pointed again to the reason advocated earlier, namely that scaling factor of m/m.

Separately in my paper: 'Anomalous Electrodynamic Explosions in Liquids', IEEE Transactions on Plasma Science, PS-14, 282-285 (1986), I presented a more detailed analysis of the incredibly high speed at which ions are driven into an electrode, in defiance of known physics. In the Correa invention to be described there is a slowing down of these fast ions by causing them to transfer energy into the build-up of electric charge in the abnormal glow discharge in front of the cathode, which energy can be drawn off as output electrical power, rather than as heat.

To complete this preliminary account I refer also to my paper: 'The Thunderball - An Electrostatic Phenomenon', presented at the 'Electrostatics 1983' conference held at Oxford University, and documented in Inst. Phys. Conf. Series No. 66, at pp. 179-184.

As can be seen from the data presented in the third Correa patent referenced above, the operation of the Correa discharge tubes at low pulse frequency indicates that energy in excess of 1,000 joules can be stored in the plasma of each discharge pulse. This implies an enormous capacitance and voltage gradients that should be far in excess of those actually prevailing. Indeed, for such energy to be contained as electric charge energy in a plasma confined within the Correa tube one would expect voltage gradients expressed in billions of V/m, unless some compensating reaction suppresses that field.

This energy of 1,000 J in a volume of plasma of the cubic cm. order is an energy density of some 10^9 J/m^3, which is of the same order as that known to exist in thunderballs produced by lightning discharges. The Correa invention therefore, in a sense, mimics the action of lightning discharges in compacting energy into plasma balls which we see as the thunderball anomalies of atmospheric electricity.

The subject paper, which will be reproduced later in this Report as Appendix II, explained how radial electric displacement, as opposed to the transverse displacement we know from Clerk Maxwell's theory, can induce `vacuum spin' or `aether rotation' which permits such energy densities to be stored in an electrically quasi-stable manner at low voltage gradients.

The Correa technology, it will be suggested, does therefore rely on `vacuum spin' for its storage function, whilst setting up the positive plasma in the discharge tube by electro-dynamic confinement in an axial sense, as opposed to the electromagnetic `pinch' sense that features in fusion reactor research. However, though it succeeds in sustaining confinement for the pulse period, the Correa device it is not powered by a fusion process. Indeed, since this author presented the subject paper at the conference at Oxford University he has become aware of independent research in three countries on electromagnetic machines which overheat owing to the low voltages and very high current involved, but which nevertheless draw energy anomalously from the `aether' by setting up radial electric fields in a conductive disc spinning in a magnetic field. The Correa technology taps this same `vacuum spin' source of energy and the subject paper published by the Institute of Physics in U.K. points to the aether phenomenon involved.

It is of interest also to mention that geophysicists and cosmologists have not been able to explain the magnetism of the Earth or the Sun in terms of unipolar charge rotating with that body, even though a connection was recognized which gave basis to the Schuster-Wilson hypothesis. This was not just because they discovered that the magnetic field reverses periodically but because the charge needed would develop those same electric field gradients of billions of V/m that are somehow avoided in the Correa tube. This really is an interesting subject of research, all connected with the evident fact that charge displacement in the aether cancels that electric field but does not cancel the magnetic field! I therefore see the Correa research as having important implications for the interpretation of several phenomena in cosmology. See also Appendix I, where I explain why the alleged self-excited dynamo theory for the geomagnetic field is quite untenable.

I refer in this connection also to 'Space, Energy and Creation', my privately published paper, for use on the occasion of a lecture delivered at the University of Cardiff in 1977. Copies are available from Sabberton Publications, P.O. Box 35, Southampton SO16 7RB, England, the publishing source of this Report. This was a lecture delivered by the author as an invited speaker addressing students in the Physics Department at that university. It dealt with the subject of anomalous electrodynamic acceleration of ions in plasma discharges and explained why this was relevant to the induction of 'vacuum spin' which was intimately linked with the energy and momentum aspects of creation of stars and planets, as well as thunderball and tornado phenomena. The basic physics of 'vacuum spin' are there presented in a concise way for easy assimilation by students. The lecture paper also explains how 'vacuum spin' can stabilize the axial discharge and pointed to some surprising experimental work by Vonnegut on that subject. Later in a note at the end of this report text from the last page of that lecture paper is reproduced for the reader's interest.

It is also noted that an important updated section of the theoretical analysis in that paper has recently been incorporated in my new book 'Aether Science Papers', now available from the publishers of this Report.

It will be evident from this that the now-emerging technology for generating power from space energy is destined eventually to upset the physics world and particularly cosmologists. Instead of exercising their criticism to block the breakthrough developments on the new energy front, they need instead to look to their own problems, as now exposed, because they have invested so much time in futile theoretical pursuits that now come under attack.

The Correa Project

Essentially the core element of the Correa apparatus is an electrical discharge tube containing a rarefied gas. It is a tube having a special construction but which can be manufactured in much the same way as a fluorescent lamp. Its objective, when used in a special circuit, is not the emission of light but rather the generation of electrical power in excess of the input power needed for its operation.

This seemingly impossible feat is proved by providing a battery of electric d.c. storage cells large enough to deliver a high enough voltage to trigger the discharge which in turn feeds output to a separate battery of d.c. storage cells which store the electrical energy generated. Since the generation of electricity is the objective there can be no better way of proving that, over a period of time, the net energy output exceeds by far the net energy input. Measurements of instantaneous power and the energy transients can reassure an investigator that there is a power gain but sustained performance conditions are essential for a definitive proof. Indeed, this will be better understood when the principle of operation is explained. The pulse of energy input is ahead of the output pulse in time-phasing, owing to the intervening opening of the gate, otherwise described as the radial electric field, which allows entry of energy from the quantum activity of the vacuum field. The battery tests, repeated during a succession of charge and discharge cycles, using two banks of cells, one charging on output power as the other discharges input power, provide indisputable evidence of a substantial gain in power. This gives a verifiable accounting of an energy inflow that can be put to good use while enough energy is returned to sustain operation of the system. Though a cumbersome part of the overall apparatus in comparison with the small and light-weight tube, which is the heart of the system, such a battery of conventional electric storage cells satisfies a research need, but ultimately, since power feedback should make the device self sustaining, one can foresee a compact product not requiring these cells and which operates to deliver electric power, as if from nowhere.

Now, our world of technology is not really ready to accept such a claim and no amount of technical comment here concerning the specific structure of the Correa apparatus can sway the minds of a professionally qualified engineering and scientific community, well indoctrinated by their teaching and by their experience to require conformity with the well established laws of thermodynamics.

It goes without saying that one simply cannot get energy from nowhere and so there are only two issues to confront. Firstly, does the Correa apparatus really deliver what is claimed? That is a question of fact which needs the testimony of those witnessing demonstrations and able to judge what they see. Secondly, given that the Correa invention does deliver excess power, how are we to come to terms with the need to understand the true source of that excess energy? To be sure, the answer is not to be found in physics textbooks and such textbooks are not noted for disclosing unsolved mysteries. Yes, they do tell us that there is still a mystery concerning the force of gravity, which we all know should somehow find unification with the theory of electromagnetism. However, gravity is something everyone of us contends with every waking hour of our lives. It weighs upon us physically, if not mentally, but there are forces and actions seated in the energy background that are revealed only in a spurious way or come fleetingly from unusual experimental conditions. These are not recorded in our physics textbooks, because those who write such books write only about topics they understand and can explain by accepted theory.

This, therefore, is why this Report is being written. We need to understand that source sufficiently to be able to do onward design work and develop the Correa invention. We need to understand it in order to reassure those who manage and invest in new energy technology, because there has to be scientific certainty underpinning any R & D venture that is not funded as a mere academic speculation. The latter is the province of the funding resource assigned to university and to government research institutions and those responsible for such funding are very careful indeed in ensuring they avoid controversy by not investing in projects which their peers may ridicule.

The Correa project is now the trigger for taking forward the theme of some earlier research findings, notably those of Geoffrey Spence, a researcher in U.K. who has demonstrated an operable `over-unity-performing' discharge device to sponsoring interests, but whose device was presumably impractical in requiring heavy magnets to guide the discharge in a kind of cyclotron spiral orbit. There is also the research of Professor Chernetskii in Russia and possibly even the work of Tesla to keep in mind, but it is the research of Dr. Paulo Correa and Alexandra Correa that has been disclosed in sufficient detail to warrant attention at this time in view of the immediate prospect it offers for rapid technological development. Later in this Report such background activity will be reviewed because the several earlier findings lend support to the Correa project, but the immediately following sections of this Report will be devoted to presenting a scientific case concerning the true source of the excess energy generated by these plasma discharge devices.

To conclude this introduction to the Correa project, it is noted, by way of a summary, that the apparatus involves a cold-cathode electric discharge with current flow between anode and cathode producing an axially-directed electrodynamic compression force which squeezes positive ions into a ball of plasma trapped against the cathode. The electron current from the cathode delivers the negative electrons at a rate which is overwhelmed by the ion discharge pulse and the powerful ball of positively charged plasma can build up enormous radial electric field gradients which induce equally enormous cancelling electric field gradients owing to a spin reaction set up in the vacuum medium.

The vacuum reacts by propagating waves when responding to transverse electric fields around a radio antenna. However, whereas the latter promote such wave propagation according to Maxwell's theory, the vacuum spin provides a contained quasi-stable field condition which draws energy from the phase-lock of the quantum spin states of the enveloping aether field. The analogy we see in nature is the creation of the thunderball which research findings show to have electrical energy densities of the order of 10^9 J/m^3 stored in their plasma forms. Some of the pulses in the Correa experiments operated at low pulse frequencies are found to contain energy of one thousand joules or more. With a 2 cm electrode spacing defining a plasma as having a volume of cubic cm. order, this gives 10^9 J/m^3 as an energy density, clearly of the same order as is reported from thunderball investigations. It has, incidentally, been reported that a thunderball was once seen to enter a barrel of water and dissipate itself leaving the water at an elevated temperature. From the data collected its energy density was estimated.

However, we can now see from the Correa research findings that the trapped energy can be deployed into electrical power output and so measured as it is shed by an output pulse and then more energy can be regenerated repeatedly at the pulse frequency. The Correa data indicate an inverse relationship between the energy output per pulse and the pulse frequency, given a sustained input voltage and input current. Therefore, much of the Correa research has involved examining different electrode configurations, gas fillings and pressures, as well as different electrode materials and operating conditions, all with the object of determining which give the best power gain. Such data is presented in the Correa patents and the technical description which will be given later in this Report is directed not to the specific technology options, but rather to the disclosure of what is relevant to understanding what governs the access to the vacuum energy source.

The Root of the Problem

It is basic to the teaching of Newtonian mechanics that momentum is conserved when energy transfers between particles in motion. Yet Newton's laws were formulated before the electrodynamic action between charged bodies had been discovered and before it was known that all matter is composed of fundamental particles which are electrically charged. Scientists today declare that a substantial portion of the matter forming material bodies on Earth is really attributable to `neutrons', which supposedly have no electrical charge. However, the neutron exhibits a magnetic moment that betrays the presence of electrical charge in its composition and all we really know about the properties of a neutron apply to something that only exists as an unstable particle having a mean lifetime of the order of 15 minutes. It is mere hypothesis to suggest that neutrons exist alongside protons in atomic nuclei and so exist as a major component of matter. In fact, beta particles (electrons and positrons) have a stronger claim to a presence in atomic nuclei and these can serve with protons to account for all the properties of the atomic nucleus.

Essentially, the point made here is that Newton devised his laws without taking proper account of the electrodynamics of interacting charges and the fact that all matter, even matter we see as electrically neutral, comprises nothing other than such charged particles.

In the electric discharges of the Correa apparatus we have a scenario where heavy atomic ions, rather than mere electrons, are also the charge carriers. A rarefied gas, such as argon, in the discharge tube is ionised and the heavy positive ions are pulled one way by an electric field, whilst the electrons go the other way. The current flow is that of electrons in one part of a closed circuit but at least partially that of heavy ions in another part of the same closed circuit. To understand the physics involved, we need to know whether Newtonian principles hold valid in such a case and whether even standard electrodynamic principles hold valid having regard to the fact that their empirical basis is not the testing of current circuits where heavy ions flow in one circuit segment and electrons flow in another circuit segment.

There are undisputed and unexplained anomalies of record in the science literature concerning the very substantial cathode reaction forces set up in what has come to be termed a cold cathode discharge. These have been mentioned already but the Correa patent specifications reference several other sources and the data provided in the Correa patents include measurements of such forces in the apparatus tested by Dr. Correa.

In the cold cathode discharge thermionic emission of electrons from the cathode is avoided and an electric potential set up between anode and cathode is relied upon to trigger the discharge. Ostensibly, it seems that there is a force acting on the cathode with no counterpart force acting on the anode

The root of our problem then has two offshoots, one being the Newtonian origin of the principle of conservation of momentum and the other being a feature of accepted electrodynamic law that says that interaction forces act on charge at right angles to their motion.

There is contradiction of principle here and virtually all physics textbooks contrive to avoid discussion on this enigmatic problem. If an electrodynamic force acts on charge at right angles to its motion it cannot do any work. This means that there can be no exchange of energy with the field background owing to that interaction and other than the energy deployments that arise from electrostatic potential. It means that physics theory obscures the process of electromagnetic induction by relying on an incompatible mixture of empirical formulations which serve us well in engineering design, provided we do not trespass into territory outside the scope of the empirical protocol relevant to our problem. The Correa invention lies in that outside territory because the current circuit through the discharge tube is not one involving a closed all-electron flow such as was used in one or other of the interacting circuits that gave basis for the accepted empirical data.

It is well accepted that if there can be any breach of the principle of conservation of momentum then there is scope for gaining, or losing energy, anomalously, in seeming contradiction with the principle of conservation of energy. However, one needs to be careful to be sure that one is looking at a total system. If the field background contains energy, even the energy stored by magnetic induction, it must participate in the energy conservation process and that field background is not something we can isolate as belonging exclusively to a particular charged particle or a particular current circuit. There is enough energy activity in the vacuum (the aether) owing to its intrinsic charge motion that underlies the quantum control of atomic electrons to assure the buffer needed to keep faith with the law of energy conservation, whatever anomalous forces are developed in any apparatus we can build.

In the university teaching of dynamics as evidenced by a textbook by an author in Cambridge, the seat of learning attended by Isaac Newton, and published by Cambridge University Press, the principle of conservation of momentum is deduced by the preliminary assumption that <u>internal actions and reactions between particles are equal and opposite in pairs</u>. It is as if each and every paired combination of particles interact with one another without any dependence upon anything else. This is manifestly not the case for the electrodynamic interaction because electrodynamics has a dependence upon motion relative to a frame of electromagnetic reference, something totally absent from Newtonian mechanics.

When Einstein tried to bring conformity between inertial and electromagnetic effects his transformations of the space and time dimensions led him to the Lorentz force law, which prescribes that the interaction force between two electric charges in motion is not directed between the two charges as internal actions and reactions between particles that are equal and opposite in pairs. This condition is only met where the two charges travel at the same speed side-by-side along parallel paths and this clearly is not the case for the discharge current through the tubes used in the Correa apparatus. An electrical discharge likes to form a kind of filamentary current with charge travelling in line, each ion or electron following behind its like form but the negatively charged electrons dodging around the heavy ions or even replacing electrons in the atomic ion and neutralizing its state.

It follows, therefore, that, whether one relies on the principles of Newton or Einstein, or both, these being the accepted doctrines, the resulting theory will have no certain bearing on the practical situation encountered by the Correa research.

This means that, with the vast majority of scientists all conforming with the restrictive disciplines of physics that confine knowledge to conventional technology, those few who venture into the new energy world with an open mind confront some very significant opportunities.

So, first and foremost, we must be prepared, when considering certain very special situations in electrodynamics, to go against the teachings of our profession and pay attention to the messages in the experimental findings disclosed by the Dr. Paulo Correa and Mrs. Alexandra Correa.

The earlier messages about anomalous electrodynamics which this author found in the many scientific papers of record were sufficient reason for investigating where the errors had crept into our theories. The author discovered how energy is stored by electromagnetic inductance within a metal body and how it is later retrieved from within that conductive material. This provided the onward inspiration for questioning how the electrodynamic interaction between two electric charges in motion is affected if they have the same charge magnitude but different mass. There was, in the metal, a magnetic field reaction which was not properly factored into the diamagnetic state as analyzed in conventional theory.

It was in fact ignored, because energy was not the focus of attention in the use of the Lorentz field formulation, but if its energy role had been duly noted and incorporated in the theory of the steady field situation, it would have given explanation of the factor-of-2 anomaly that became known as the g-factor. This is a phenomenon of charge in orbital motion, but theoretical physicists sought to solve the problem by inventing what they called 'spin', even though a charge which `spins' is not moving its centre of charge and so its field is not changed by a changing spin condition. There are angular momentum issues involved here in relation to magnetic moments and the g-factor was measured in solid metal rods by the ratio of these two quantities. The essential step needed to explain that factor-of-2 in terms of orbital reaction of electron motion required taking the argument from within the metal to the external vacuum field. There has to be in the aether the same basic g-factor reaction as applies within a metal conductor and this clearly points to the g-factor reaction being at the heart of the field energy storage by magnetic induction. The aether and its angular momentum properties as well the thermodynamic properties associated with the activity of its charge composition cannot just be brushed out of sight by a flourish of the mathematician's pen.

I interject here the comment that I am not unaware of the anomalous g-factor account afforded by Q.E.D., the theory of quantum electrodynamics. This is regarded as being the only theory of relevance on the subject of electron dynamics, because it can explain the g/2 factor of the electron as being 1.001159652. It involves copious mathematical exercises that are far too extensive to be fully worked through and documented to that precision in any textbook. Indeed, as the successive advances in precision measurement crept to this quoted value, the theoretical physicist was always found to be lagging behind in trying to work through to the next iteration in the calculation. If, on the other hand, the reader would like to see a derivation of the factor 1.001159652200 fully presented in only three printed pages, the reference is the Lett. Nuovo Cimento, **32**, 114-116 (1981), this being a well known English language periodical published by the Italian Institute of Physics which was noted for its rapid publication of new scientific contributions.

A later very relevant reference on the same theme, but more closely connected with the energy source we are concerned with in the Correa invention, is my paper entitled 'Fundamental constants derived from two-dimensional harmonic oscillations in an electrically structured vacuum', which appeared in Speculations in Science and Technology, **9**, 315-323 (1986). This paper, as the title implies, referred to synchronizing constraints as between aether charge in its quantum activity as part of the vacuum medium. The analysis, which is quite brief, is also reproduced in my new book 'Aether Science Papers'.

As energy is 'lost', as by thermal radiation into outer space, it is absorbed into the quantum activity of a two-dimensional oscillating system. There is equipartition of energy as between charge displacement and kinetic energy. Now, if this energy system of the field medium is caused to move in one region relative to another region of that same medium, this invokes that constraining action because the aether charge is kept in synchronized motion at a universal rhythm, the photon frequency at which the surplus energy can materialize as electron pairs or heavy electron pairs (the latter being otherwise known as `muons').

If, on the other hand, one interferes with this activity by producing a positively charged cluster of ions, this sets up a radial electric field and forces radial charge displacement in that aether medium. This would upset the timing as each displaced element of aether charge in its quantum orbit moves faster about the centre of the orbit in one half cycle and then slower in the next half cycle. However, the synchronizing power coupled to all that energy in the aether resists that and assures a perfect phase-lock with the result that, to hold smoothly in that state, the whole system of aether charge has to rotate about the centre of that radial electric field. The glow discharge in the Correa tube becomes the seat of what this author has called 'vacuum spin'. Such a spin condition derives its power by drawing on energy from the universal field system enveloping the glow discharge. In other words, the action promotes the inflow of aether energy from outer space.

The key to all this is that synchronizing influence or phase-lock that is at the very heart of quantum theory, this being a theory that represents the properties of the harmonic oscillator and is governing at the microcosmic level where individual electron motions are coupled to the action quantum. Planck's constant is, in fact, determined by the structural form of the array of aether charge which constitutes the elusive, but real, medium we call the 'vacuum'.

This link between the vacuum medium or vacuum energy field and electrons is crucial to our problem of tapping energy from what we see as empty space, but to get things started we need to set up that positive core charge. Here, rather than just using electric field effects to pull electrons out faster than the positive ions can make their way to the cathode of a discharge tube, we find that the action can be augmented electrodynamically as a function of current discharge.

The heavier mass of the positive ions helps enormously in making them more sluggish, but it needs real force to compress those ions into a positive ball of plasma and here the anomalous electrodynamic interaction forces along the current axis become effective.

It is a curious fact of accepted physics that the interaction forces between two charges in motion are assumed not to have any dependence upon the mass of the particles transporting those charges. We use Newtonian mechanics to argue that momentum has to be conserved, momentum depending upon mass, but somehow eliminate mass from the electrodynamic problem. Why then should we be surprised to hear that when experiments are performed involving charge interactions between heavy particles and light particles, atomic or molecular ions and electrons, we encounter energy and momentum anomalies?

The very substantial anomalous cathode reaction forces observed in reported experiments indicate that a powerful force is exerted on the cathode with no counterpart reaction on the anode. They indicate, by theory alone, that energy is being shed by the inductive system in excess of that supplied when the discharges through the device are pulsed. However, the Correa research gives us the experimental proof.

As an aside here, it is mentioned that the energy source is much the same as that already discussed in Report No. 1 in this series, where the author has pursued his interest in ferromagnetism to show that the energy set up inductively in a gap between two magnetic poles can exceed the energy input to a magnetizing winding. The energy source in the latter case is the quantum priming of the electron motion in the atoms in the ferromagnet. However, in the Correa situation, access to that energy is more directly associated with the motion of the underlying electromagnetic frame of reference. In a sense, the quantum world involves microscopic orbital motion of a charge system constituting the vacuum medium at a very high frequency, the Compton electron frequency, whereas superimposed on this there is a low frequency rotation of a very extensive electromagnetic system. Both of these motions feed the anomalous energy to the Correa apparatus.

The Earth would have to stop rotating and to arrest its translational motion with the local galaxy before the energy resource harnessed by the electrodynamic action in the Correa apparatus can be exhausted. However, the energy of the quantum activity at that Compton frequency will never be exhausted, simply because the rest condition of the vacuum medium is one of negative electric potential and the absolute ground state cannot go sub-zero anywhere. Then, because energy is conserved overall, we must have activity, meaning motion of charge, which keeps the charge displaced to positions of positive finite potential in which its motion stores additional energy, the fluctuations of which give life to the universe.

Now, physicists, except at least for this author who is also professionally qualified as a physicist, are locked into the belief that momentum as well as angular momentum are conserved, meaning that an isolated system cannot by its internal interactions develop any angular momentum or linear momentum. For this reason, so far as they are at all interested in the problem, they have been very perplexed by the fact that the solar system has angular momentum that is not zero. Indeed, the Sun and the planets all rotate in the same sense and so the Sun must have been created in a rotating state before it shed matter to form the planets. By standard physical theory this is not possible but it is nevertheless an indisputable fact. How then have cosmologists come to terms with this problem? It is all too easy to say that the angular momentum was there, shared by matter in its galactic circulation, before that matter condensed to form the Sun, but that says nothing about how it all started. One hypothesis was that another star grazed past the Sun to set it in rotation and in the process disperse the matter that condensed to form the planets. Yet when the chance of this occurring was estimated it was found so improbable that of all the stellar systems in the universe the solar system would possibly be unique as the one having planets. Another hypothesis was that all the stars were created together in a Big Bang and were so close at the time that they could exchange angular momentum and so move outwards in a spinning state.

What is not seen as possible by accepted physics teaching is the acquisition of angular momentum and linear momentum as energy was fed into the nucleating star to create it. Energy transfer from 'somewhere' surely implies that momentum and angular momentum can flow in from that same 'somewhere'. So it seems very logical for some of us to be open to the possibility that somehow Nature has a way of breaking faith with what we have adopted as the laws of physics, because, as surely as the Sun was created, there is a physical process that is non compliant with our modern physics teaching.

The author submits that it was the initial onset of gravitation that triggered creation and caused the dispersed electric charges in the universe to condense to form stars, in much the same way as ferromagnetism appears in iron as it cools through its Curie temperature. This brings into account the anomalous transfer of energy and momentum to matter. The heavy protons would converge to form the stellar nucleus before the lighter-mass electrons could come together to neutralize the star so formed. The electrodynamic interactions between electrons and heavy ions during this primordial period would set up the linear momentum of the star and the transient radial electric field in the conductive plasma would develop the vacuum spin which imparts the angular momentum.

The technological discovery evident from the Correa research is therefore giving direct evidence of the anomalous electrodynamic force interactions between heavy ions and electrons, which go hand in hand with anomalous momentum and anomalous energy. The physics involved in such research is much closer to the subject of energy powering the Sun than is the physics of nuclear fusion.

Readers who decide to look up their book references on Newton's laws should consider the right way and the wrong way of presenting those laws in the light of our knowledge of electrodynamics. Newton himself, if he were alive today, would surely be prepared to restyle his argument if, by doing so, he could adapt the laws to extend their cover beyond macroscopic mechanics and embrace the microscopic dynamics of electric particle interactions.

Firstly, note that it is Newton's third law of motion that is in issue, the balance of action and reaction. Newton combined this law with the principle of conservation of energy and was able to deduce that two particles, not necessarily having the same mass, would emerge from a collision with their relative velocity reversed. In sharing their energy the velocities of the two particles have to adjust so as to assure that they separate from the collision with a relative velocity that is -1 times their relative velocity just before impact. This is known in mechanics as 'Newton's rule'.

Secondly, note that it is logical that if two conditions determine a third condition then that third condition taken with one of the two conditions can determine the other of the two conditions. If, therefore, Newton had taken his 'rule' to be his third law, especially as it is more easily demonstrated, as by propelling a metal ball into another at rest and observing that it transfers its motion to that other ball, then he would have got things the right way around. The new law would be a 'law of relative motion' and, taken together with the principle of energy conservation, one can then deduce that action and reaction follows 'as a rule'.

Thirdly, given this latter entry to the physics of electrodynamics, one can give support to the 'law of relative motion' because electric charge interactions are dependent upon relative position and so upon relative motion, but not dependent upon mechanical inertia.

Fourthly, however, we have a new scenario once electrodynamics get into the act, because whereas a pure mechanical system involves the summation of discrete collisions between pairs of constituent particles, which only see their own energies as involved at the instant of collision, the case is entirely different for the electrodynamic interaction. The reason is that there will invariably be numerous other electric particles in motion in the immediate locality of the colliding charges. The conserved energy is not exclusively that of a collision between a discrete pair of charges.

In the latter situation the derivation of the 'rule' that action and reaction are always equal will fail. Energy will always be conserved but one cannot in this case formulate the relevant energy exclusively in terms of the square of a relative velocity. In mathematics every square power of a quantity has two roots, one positive and one negative, which is why we see the relative velocity of two colliding balls reverse after their impact. It is all a question of mixing vector and scalar quantities. Energy is a scalar quantity but velocity is a vector. We can take numerous particles conforming with linear vector equations and add their individual contributions to determine the overall state of a combined system, but once we start changing those vectors by working out the square roots of component scalar energy quantities, without being able to exclude the external cross interactions between charges acting on the two in collision, we really are headed for trouble.

The well proven laws we have accepted for mechanics cannot be applied to practical situations where there is a dominant electrodynamic effect involving the interaction of electrons and heavy ions.

This rider has been added because Nature contrives to deceive us in a rather curious way when we apply the Newtonian philosophy to the electrodynamics of the closed circuital all-electron current flow. We find we can use the Lorentz force law which does not conform with Newton's law of action balancing and reaction and apply this to all the discrete elemental current circuit interactions to find in the end that they sum to give the balance needed to satisfy Newton's law for the circuit as a whole.

This is a quirk of the mathematics of this situation combined with the fact that the Lorentz formulation prescribes force on charge in motion acting at right angles to that motion. A force so directed can do no work and so the summation of all the individual interactions will result in no work being done, meaning that the circuit carrying current is not giving or drawing power from its field environment. It can therefore not assert force on that environment and so internally its action overall must balance its reaction. Yet, as soon as we change that current, there is inductive energy exchange with that field environment, which means that somehow the forces on the electrons moving through that circuit are no longer at right angles to charge motion. Electric fields have been set up by induction effects and the moment these are introduced one is bringing into play empirical rules, all of which have been discovered by experiments where at least one of the interacting current sources is all-electron closed circuit flow or its equivalent.

Once one departs from the latter constraint one enters a realm needing new physics tailored to the problem of electrodynamic interaction between heavy ions and electrons, because the mass of the charge carrier has to play a role in the dynamics of force-producing situations. In fact, analysis shows that it is the mass ratio between two interacting charge carriers that is the dominant consideration and it so happens that in the all-electron current flow circuit this ratio is unity, thereby disguising its true relevance in an electrodynamic formulation. Once that ratio is measured in thousands as is the case the heavy ion to electron mass ratio, then we enter a whole new scenario, the one into which the Correa research has ventured.

In summary, therefore, the root of the problem of understanding why the Correa apparatus actually works is intermeshed with the basic principles of Newtonian mechanics and their inadequacy in coping with the conditions peculiar to the electrodynamic interaction. To adjust our theories to the facts of the Correa experiments and at the same time bring conformity and unification into the connection between Newtonian mechanics, gravitation and electromagnetism, we need to correct the empirical law of electro-dynamics so that it embraces the interaction between heavy ions and electrons. There has to be a mass term in the law of electrodynamics.

This author derived the inter-electron interaction law nearly 40 years ago and the version with the mass ratio term some 30 years ago but it was not until 1969 that its derivation featured in a scientific paper as published by the Journal of the Franklin Institute. This was referenced in the earlier introduction. The law thus formulated in no way conflicts with the accepted Lorentz law when applied to the same problems, those involving closed circuital electron current. It indicates powerful anomalous forces on heavy ions flowing between electrodes in a gas discharge tube where the current circuit is completed by a partially closed electron circuit. These anomalous forces generate the build up of electric charge at the cathode which establishes the condition needed to trigger excess power output from the Correa discharge tube.

The Dilemma Confronted

Hopefully the reader will now join the author in confronting the dilemma which has been introduced in the foregoing pages.

We have on the one hand certain anomalous facts of experiment which have been building up over many years and are now crowned, not so much by the Correa discovery, but by the fact that the Correa patents disclose so much experimental data that technologists have the way charted to begin to invade the new energy world.

We have on the other hand a well established scientific belief system enshrined in notions of the so-called Big Bang creation of the universe and the notions of a relativistic four-dimensional space-time metric which aims to destroys belief in an aether brimming with energy.

We have intermediate these extremes the knowledge that physicists and cosmologists openly admit that they are still searching for their Holy Grail, the Unified Field Theory, by which they mean a theory conforming with the Einstein doctrine but yet bridging the gap between electrodynamics and gravitation.

Supplementary to this we have the very extensive theoretical contributions of this author, all built on the revision of physics resulting from acceptance of a vacuum energy medium and that law of electrodynamics as adjusted to permit anomalous force imbalance in the interaction of moving electric charges of different mass. The author's theory is an all-embracing unified field theory.

In the appendices which follow this text many of the relevant references will be listed. The author has come to realise that the scientific community is so entrenched in its dedication to the Einstein doctrine, which is linked with the Lorentz force law, that no amount of contrary reasoning based on new theory will be heeded.

This is why the experimental discovery demonstrable by Dr. Paulo Correa and Mrs Alexandra Correa is of vital importance, not just as a way forward which offers us direct access to a new source of energy, but for its scientific significance.

The anomalous cathode reaction forces discovered and duly recorded by past experimenters have been swept aside by physicists with the presumption that there must be sufficient electrode vaporization to explain the cathode reaction force. That process would, of course, impart a back pressure on the vapour that would assert a balancing force on the anode. However, I am not aware of any tests that confirm the balancing reaction on the anode and I find it difficult to understand how vaporization of a metal can impart much more energy to the freed atoms than is implicit in the latent heat of vaporization. See the later comment on this point.

The generation of excess energy in seeming breach of the law of action and reaction is the decisive factor in determining the scientific truths involved in this situation and the Correas have taken us forward decisively on that front.

What lies ahead, therefore, is not only the entry into a new energy regime, but the prospect of a developing thrust in aerospace applications and a scientific revolution as the extremes of modern philosophy in physics collapse into a more rational picture.

The dilemma the reader now faces is whether to do nothing and simply watch events, leaving the task to others, or whether to explore and probe the Correa claims to try to trace a flaw in their experiments, (if there is one to be found!) or whether to stand by the principle that what amounts to 'perpetual motion' is impossible and so pass judgment solely on the strength of that conviction.

It may or may not help the argument to say that each atom in the reader's body exemplifies the reality of 'perpetual motion', because if the reader were to die and be cooled down to the absolute zero of temperature, minus $273^{o}C$, the electrons in every atom in the reader's body would keep moving perpetually. All that is suggested by the new theory underlying the new energy science is that, by understanding the quantum activity of the aether and showing how it determines the Planck constant and regulates electron motion in atoms, we can see a way forward to tapping into that energy system.

The obvious challenge comes in the statement: "Prove it by demonstrating something that works." Well, the Correas have done that! Yet even that will not be enough to turn the scientific world upside down, because the cry then is: "Where does the energy come from?" Well, the author has outlined the explanation above! Yet that will not be enough, because the scientists who are able to judge the theoretical arguments would rather not waste time in that effort, being so confident that there must be flaws.

So, assuming the worst case scenario, the final arbiter is likely to be the public at large, those who care little about where the energy comes from, so long as it is cheap, plentiful and non-polluting. That means that we will need to see several technologies develop all generating energy in a way which confounds the physicists but all aimed at the domestic market or the small user, such as by providing back up power to keep electric batteries on a boat charged when the boat is not being used.

In saying this, the author is aware of initiatives around the world and particularly in Japan which do seem to be backed by adequate funding and which suggest a lower level of prejudice against the new energy theme. So it is really now a question of waiting to see how the situation develops, trusting that what is explained in this Report will contribute to forward developments.

Even though we will hear much about new technology in the form of anomalous heat generation at water temperatures and new motor technology in which magnets play a dominant role, all pointing to excess energy generation, whichever technology is the first to command enough attention to convert Establishment opinion from disbelief to belief will pave the way for acceptance of the other technologies.

In this race, the Correa technology has a distinct advantage in that it is already the subject of three granted patents in USA, in that the claims of these patents cover, quite broadly, the three key aspects of what the Correas have discovered and in that the scientific basis is seated in anomalies long recognized in scientific literature by authoritative institutional researchers.

This is why much of the remainder of this Report simply gives references and abstracts as there seems little that needs further explanation other than the provision of a brief description of the way in which the Correa tube taps aether energy.

As with any technological development introducing a new electronic device it will be necessary to involve experts in the design for mass production, with particular attention to the problem of enhancing electrode lifetime. There will be scope for more invention in improved design structure of the electrode configurations and choice and composition of electrode materials, but there are some new and interesting principles embodied in the patented Correa apparatus and these should survive and have value as the technology comes into commercial use.

I am writing this section of text on February 13, 1996 and have just received my copy of the February 1996 issue of New Energy News, a monthly publication edited by Dr. Hal Fox and issued from a postal address P.O. Box 58639, Salt Lake City, UT 84158-8639. At pp. 10-12 I summarized the 1 hr documentary shown on British television on 17th December 1995 concerning 'free energy'. That programme included reference to research on energy from plasma discharges, notably by reference to the research of Professor Chernetskii in Moscow, but the programme was compiled before news concerning the Correa discovery came to light. Accordingly, in my submission to New Energy News I did refer to the Correa research in Canada. I find, incidentally, that the editor, Hal Fox, interjected the additional note that "The work by Kucherov, Karabit & Savitimova has also shown excess heat generation from a `glow discharge'", but I have at this time no data on that subject.

The remaining body of this Report will concentrate on a simple illustrated exposition as to why the abnormal glow discharge in a Correa tube generates excess energy and how that energy is taken off as electric power rather than as heat. So far as possible what is presented will be extracts from what has already been published on the subject, since it is not appropriate to elaborate new theories to explain the operation of the technology discovered by Dr. Paulo N. Correa and Mrs Alexandra Correa. The object here is to show that the scientific basis of the discovery is something in common with natural phenomena that have hitherto defied accepted explanation when the physics was there on record but was ignored.

Operational Characteristics of Correa Discharge Device

The excess energy mode of operation of a typical Correa discharge device involves cyclic current oscillations in the EF region of the operational characteristic depicted in Fig. 1 of U.S. Patent No. 5,416,391.

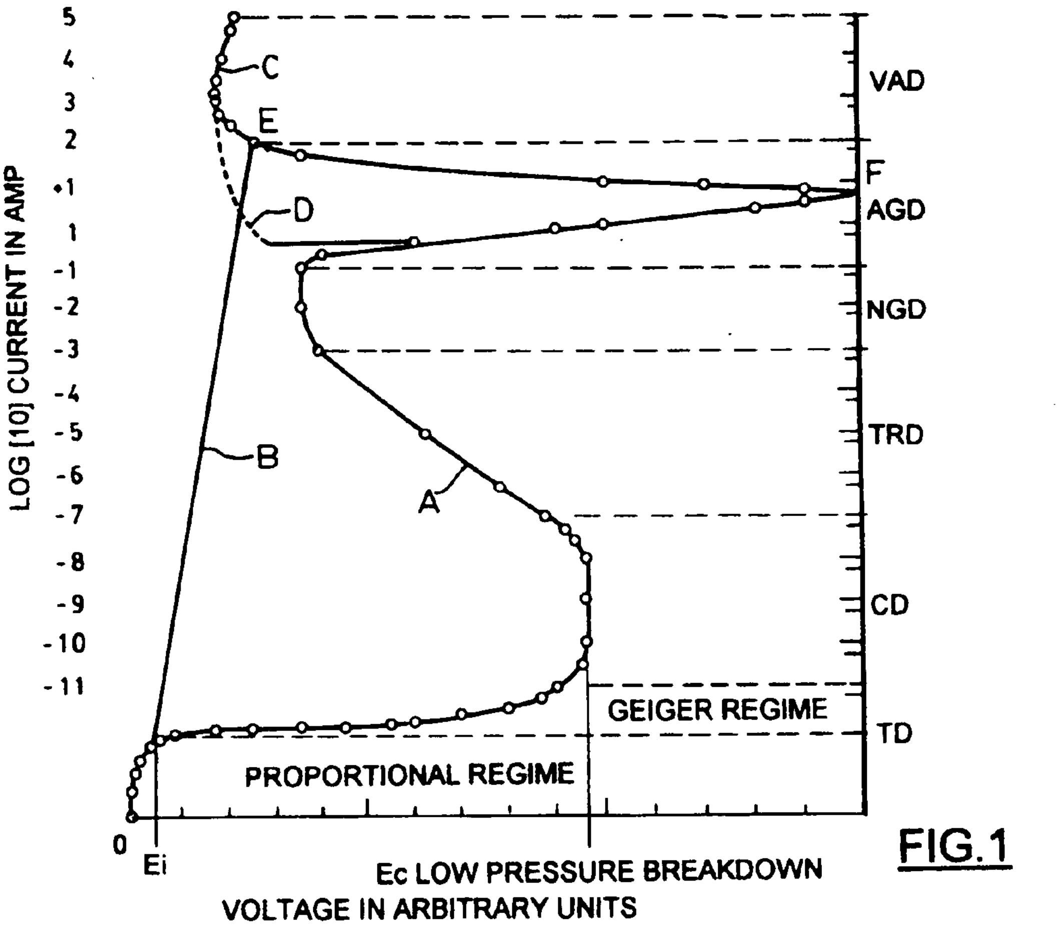


FIG.1

Note that AGD denotes the abnormal glow discharge region. The plotted data show how current varies as the voltage between the electrodes increases. There are two regions of negative resistance. The one at higher current is used to develop pulsating current oscillations which allow excess energy to be drawn from the device.

To get current to flow between the two electrodes in a cold-cathode discharge tube containing a rarefied inert gas such as argon a sufficient voltage, of the order of 1,000 V, is needed to initiate ionization. Much then depends upon the circuit connected to the tube and the load conditions that can limit the current to certain levels, which in the case of the Correa invention hold the current in a stable pulsating oscillation mode. Normally the current will climb to the VAD region where the high current vacuum arc discharge condition applies. That state does not deliver excess energy output.

Once the ions are formed (Fig. 2) a flow of current through the tube arises by the attraction of electrons to the anode and the migration of the positive ions owing to their attraction to the cathode.

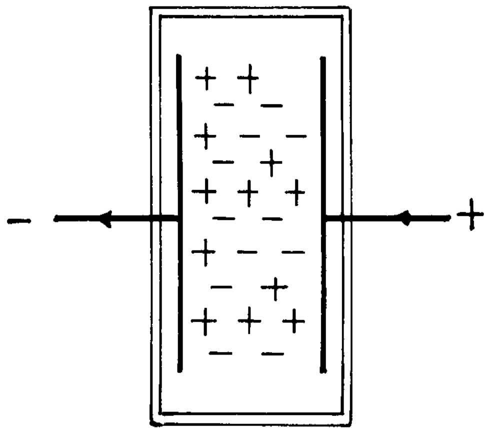


Fig. 2

Because the heavy positive ions do not move as rapidly in the field between the electrodes as do the electrons, there will be a residual positive space charge established, particularly adjacent to the cathode.

This means that there will be a radially directed electric field gradient from the centre of the glow discharge. Now, how does the medium to which we attribute electromagnetic wave propagation in terms of Maxwell's displacement current respond to a radial electric field? It responds by trying to cancel the plasma charge field, just as it does in a parallel plate capacitor. Nevertheless there is a difference. There the electric field is applied from outside, namely from the electrodes, and the Maxwell displacement, which comprises two separated layers of charge of opposite polarity, simply confronts the charge on the plate electrodes and screens it by placing one polarity charge adjacent one plate electrode and the other polarity charge adjacent the other electrode.

In the absence of an electric field vector, the scalar reaction of the aether is to store energy by equipartition between kinetic and electric displacement energy by expanding the radii of the orbital quantized motion of the elements of its aether charge. This is the basis of this author's theory for the photon and the derivation of the theoretical value of the fine-structure constant [Reference 2 in the bibliography].

The aether responds to the field vector mode of a linear electric field displacement by storing energy as electrical field energy. This amounts to an internal strain in the aether and, if a gas is present, it may become ionized. Here there is translational motion of the charge system in the aether but no kinetic energy is added to its overall quantum state because the displacement of the charge orbits in local aether regions is affected by synchronizing constraints exerted from external aether regions which assure phase lock. These constraints, rather than the applied electrical field, provide the energy needed to sustain that translational motion. This is why the aether cannot be sensed in terms of the mechanics of linear motion. This aspect is a subject mentioned in reference [57].

The aether responds similarly in response to the radial electric field vector, because it is able to set up a state of spin or rotation which involves inflow of kinetic energy in the aether itself, energy which is supplied from the external aether owing to the phase-lock just mentioned. In this case, if the external influence which sets up the radial electric field subsides in strength, the phase-lock persists but the kinetic energy which has been fed into the field system from the external aether cannot return to its source by virtue of that same phase-lock. This is akin to the situation where a dog with its feet firmly locked to the ground can wag its tail, but the tail cannot wag the dog and, with it, body Earth. Therefore, the energy in the aether spin has to be shed in a different way, but by virtue of the synchronizing constraint which now forces a radial charge displacement powered by the captured aether spin energy.

In other words, what is stored in the spin state as aether input energy becomes available as electric field energy which can be tapped by drawing power from the electrodes of the Correa tube, just as if the glow discharge were a capacitor.

To do this it is necessary to have pulsations and here there is an aspect which warrants further theoretical research, but which seems to have already found a practical solution in the Correa device. The point of interest is that, in theory, we need to add as many joules of energy to build the electric field condition as we can expect to draw in as excess energy from the enveloping aether. This is because the aether has certain harmonious features consistent with equipartition of energy between electric and dynamic (kinetic or magnetic) states. The puzzle then is that of understanding how energy efficiencies in excess of 200% are possible. The answer is easily found if there is a Q factor applicable to the circuit, meaning that the electrical energy oscillates as between the discharge and an external capacitor. However, it may well be that in the Correa tube the extended form of the cathode in relation to the electrode spacing allows multiple discharge zones which can cooperate in exchanging some portion of the electric energy whilst the aether energy inflow is pumped into all such zones in each external pulse cycle.

In summary, therefore, there are undoubtedly some very special advantages in the way in which the Correa discharge tubes are designed. The design of the electrode configuration as covered by the Correa patent position seems therefore to be crucial to securing high conversion efficiencies with excess power generation well in excess of 200%.

What is clear is that the radial separation of positive and negative charge in the plasma in the Correa discharge tube will capture large amounts of aether energy. Fig. 3 depicts that radial separation and shows two capacitors denoted C which make a circuit connection with a load resistance.

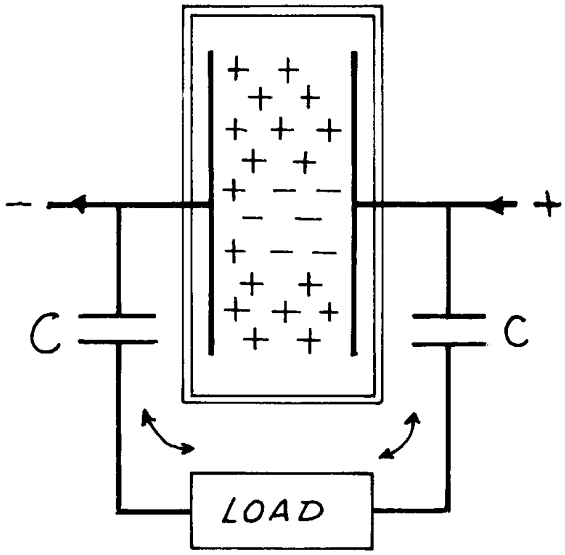


Fig. 3

The object here is to set up an oscillation in the a.c. output circuit connected in parallel across the discharge tube electrodes.

Suppose that there is an oscillation which allows us to draw a.c. current through the load. There will be times when the current through the tube collapses rapidly and this means that the current in the discharge drops. The rate at which positive ions are being created will drop as well and so the radial electric field can fall below the value corresponding to the state of aether spin. This then uses the kinetic energy of the aether spin to set up radial electric field displacement in the aether itself and that, in turn, releases the plasma charge at a higher potential, corresponding to that negative resistance characteristic. The result is that the tube delivers power drawing on aether spin and sheds it in those output current pulsations that are channelled around the a.c. shunt loop through the load resistor shown in Fig. 3.

Now, to accentuate this effect, one of the features of the Correa patents involves a discharge tube having an extended cathode structure with a relatively small anode in fairly close proximity. As indicated in Fig. 4, this has the effect of spreading the cathode current and so the distribution of positive ions over the area of the extended cathode, whilst the anode current is more confined to the central part of the tube.

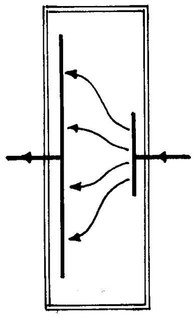
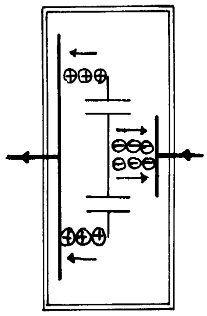
 

Fig. 4 ....Fig. 5

Thus, in Fig 5, the way in which current flows through the tube is illustrated by the separation of positive ions and electrons. These can recombine, as by the electrons entering the anode migrating around the d.c. supply circuit path to find their way to the cathode. However, the significant point of interest is that the AGD discharge has a charge storage feature which is depicted by the notional capacitors illustrated inside the tube.

One has then to visualise a region of aether spinning about the centre of that plasma forming the glow discharge and contriving to contain the build-up of an enormous amount of charge separation. Under the cyclic relaxation control of the suitably-adjusted parameters of the external load circuit, the oscillation which develops can literally pump energy from the aether as the positive ion state of the plasma is increased and allowed to decrease, increasing under control of the power input, but decreasing spontaneously to draw on the aether energy stored once the input loses control.

It is not the purpose of this Report to describe precisely how the circuits of the Correa experiments are designed to exploit this phenomenon, but before mentioning other related research and before giving further explanation of the physics underlying the spin phenomena, one example of the reported performance data will be quoted from U.S. Patent No. 5,449,989. That patent together with the other two already mentioned show several circuit diagrams to which the reader can refer.

<u>Performance Data Exemplifying the Correa Discharge Device</u>

In experiment No. 8 as listed in Table 5 in column 36 of the patent specification, it is shown that a battery pack in which 46 batteries, each of 12 V rating, provide an input voltage of nearly 600 V. As energy is drained from this battery pack a separate pack of 28 such batteries is charged by the rectification of a.c. output drawn from the pulsating oscillations of the discharge tube.

The experiment begins with the driver pack at a voltage of 582 V, corresponding to 12.65 V per cell, which was an 87.5% state of charge. The charge pack had an initial voltage of 328 V, corresponding to 11.71 V per cell, which is a 20% state of charge.

The cathode in the discharge tube was of hardened aluminium and had an area of 64 sq. cm. There was a 4 cm. gap between electrodes and the gas pressure in the tube was 0.8 Torr. The experiment ran for 28.5 minutes.

Thereafter, the driver pack was found to have lost very little of its charge, its voltage having reduced to 579.5 V, corresponding to an 84% state of charge. It had shed 0.134 kWh of energy. In contrast the charge pack had climbed to a voltage of 350 V and become 76.5% charged, an energy increase of 1.213 Kwh, which is a ninefold increase. The energy conversion efficiency was greater than 900%.

The Vapour Reaction Hypothesis

The conventional assumption concerning cathode reaction force in the cold-cathode discharge is that the discharge involves vaporization of the cathode material. The reaction force on the cathode is then attributed to the rate at which momentum is imparted to the ejected vapour. The speed of ejection times the rate of loss of cathode mass should then equal the measured anomalous force.

It is therefore interesting to compare that speed, and the kinetic energy it implies for an atom shed by the cathode, with the thermal state of such an atom just prior to its release, as determined from the latent heat of evaporation of the cathode metal.

For an aluminium cathode, given that the latent heat of evaporation is 10,800 J/gm, the speed of the vaporized atoms can be little more than 5,000 m/s. This is estimated by equating the kinetic energy of unit mass to the energy 10,800 J. It follows that, the force of 245.2 dynes as measured and reported in Table 15 of the third of the Correa U.S. patents for a current of 1.6 A, will require the cathode to vaporize at the rate of $490.4\ 10^{-6}$ gm/s to impart the necessary rate of reaction momentum to account for that cathode reaction force. This assumes that the force is not set up by electrodynamic action.

Now, in column 20 of U.S. Patent 5,449,989 the rate of erosion of cathode material is discussed on the basis of the Correa data on actual measurements of craters formed by vaporization activity. That data allows the conclusion to be drawn that electrodes having a mass of less than 100 gm would have a useful life equivalent to the generation of power of 40 Mwh.

Assigning 250 V to the 1.6 A current implies output power of 400 W and, if that were to consume the cathode at the rate estimated above, a 100 gm electrode would be consumed in 56 hours, corresponding to a lifetime energy production of 0.0224 Mwh.

This is discrepant by a factor of the order of 1,000 when compared with the erosion observed. It follows, therefore, that the cathode reaction force has to be almost wholly attributable to some cause other that reaction produced by vaporization. Hence the anomaly already discussed in connection with this new source of energy!

The Author's 1977 Plasma Discharge Device

This was the subject of U.K. patent Application No. 2,002,953. It proposed the concentration of heavy positive ions in a central chamber by the anomalous electrodynamic forces of the cold-cathode discharge, with the object of producing heat in excess of that generated by electrical input power. The invention was based on the recognition that the aether can shed its `intrinsic' energy.

The last paragraph of the specification was:

"The ion acceleration technique provided by this invention becomes, in such situations, a catalyst by which high energy concentration in suitable ionizable media may trigger transformations and possibly release of intrinsic energy."

The circuit shown in the following reproduction of Fig. 11 of the patent had the merit of avoiding cathode overheating by injecting ions into the heat generation chamber and subjecting them to accelerating effects produced electrodynamically by auxiliary cold-cathode discharges.

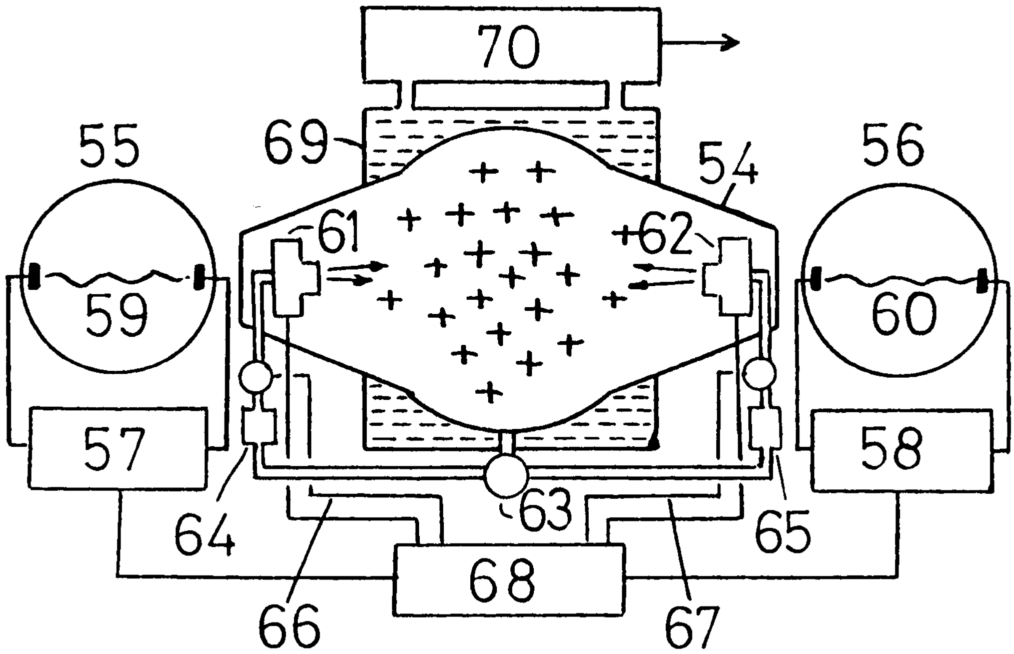


FIG.11

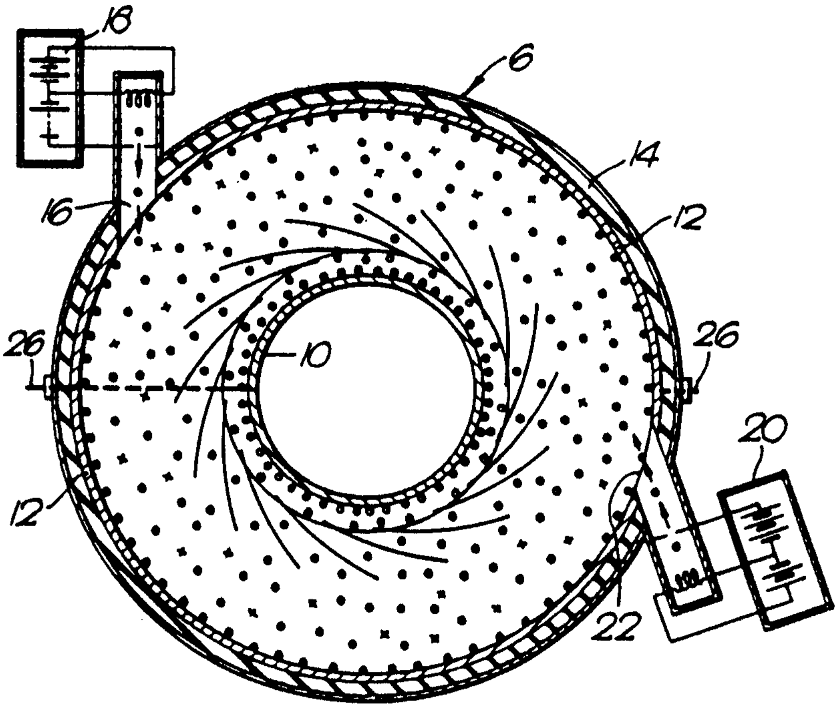
Spence's 1986 Energy Conversion System

This was the subject of U.S. patent 4,772,816. See the figure below of the patent.

Geoffrey M. Spence of Crowborough in England assembled operative plasma discharge devices which generated more electrical power output than was supplied as input.

The abstract of the patent reads:

"The apparatus uses a magnetic field (80) to accelerate a charged particle radially towards a target electrode (10). The increased kinetic energy of the particles enables the particle to give up more electrical energy to the target electrode (10) than was initially given to it. This charges the target electrode (10), and the increased energy is extracted from the apparatus by connecting an electrical load between the target electrode and a point of lower or higher potential."



Chernetskii Vacuum Energy Breakthrough: News Release dated 1989

The Novosti Press Agency, Moscow, USSR issued their Press Release No. 03NTO-890717CM04 in 1989. A few sentences from that document are quoted below:

"Abstract: A design model of a plasma generator which can convert physical-vacuum energy into electricity has been developed under Professor Alexandr V. Chernetskii at the Moscow Georgi Plekanov institute of the National Economy. Such generators could lay the groundwork for a future environmentally-benign power industry."

"Classical physics cannot explain what happens when a plasma discharger placed in a Chernetskii circuit is started. For no apparent reason the ammeter pointer suddenly shows triple strength of current increase and energy output is several times more than input. The plant's efficiency is suddenly much more than ONE! No magic is involved. Additional energy outputs at specific plasma discharges have been established in several independent 'Expert reports' by staff from the V. I. Lenin All-Union Institute of Electrical Engineering (Moscow) of the Ministry of the Electrical Equipment Industry. This effect has been checked by different methods. Where does this mysterious energy come from?"

"The self-generating discharge emerges when the discharge currents reach a definite critical density, when the magnetic fields they create ensure magnetisation of the plasma electrons and they begin to perform mainly cycloidal movement. The interaction of currents with their magnetic field forces the electrons to deviate to the cylinder-shaped discharge axis and the electrical field emerges. ..... Clearly, only part of the tremendous vacuum energy is extracted."

"We've developed several circuit versions which can find application. In the latest experiment which had an input power of 700 watts, the generator produced three kilowatt for load resistance, or nearly five times as much. This is only the start and not the limit. The calculations for more powerful plants show that many megawatts of free energy can be produced from a minimal power source."

A Concluding Note

In this concluding note there are two points which it is believe warrant attention. One is quite topical in that it has attracted media interest in the vacuum as a new energy source. The paper generating that interest is that of C. Eberlein in Physical Review Letters **76**, 3842-3845 (1996) entitled 'Sonoluminescence as quantum vacuum radiation'. It is the phenomenon by which sonic pulsations applied to water result in the water emitting optical radiation which betrays the release of energy in bursts which signify high temperatures. See also the report by Peter Knight 'Sound, Light and the Vacuum' in News and Views in the journal Nature (**381**, pp. 736-737, 27 June 1996).

This phenomenon is of little practical consequence when measured against the discovery underlying the Correa invention, but it shows that scientists need to face up to the reality of the new energy world. The sonoluminescence phenomenon is, in my opinion, another manifestation of the vacuum spin scenario. By compressing tiny air bubbles at frequencies of 25 kHz the positive H_3O hydronium ions and the negative OH hydroxyl ions in water converge radially towards each bubble of air during the pressure impulse period. The heavier ions respond more slowly and each such pulse sets up a small radial electric field displacement. This induces aether spin or vacuum spin, with inflow of energy from the quantum underworld, owing to the phase lock action of the quantum environment. As the pressure relaxes the ions do not recover their original positions owing to the neutralizing field effects inherent in the aether spin. Each successive sonic pressure pulse then augments the effect by forcing further radial charge displacement. This is an escalating situation broken only when the build-up of vacuum spin energy centred on those air bubbles grow in physical size until instability sets in as by surface collision with other such spin states. These collisions in their random distribution will be triggered in time with the sonic pulsations and local flashes of light will be emitted. In effect what one sees is a kind of very tiny thunderball phenomenon, where the stimulus exciting the formation of the glowing balls is not an electrical discharge but a pressure wave.

While physicists ponder on that sonoluminescence phenomenon, those interested in the practical pursuit of the new energy opportunity can follow the Correa lead, confident that scientists who decry the `free energy' prospect have their own problems in understanding sonoluminescence.

As indicated earlier in this work, the theme of charge induction by vacuum spin featured in my 1977 lecture paper 'Space, Energy and Creation' and I stated that I would from quote something from the end of that text. This now follows:

Finally, an interesting experiment has been performed by Ryan and Vonnegut (1971)*. They arranged for a cage to rotate around an electric arc discharge at quite low speed and found that this stabilised the arc. The task of stabilising an electric arc is one of the major problems of thermonuclear fusion research. It seems therefore very difficult to believe that the wild antics of the arc discharge are tamed merely by the slow rotation of a column of air. Here then is more scope for research. Can an arc be stabilised by a in a vacuum by cage rotation? It is research which the modern physicist will not readily undertake because there is widespread belief that the vacuum is a non-entity devoid of any special properties. It is a belief encouraged by the development of relativity and in my experience those who believe in relativity deny the existence of the aether. On the other hand I was once reassured by a comment Professor Cullwick** made about something I published. He quoted Einstein as saying:

'The special theory of relativity does not compel us to deny the existence of the ether .... there is weighty evidence in favour of the ether hypothesis.'

(H. Aspden, 15 September 1977)

* Nature Physical Science **233** 142 (1971).

** Electronics & Power **22** 40 (1976).

APPENDIX I

WHY THE EARTH IS NOT A SELF-EXCITED DYNAMO

Introduction

Readers of 'The Homopolar Handbook' by Tom Valone will see that it has the sub-title 'A Definitive Guide to Faraday Disk and N-Machine Technologies'. They will also see on its page 78 a reference to a Scientific American article which gives weight to such technology by declaring that the Earth is a self-excited dynamo analogous to a Faraday disk generator which powers the self-induced magnetic field. The article appears in the February 1979 issue of Scientific American at pp. 92-101. Its authors are Charles R. Carrigan and David Gubbins and it is entitled 'The Source of the Earth's Magnetic Field'.

In the December 1979 issue of Scientific American at pp. 120-130 there is an article by Lewis P. Fulcher, Johann Rafelski and Abraham Klein entitled 'The Decay of the Vacuum'. This latter article predicts that matter can be created from empty space in the close vicinity of the atomic nuclei of high atomic mass.

One at least of those two articles just quoted is based on a false foundation, but both bear upon the subject of this Energy Science Report.

I make this statement well recognizing the authority of authors who write for Scientific American, but knowing that where magnetism and the aether's energy properties are concerned one really needs to be discerning as to what one is willing to believe.

In this Appendix I it will be shown why the Earth's magnetic field cannot be self-induced by homopolar induction. Appendix II reproduces my paper as read at an Institute of Physics conference at Oxford University, England in 1983. It provides the authentic explanation of the induction of the Earth's magnetic field as an aether phenomenon, consistent with the foregoing analysis of operation of the Correa PAGD technology.

The Logic of My Case

1. For there to be self-induction of electric or magnetic effects attributable to the rotation of any system that system must comprise a composition of electric charges.

2. The electrostatic force acting between any two charges is directed along the line joining them and there is balance of action and reaction, meaning that the system will not develop an out-of-balance reaction force that can enhance or retard a state of spin.

3. If the system is already spinning then there will be mutually-induced electromagnetic forces acting on the charges as each moves under the influence of the field set up by the motion of other charge.

4. By the Lorentz force law these forces act at right-angles to the charge motion. The effective motion of each charge is in a circular orbit about the axis of spin and so any electromagnetic force must be radial with respect to that spin axis. This means that no force component will enhance or retard the spin.

5. It must be concluded that the mutual-interaction of charges within a spinning body cannot set up any electromagnetic forces affecting that spin, this being, of course, consistent with the principle that angular momentum is conserved in the absence of an external influence.

6. A consequence of this is that there can be no circulating electric current induced inside that system owing to its rotation as that would draw on the inertial spin energy and mean that the spin speed must reduce.

7. This account does not preclude the setting up of EMFs in the body of the spinning system of charge because those EMFs would be balanced, meaning that the perimeter is at a different potential from that at the axis.

8. In an operable homopolar generator based on the Faraday disk principle there is a non-rotating return current circuit path external to the rotating disk and that accounts for the unbalanced EMF around a circuit whilst providing the external structure which can absorb the forces affecting the spin speed of the disk.

9. Body Earth has no external structure against which to apply the requisite force action if it is to slow down owing to self-exciting dynamo properties.

<u>The Alternative Solution</u>

There is, of course, a solution to the mystery of the Earth's magnetic field, but it depends upon something totally unfamiliar to those expert in the physics of field theory. It concerns 'vacuum spin' and a 'phase-lock' effect and that connects the phenomenon of the Earth's magnetic field with the energy activity intrinsic to the aether. It involves a process which taps that aether energy, which is why the subject is important in our quest to discover a new and commercially viable source of energy.

Appendix II should now be read, keeping in mind that the self-generating magnetic dynamo theory as an explanation for the Earth's magnetic field is flawed and must be rejected.

APPENDIX II

THE THUNDERBALL - AN ELECTROSTATIC PHENOMENON

This is the text of the author's paper as presented at Electrostatics 1983, Oxford and as published in Institute of Physics Conference Series No. 66 at pp. 179-184.

Abstract A quasi-static electric displacement according to Maxwell's theory is considered in a novel context, that of a forced radial electric strain centred on a source of energy. The resulting balancing charge displacement in enveloping matter may have transient stability and should exhibit ionization if gaseous. Potentially hazardous pockets of migrant electrostatic energy may well be created in the vicinity of electric discharges. Analysis shows the energy content to be within the range applicable to the thunderball, that is between $2x10^9$ J/m^3 and $5x10^9$ J/m^3.

1. Introduction

Maxwell's equations are very much a part of the accepted physics in use today. They are used without much regard for the physical model on which Maxwell developed his theories. Jeans (1966) has referred to Maxwell's displacement theory as 'part of the scaffolding by which electromagnetic theory was constructed' but said that it was an open question whether this scaffolding ought now to be discarded.

Some impetus in examining this question stems from the recent experimental discovery by Graham and Lahoz (1980) that the field medium can provide a reaction force to quasi-static fields. The evidence from this experiment, which is electromagnetic in character and depends upon current displacement between capacitor plates, is so strong that the authors ended their paper with the comment that 'the quasi-static Maxwell's field is not merely an invisible medium of interaction between matter and matter; it has in fact the mechanical properties postulated by Maxwell, in contradistinction to any "action at a distance" theory'.

This encourages the author to present a proposition directly based upon Maxwell's displacement theory. The question at issue is whether the vacuum, as a physical medium in its own right, can be set in a state of electrical strain and might, under certain circumstances, retain this strain transiently so as to store energy in a quasi-stable manner. In particular, it seems worthwhile to ask whether radial electric displacement centred on a source of energy has a role to play in physical phenomena. Note that this contrasts with the lateral oscillatory displacement we associate with wave propagation. We are considering a static displacement such as is associated with the storage of energy by a charged capacitor.

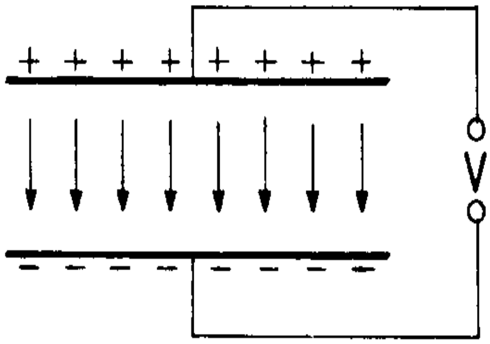


Fig. 1

We believe that when the parallel plates of the capacitor shown in Fig. 1 are electrified, as by the potential V, the linear displacement in Maxwell's field medium (depicted by the arrows) effectively neutralizes the capacitor charge and stores energy in the state of strain in the dielectric and the field medium itself. The hypothesis we now address is that Nature may operate in the reverse mode, particularly in response to a radial displacement, and somehow sustain a state of radial electric strain in the vacuum medium so that it asserts a primary role and causes the electric charge in enveloping substance to take up neutralizing positions. Instead of the electricity applied to the capacitor causing energy to be stored, we have an event accompanied by the injection of energy into the strain storage system of the field medium and a consequent electrical adjustment in matter.

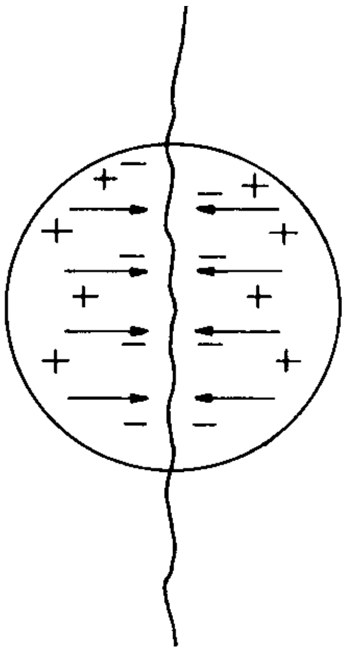


Fig. 2

A lightning flash is a likely candidate for such an event. Its action must be to pinch the discharge into a thin filament in which the more mobile electrons concentrate along a core as shown in Fig. 2 and set up radial electric strains bounded by the inert positive ions.

If the field medium reacts in some way to preserve this strain and store energy in a quasi-stable form for a transient period before the electrons and ions recombine, then the condition according to the hypothesis outlined above is achieved. The resulting pocket of energy optimizes its form to that of a sphere and asserts a primary role in keeping the positive and negative matter charge displaced, pending eventual decay.

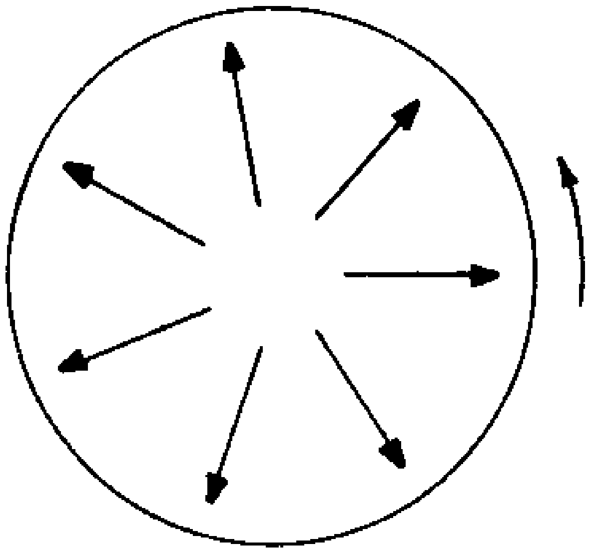


Fig. 3

A useful concept giving strength to this hypothesis involves an imaginary state of spin, which we will term `vacuum spin'. The idea here is that if the vacuous field medium were to contain charges capable of displacement then it would be feasible to imagine a sphere of such a medium rotating as shown in Fig. 3 about an axis through the centre of the sphere. The charges would be subject to a centrifugal action and so would be displaced radially. Energy would be stored by the spin state and by the radial electric fields induced. In the presence of matter such as the atmosphere these fields might well be cancelled by ionization and separation of charge in the matter itself, leaving only the spin energy. Nevertheless, the spin would sustain the electric displacement in the field medium and a transient state of ionization pending the eventual dissipation of the spin energy. Hence the vacuum spin concept does convey some understanding of the quasi-stable character of the phenomenon under discussion.

2. Theoretical Analysis

We can proceed to analyze a spherical field system subject to symmetrical radial strain, without further recourse to this spin concept and solely by reference to the charge separation in matter. Consider a spherical shell of negative charge Q enveloping a uniform sphere of distributed charge +Q developed to balance the radial electric displacement. The electric energy is simply the sum of three terms. These are (i) the self-energy of the distributed charge $3Q^2/5R$, (ii) the self energy of the charge Q which is $Q^2/2R$ and (iii) the mutual energy of the interaction between -Q and Q, which is Q^2/R. The total electric energy becomes $Q^2/10R$, where R is the radius of the sphere subject to the electric strain.

Given this amount of energy applied to form the spherical object under discussion, we know that it will be characterized by a charge Q and a radius R connected by the above formula.

To proceed further it is helpful now to digress a little and consider the possible creation of such a spherical object wholly within a larger spherical object of similar character. This is possible because we are talking about fields and the field medium and can envisage pockets of this medium permeating matter. As depicted in Fig. 4(a), a sub-sphere of electric strain is contained wholly within a much larger sphere of electric strain. The strains are radial in each sphere and combine to determine the strain energy density at points within the sub-sphere. Because the main sphere is very large in relation to the sub-sphere we can regard the strain of the larger sphere as uniform over the volume of the smaller sphere. This means that when the electric strain vectors of the spheres are combined at points within the sub-sphere the cross products will balance and so cancel to leave the energy needed to form the sub-sphere independent of the strain within the larger sphere.

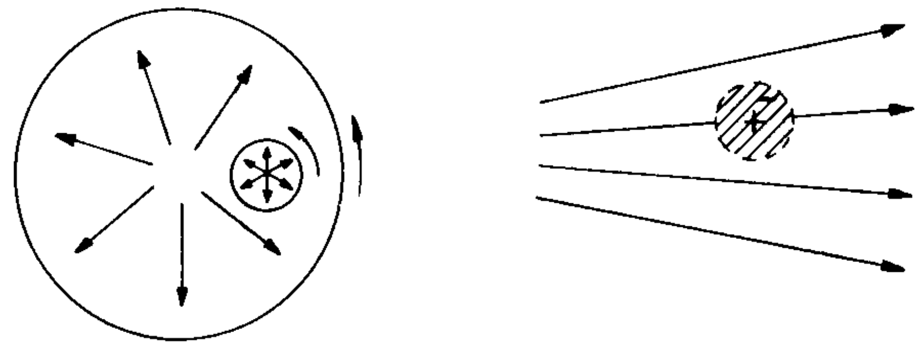


Fig. 4(a) .... Fig. 4(b)

Fig. 4(a) shows a sub-sphere of radial strain within a larger sphere of radial strain and Fig. (b) shows an ion and its associated electron influenced by a non-linear electric strain.

Note that we have in mind the possible ionization of matter and the separation of electrons and positive ions. The electrons present will, by their thermal equilibrium with the ions, have a range of travel well in excess of that of ions with which they are associated. Thus, collectively each ion and its paired electron will form a system which is electrically neutral overall and which can be represented, as shown in Fig. 4(b) by a positive central charge surrounded by a spherically symmetrical negative charge distribution attributable to the statistical random motion of the electron. This is because the electrons have a much smaller mass and a much greater speed and, though confined to the spherical boundary of the sub-sphere in order to balance the effects of the strain discussed above, they are less confined than any ions present at that boundary.

Owing to this greater range of motion of the electrons it is the polarity of the electrons that determines the direction in which ionized matter tends to move in a non-linear electric field. For stable confinement to a sphere the electric strain everywhere within the bounds of that sphere must correspond to the action of a positive charge. Thus the radial electric strain of the sub-sphere at its surface is limited by the prevailing electric strain in the larger sphere and the latter must correspond to the action of a positive rather than negative charge.

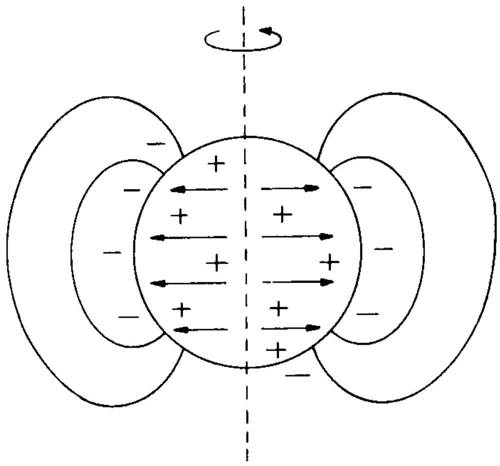


Fig. 5

Imagine now that what we have described occurs in our own environment, with the Earth and its ionosphere constituting the larger sphere and the subspheres being the thunderballs induced in the Earth's atmosphere. The Earth rotates, as depicted in Fig. 5, and so the charge just mentioned would rotate to produce a magnetic field attributable to a distributed positive charge and a balancing negative charge at the upper bounds of the atmosphere. Overall this would give the Earth a geomagnetic moment attributable to a negative charge, which is found to be the case. Furthermore, no electric field

would be detected directly because the strain caused by vacuum spin would be balanced. It is well known (Rosser, 1968) that this strain causes no magnetic field itself as, otherwise, charged capacitors when rotating would induce no magnetic field, yet such a field is observed.

The magnetic moment attributable to the collective action of a surface charge Q is readily shown to be:

$$M = QR^2/5c$$

(1)

where R is the body radius and is its angular speed. c is the speed of light. Note that this expression is in electrostatic units and both the dielectric constant and the magnetic permeability are taken to be unity. For the Earth the geomagnetic moment M is 8.1×10^{25} gauss-cm, R is 6.4×10^{8} and is 7.26 10^{5} rad/s. c is 3×10^{10} cm/s. Thus Q is readily found and so the surface electric strain Q/R^2 as applicable in atmospheric regions.

This sets the surface strain of the sub-spheres and determines the energy density associated with their overall energy. The mean energy density of any such sub-sphere is found by dividing $Q^2/10R$ by the volume $4R^3/3$, R now being the radius of a sub-sphere and Q its charge. This energy density is simply 3/40 times $(Q/R^2)^2$ and as this latter quantity is the same throughout the Earth's atmospheric layer we may expect all sub-spheres to have the same energy density.

It is known that thunderballs all exhibit the same energy density, regardless of their size, as was reported by Altschuler et al (1970) and that this energy density lies in the range 2×10^9 J/m^3 to 5×10^9 J/m^3.

We have, therefore, an encouraging link with the hypothetical model under consideration. However, more than this, we find that the energy density calculated from the above expression and using the value of the parameter Q/R^2 derived for the Earth itself is $2.37x10^9$ J/m^3. The theory is therefore supported also by a quantitative connection with the geomagnetic field.

3. Discussion

The greatest puzzle of all concerning thunderballs is their ability to pass through solid matter and still preserve their form. This is explained by the above theory. As a phenomenon of electric strain in the vacuum itself, a strain which is primary and sustained by some inner mechanism of the vacuum state, the thunderball can pass through solid matter just as easily as solid matter can pass through the vacuum. What is seen of the thunderball is merely the ionization in the atmosphere resulting from the decay of the energy locked up in this state of strain. As the pocket of strain passes through solid matter any ionization on the entry side merely subsides to be replaced by ionization on the exit side once the sub-sphere surface of the thunderball emerges.

Another property of these objects is that they would exhibit a magnetic field of the same order as the Earth's magnetic field. This is quite small but, bearing in mind that the mass of the thunderball is that of the field itself and therefore negligible, it needs very little force to displace them. Accordingly, it becomes possible to explain why thunderballs can hover over the surface of an aircraft wing in flight without being swept away in the slipstream (Aspden, 1980). In separating from the conductive surface of the wing, eddy currents would be induced by weakening the flux linkage sourced in the ball. These would develop a magnetic attraction for the ball and resist its separation, so holding the ball for a period in the proximity of the aircraft.

Connected as they are with dramatic and dynamic events such as lightning discharges, it may appear to be bold speculation to suggest that these glowing spheres really are manifestations of a quasi-electrostatic effect. Yet, as we have seen, their unusual properties can be explained on such a theory. Given data concerning the amount of energy released, the theory suggests that the size of these objects is then determined by the standard energy density already estimated. This means that even a small amount of energy released by a discharge that is quite weak could produce a tiny thunderball. Since the electric field gradient is the same at the surface of all such objects and this is sufficient to ionize large and easily visible objects, we can expect even the smallest to exhibit ionization as well.

They become, therefore, a potential hazard where explosive and inflammable substances are present. They constitute an unexpected hazard because they have a durability and a mobility not shared by other electrical phenomena.

They are so elusive in character that they may exist without having been noticed except as an apparent illusion. Yet the thunderball is unquestionably a real phenomenon and a dangerous one.

In order to devise experiments by which thunderballs may be created and examined under controlled laboratory conditions, one needs at least to begin with a viable hypothesis as to their character. This has been offered in this paper. The theory presented should be judged in the light of the very great spectrum of theories proposed hitherto and discounted for many reasons. See, for example, the excellent review articles by Golde (1977) and Charman (1979). Of more practical concern on a grand scale are the efforts of Nobel laureate Kapitza (1979) who, recognizing that the energy densities of the thunderball are of the right order for application in fusion reactors, seeks to create them artificially by R.F. techniques, this mechanism being his assumption of how these objects may derive their energy.

Finally, it is noted that the author has explored in considerable depth the possible physical basis of the underlying `vacuum spin' on which the argument was developed (Aspden, 1980). It remains to devise and conduct experiments aimed at inducing this spin condition by using radial electric fields, so as to verify and perhaps apply the phenomenon to useful ends.

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LISTING OF PUBLISHED WORK OF DR HAROLD ASPDEN

In writing this Report I had occasion to refer to just a few of the various published papers I have written over the years and am mindful that I have been writing in a confident style, taking strength from my other related efforts on the creative properties of the aether. The Correa research findings have been my inspiration by opening the door giving access to that aether. It may be that the following list of my papers may serve as a partial index giving guidance as to what also lies a little further behind that door.

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ENERGY SCIENCE REPORT NO. 9

POWER FROM MAGNETISM: OVER-UNITY MOTOR DESIGN

by

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ENERGY SCIENCE REPORT NO. 9

POWER FROM MAGNETISM: OVER-UNITY MOTOR DESIGN

Contents

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POWER FROM MAGNETISM: OVER-UNITY MOTOR DESIGN

Introduction

This Energy Science Report is one of a series concerned with new energy technology and the fundamental energy science that is involved. In this series of twelve such reports there are three, Nos 3, 8 and 9 of which are of outstanding importance. Report No. 8 was devoted exclusively to the remarkable discovery of Dr. Paulo Correa and Mrs. Alexandra Correa of Concord, Ontario, Canada. In proving that electrical power at normal power voltage can be generated by tapping aether energy by a plasma discharge technique, we have in prospect one solution for our future energy needs. In this Report No. 9 this author now reveals another way forward to tapping aether energy, one which could well replace main electrical power generating installations in the years ahead. In Report No. 3, soon to be issued, the author will describe a technology which, when developed, will serve as a `free energy' air-conditioning or refrigeration unit. This latter technology does not tap aether energy. It does, however, operate in defiance of the second law of thermodynamics by extracting electricity from ambient heat.

This Report in four parts. Part I outlines the design of a large scale motor such as might become a prime mover in a power generating plant or used to power an ocean liner. Part II concerns the design features of a small prototype motor that can be assembled in a home workshop. Part III is an academic discourse aimed at educating students and even university professors of electrical engineering on some elementary, but unfamiliar, principles of magnetism. Part IV discusses further the scope for research and commercialization. It is aimed at government officials and research directors in industry, with a view to urging action to exploit this new technology.

For the record, the author explains that he has begun writing this Report on October 6th 1996 and aims to publish by November 6th in advance of a New Energy symposium to be held in Rotterdam on November 9th. This Report will be revised and reissued in updated forms periodically thereafter in the light of developments.

> [Note added here in this June, 2003 reprint of this Report for placing as a record on the author's website www.energyscience.co.uk and listing in the paper section of the author's other website www.aspden.org which is where any such commentary as to onward development will be reported. However, it is mentioned here that, at this time, the author's attentions have been more directed at the understanding the scientific physical basis on which energy can be tapped from our aetheric environment, replicating in a sense the process by which our Earth and sun acquired their energy. The future prospect here points towards solid-state technology, rather than the theme discussed in this Report.]

PART I: Multi-Megawatt Over-Unity Design

There have been many reports of motors incorporating permanent magnets and claiming over-unity performance. By `over-unity' is meant the generation of output power in excess of the electrical power input. It is important to note that the use of permanent magnets in motor construction is standard practice for many commercial d.c. motors. Usually the motor drive is generated by currents in conductors interacting with the magnetic field to produce lateral forces on the structure supporting the conductors. In this case the resulting motion induces back EMFs which absorb input power to set up the drive force. There is no anomalous energy gain in such machines. An entirely different motor principle involves setting up a magnetic field in a pole gap as the poles come together and weakening the magnetizing field during pole separation. Such machines are known as `magnetic reluctance' motors. Incorporating permanent magnets in such machines poses problems but offers scope for `over-unity' performance.

It should not, however, be assumed that energy is being drained from the magnet. The magnet is merely a catalyst in energy conversion. Also, whatever function can be performed by a magnet can also be achieved using an electromagnet, meaning a ferromagnetic core excited by a magnetizing winding, subject to the scale of the system involved.

In large electrodynamic machines used in power generation there is a developing tendency to use superconductive magnets, superconductive coils having no ferromagnetic core. The fact that electric current can be sent around a multi-turn magnetizing winding with no loss that produces heat offers the alternative to a powerful magnet for many scientific applications. This is especially the case now that `warm superconductors' have been discovered, with the promise of room temperature superconductivity. However, here again, it must be noted that, if the ferromagnetic core is to be used as the catalyst for tapping energy from the aether, the use of superconductive windings must be accompanied by the presence of ferromagnetic cores within those windings. The design of the multi-megawatt power generating machine to be described below does, therefore, use superconductive windings on ferromagnetic cores.

The general principle which forms the basis of the design combines (a) the avoidance of loss by using superconductive magnetizing windings and (b) the minimization of inductive power input by near-to-total enclosure of the complete core circuit of the machine within a single solenoidal magnetizing winding.

The operating principle of the conventional magnetic reluctance motor is easy to understand. One stores energy in the magnetic field within the gaps between the rotor and stator poles. The poles come together by magnetic attraction. That magnetic field energy fed in as inductance is then converted into mechanical work imparting drive torque which delivers output power to a motor drive shaft. All one then has to do is to be sure that the magnetizing current is switched off when the poles come into register as the pole gaps are very nearly closed and then they can separate to step on to the next operating position without there being much magnetic drag arresting the motion. The energy fed in as inductance energy is deployed as mechanical output. There is no power gain, but there is some loss owing to magnetization (hysteresis and eddy-currents) and, unless superconductive windings are used, there is ohmic heating loss attributable to the currents in the magnetizing windings.

Now just reconsider this situation. Firstly one assures that there is energy stored in the magnetic field of the pole gaps. Then one converts virtually all of that energy into mechanical work. Finally one ensures that no further magnetic energy is fed into the pole gaps during their separation. There is no reference to a magnet in this sequence of events. So let us now introduce a magnet and regard the rotor poles as being those of a permanent magnet, with the stator poles being those of an electromagnet, the latter having a magnetizing winding.

Instead of supplying electric current to set up the magnetic field in the pole gap during the pole closure phase we let that field be that solely attributable to the permanent magnet. The magnet will pull the poles together and supply mechanical drive torque which spin the motor. The electromagnet will be excited during pole separation so as to set up a magnetic field in opposition to that of the magnet, in effect neutralizing the field, or as some might say setting up poles of the same polarity so that they repel whereas there was attraction during the pole closure phase when a magnet pole attracted a non-magnetized soft-iron stator pole piece. Here the situation is that the magnet does the work first to drive the machine and then we do something by which we input power to reset the machine for a repeat cycle. If what we do requires less energy that was delivered by the magnet, then we have `over-unity' operation.

Whatever we do in feeding that energy into the machine involves the process we call `magnetic induction'. There has to be a back-EMF set up in the magnetizing winding when we supply current, if there has to be energy input. By our laws of physics there has to be what is termed a rate of change of magnetic flux linkage to set up that back EMF. The question at issue therefore is whether we can set up a current in the magnetizing winding which opposes the magnetic field in the pole gap but does not promote any change in the net magnetic flux linking that winding.

To reduce this to something quite simple, imagine you are sitting at a table in a room and you have a magnet in one hand and a piece of soft iron in the other hand. See Fig. 1.

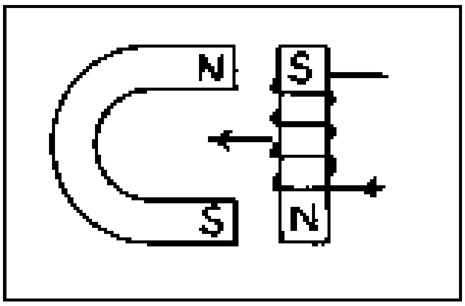

Figure 1

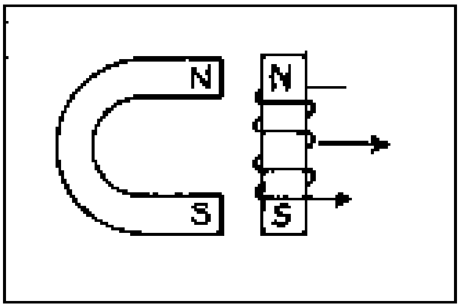

Figure 2

The word `soft' in this connection merely means that the iron is of normal composition and not an alloy or special substance that is used for making permanent magnets. It means that it readily accepts change of magnetic state and readily loses its magnetic state given a demagnetizing field. A permanent magnet requires an extremely strong demagnetizing field before it suffers any permanent loss of magnetism and it recovers from any temporary reduction of strength promptly upon removal of the less-than-extremely-strong demagnetizing field. You can feel the pull of the magnet towards the soft iron. The two having come together, you try to pull them apart to find that it needs a lot of force. If you apply current to magnetize the soft iron bridging yoke then, depending upon the current direction, the yoke will be pulled towards the magnet with even greater force (Fig. 1) or that force will be weakened or even reversed (Fig. 2). If you introduce alternating current (Fig. 3) then the force will oscillate and you can contemplate building a motor by fitting a flywheel, connecting rod and crank shaft.

Now there is nothing contrary to simple electrical engineering principles in this method of designing an electric motor. Indeed, for anyone interested in building model steam engines there could be a fascination in using the connecting rod, crank and flywheel arrangement to convert pulsating translational motion into a rotary form of motion. It so happens, however, that the usual design of an electric motor is more suited to producing rotary motion. It is based on the magnetic poles on a rotor and a stator moving owing to a sideways pull which exists even though the interacting rotor and stator pole faces are equidistant whilst altering their areas of overlap.

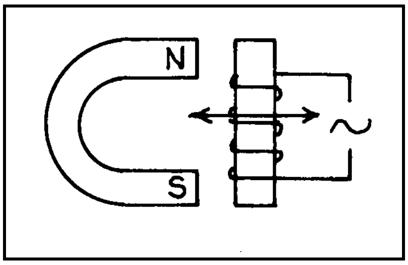

Figure 3

However, staying with our horseshoe magnet and reciprocating engine model, suppose now that, wrapped around the room, running around the perimeter walls, there is a magnetizing winding (or rather a demagnetizing winding) and someone switches a current on in that winding (Fig. 4). Its field acts on the magnet and the soft iron just as it would if the winding were closely wrapped around that soft iron bridging yoke. You would still find you can easily separate the two, thanks to that current in the winding, if it flows in the appropriate direction.

Now you do have a problem. You know enough about magnetism to accept that magnetic flux lines close around their paths in loops quite close to the magnetic source. The flux lines emerging from the magnet and the soft iron are therefore all virtually completely closed well within a metre or so from that table. However, that winding around the room is all embracing and hardly any flux escapes as a linking flux through that winding. There is negligible back EMF induced as it accepts the current which breaks the pull between the magnet and the soft iron. Therefore, one has a situation where power can be generated from the magnetic reluctance action as the poles come together but we input no inductive power to weaken that attraction and so allow the poles to separate to reset them for the next action cycle.

This is a recipe for `over-unity' operation. We have drawn energy from the thermodynamic system of the quantum power state of the magnet and used it to serve a mechanical purpose and we find that no energy input is needed to reset the system for the next cycle of operation.

Now it is not realistic to suggest that windings should be placed around the whole room housing a motor but one can so design a motor that the magnetic flux circuit is closed within a solenoidal winding as if that solenoid does house virtually the whole motor. It is also

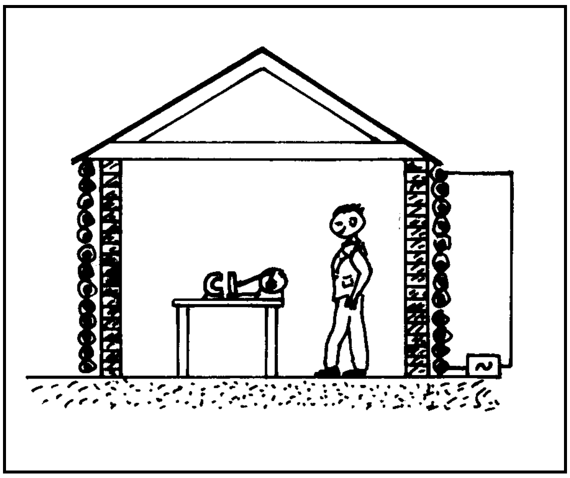
Figure 4

realistic to contemplate the use of superconductive windings to avoid loss of energy by normal joule heating produced by current flow. It is even realistic to build a small prototype machine which does not use superconductive windings and perform tests to verify the principles just outlined. That is described in Part II below. Furthermore, in Part III we will come to understand where that energy that is drawn into the machine to give it `over-unity' performance enters the machine, though a full understanding of its underlying source, which is within the aether, is beyond our scope here in this Report. For that one needs to study this author's book `Aether Science Papers' [This was listed as ref. 1996a in the Appended Bibliography that was included in the original version of this Report. That bibliography is not included here as it can be found on website www.aspden.org along with a copy of that book in PDF format.]

To summarize, given that one can design an electrical motor having a magnetizing winding which has no resistance loss and sets up no significant ferromagnetic inductive reaction when carrying an alternating current and given that the motor will run at a synchronous speed set by the pulsation rate of that current, we can design an `over-unity' motor.

As already indicated the design of a multi-megawatt system will be presented first, before we come to the design of the small bench-type test machine which the author has devised. Of necessity, the latter form of machine has had to use magnetizing windings which are resistive and which do involve inductance, though these are minimized by astute design. However, since the real significance of this effort is the implication for large scale exploitation as power generators in the electrical supply industry, it is appropriate to present the multi-megawatt design next, the object being to arouse interest in government circles and in the electrical power supply industry.

This is done with deliberation, because there have been several claims by inventors asserting that they have ‘over-unity' machines. Often the inventors lack the formal technical academic background of the heavy electrical engineering profession. If their machines work they get involved with prospective sponsors who want the secrets of the invention to be kept confidential until they have exploited the rights, but it needs the engineering talents of the established corporate motor manufacturer to develop the technology. The reason is one of scale. The larger the machine, the easier the task of overcoming the power loading involved in breaking through the ‘over-unity' threshold.

A dynamo-electric machine rated at tens of megawatts needs to have dimensions for which the rotor diameter would be of the order of a metre and a length of two or three metres. Machines of this size are not built as a speculative experimental exercise. They should be, in this author's opinion, because the research funding is negligible when compared with the expenditure which governments waste on high energy particle accelerators and reactors aimed at hot fusion power generation.

The problem, of course, is that scientists think they know all there is to know about the way in which the dynamo-electric machine operates. They devote their research efforts to writing programs for computer-aided design and thereby underline the point that the basis of their formulations is sound and beyond any dispute.

About ten years ago I asked a university lecturer, who specialised in teaching electric machine design and was active in creating computer programs for that purpose, how he allowed for the `eddy-current anomaly' in his calculations. His response to me was that he had never heard of the `eddy-current anomaly'. I was surprised because I had spent three years of my life doing Ph.D. research on that very subject in the Department of Electrical Engineering at Cambridge University in England. I knew that the precise way magnetic flux density B in iron varies with the magnetizing field H is not something one relies upon from electrical steel manufacturers' specifications. I will not bore the reader here by enlarging on that theme. If you are interested then do refer to Energy Science Report No. 3 in this series, but take my word here for the fact that the machine design I shall describe below would not be something that could perform in the manner predicted by use of those programs for computer-aided design. Ask yourself, "Could such a program on offer commercially today really predict the `over-unity' performance of an electrodynamic machine?"

You see, I know of two fundamental processes that are at work in such machines, either of which has `over-unity' implications. One is the process that undermined by Ph.D. research effort. I found that the eddy-current induction losses in electrical sheet steels could be six times greater than theory predicted, albeit only over a limited portion of the B-H hysteresis cycle. I attributed this to a loss mechanism as if there was a mystery time delay in the flux transitions accompanying change of magnetic state. I was not, in those Ph.D. research years (1950-1953), aware of the possibility of breaching the second law of thermodynamics. Otherwise I would have been writing about `over-unity' machines and `free energy' power sources in my early career, rather than now in my retirement. The mystery which underlies the `eddy-current anomaly' is the regeneration of electrical power from heat wasted by ohmic resistance loss! That six-fold factor I measured, later to be surpassed by researchers who found that a factor of 10 was in evidence in some steels magnetized across the direction in which the steel had been rolled to form in into sheets, tells me that there is thermodynamic regeneration of power on a mammoth scale. It exceeds by far any level set by the Carnot criteria and I see in that the basis of a new technology. That may explain why I deem Energy Science Report No. 3 to be very important.

Now, in the design of the multi-megawatt machine under discussion here, I need to keep that `eddy-current anomaly' in mind, while aiming to tap energy from that quantum world which powers the ferromagnet. The energy source is thermodynamic, but whereas the `eddy-current anomaly' draws on normal heat energy generated in the steel by resistance loss, the quantum activity taps entropy of the underlying vacuum medium, or aether, which is where the quantum (Planck's constant) is determined.

Moving on, I stress that those who will be consulted in the evaluation of what I say here will not find they can use their computer-aided design techniques to verify in advance whether or not my machine will work to deliver `over-unity' performance. They need to understand rather more about `magnetic flux leakage' than they do at present, before they can even adapt those programs to face this new task. Furthermore, they need first to understand inductance and the `half-field reaction' phenomenon that I describe in Part III of this Report. The only way forward is to bite the bullet and spend the money needed to build the test prototype machine I now describe. They can by all means debate the pros and cons of my proposal, but they will not be able to deny the validity of my overall conclusion, because of what I say above by reference to Fig. 4 and what I shall describe below in Part II.

Fig. 5 shows the sectional side elevation of the machine and Fig. 6 shows the sectional end view from the position indicated by the outer arrow markings. The machine comprises a solid steel rotor having a laminated set of toothed electrical steel stampings at each end. The teeth on these stampings form rotor poles which interact with the six stator pole members. These have the form of laminated electrical steel stampings assembled in a stator support frame (not shown) and forming bridging yokes. The structure is comparable functionally with the simple arrangement depicted in Fig. 3.

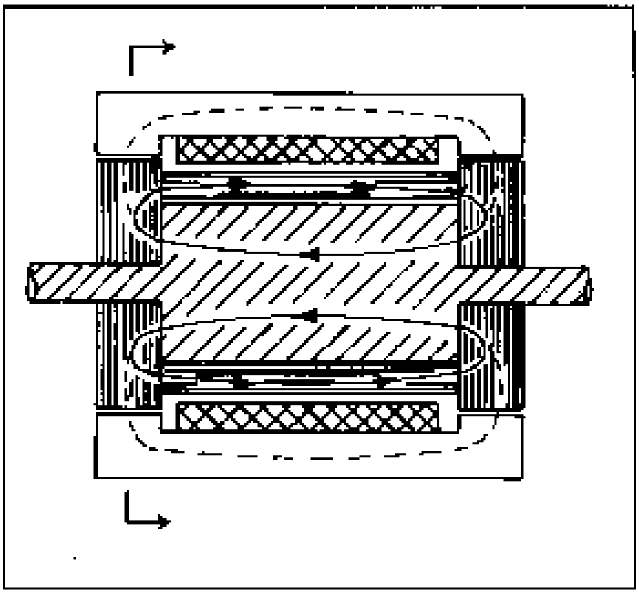

Figure 5

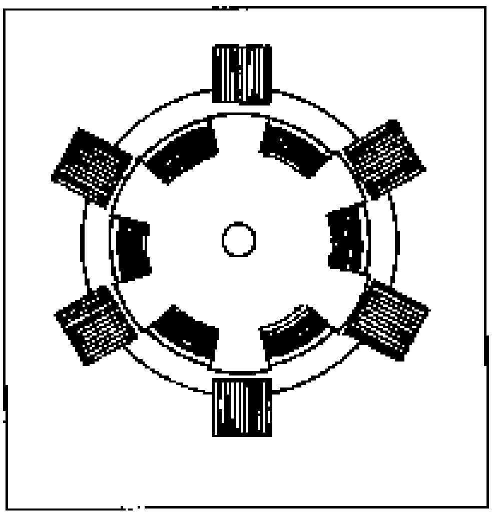

Figure 6

However, there is a fundamental difference in the way in which the magnetizing winding is incorporated. The main magnetizing winding is solenoidal and shown as the cross-shaded stator-mounted structure in Fig. 5. It is superconductive. There is, however, an additional magnetizing winding (not shown in Figs. 5 and 6) that is positioned in slots around the perimeter of the solid steel rotor. See Fig. 7 for an outline of constructional detail. This winding is a normal copper winding connected between slip rings mounted on the rotor spigots.

Between adjacent pole teeth on the rotor laminations there are blocks of electrical steel laminations interfacing with the sides faces of the teeth to guide magnetic flux from the pole teeth around a closed circuit shown by the three arrow markings on the full line curves in Fig. 5. The path is through a spiral wrapping of laminated electrical sheet steel

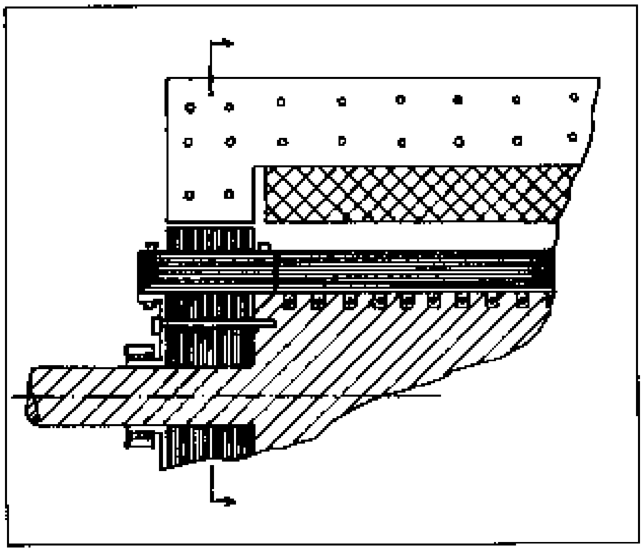

Figure 7

providing infill between the inter-teeth blocks. As can then be seen there is a closed flux path through the body of the rotor and this spiral wrapping, so that very little magnetizing current in the rotor winding can produce a flux density near to magnetic saturation around that rotor circuit. For design purposes one can assume a magnetic permeability of several thousand so that 15,000 gauss can be developed by a few ampere-turns per cm. length of the rotor.

Very little power is therefore expended in introducing the priming magnetic condition of the rotor. So far as induction is concerned, note that the rotor body comprises solid steel. Once the magnetic flux is set up in it the rapid fluctuations of any externally-applied field will have no effect on the rotor body. Eddy-current screening will confine related flux changes to a very small penetration depth and losses arising from that at the surface of the rotor body will be negligible. However, in resisting inductive flux change through the body of the rotor, the flux has to remain constant and that means that, external to the core body of the rotor, it must find a through path regardless of the varying position of the poles of the machine.

The task in operating the machine is, therefore, that of ensuring that the magnetic flux from the solid body of the rotor either finds its way back through the spiral laminar steel wrapping on the rotor or diverts through the outer perimeter faces of the rotor poles and finds its closure path through the bridging yokes of the stator. The latter route is indicated by the broken line curves shown in Fig. 5.

With no current in the superconductive winding the paths of least reluctance are those shown by the full line curves. The 15,000 gauss flux density of the core body will, by appropriate design in determining the ratio of the cross-sectional areas of the solid and laminar portions of the rotor, be such that 8,000 gauss, say, applies in the right-hand direction within the laminated portion. However, when current flows in the superconductive winding in a sense that reverses this flux direction, the design requirement is that the combined effect should produce a 20,000 gauss flux density in the stator bridging yoke members.

The plan is to operate the machine by feeding current pulses into the solenoidal winding to divert the rotor core flux across the pole gaps as the rotor and stator poles come into register and have no current in that winding as the poles separate. What is so special about this machine design is the fact that we have built into the machine a basic polarization bias which allows us to use a solid-bodied rotor construction, needed for strength in withstanding rotation at, say, 3,600 rpm and have located a single solenoidal stator winding in a structure that is easy to cool to assure the superconductive condition.

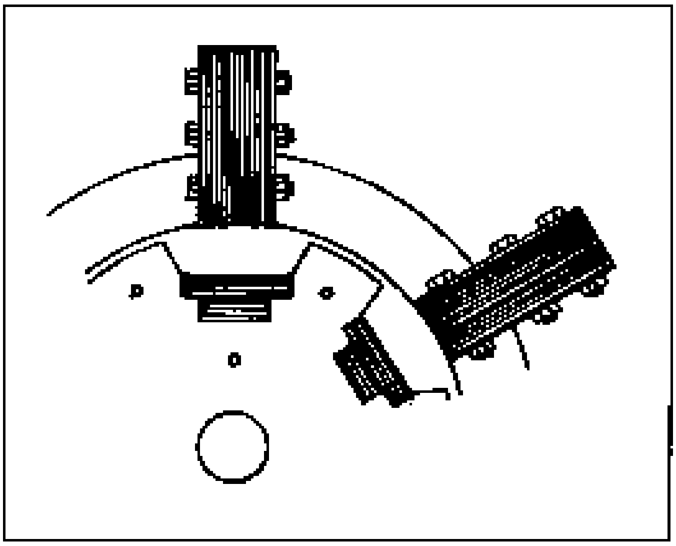

Figure 8

It is special also because we have a ferromagnetic core subjected to pulsating magnetic flux conditions by a unidirectional current pulse fed to that superconductive winding. Note further that the flux density range of change in the spiral laminar wrapping around the rotor is between, say, ±8,000 gauss, which is very moderate in electrical machine design terms, whereas the flux density range of change in the bridging yoke members of the stator is between, say 5,000 and 20,000 gauss in the same direction.

The thickness of the latter members can, as one sees from Fig. 8, be made such that this 20,000 gauss level of flux density is assured, given that the 15,000 gauss of the solid rotor core portion will be sustained by induced reaction currents if the current excitation of the superconductive winding is not perfectly matched to the load conditions. Also, in the design of this machine an important factor is the retentivity or residual magnetism trapped in the stator bridging yoke members. This residual magnetism makes it easier for the basic level of stator flux density to be maintained at 5,000 gauss.

Now, although we have, by reference to Figs. 1 to 4, seen that it is possible to operate a motor with `over-unity' performance, we have not explained how the energy is drawn in from the aether to balance that gain. As we shall see presently from Part III of this Report, we need to activate a magnetic core over a range of magnetization where the ferromagnetic domains in the steel begin to turn owing to the action of a magnetic field, as distinct from flipping spontaneously by trigger action involving a weak magnetic field. The latter is what happens at low flux density.

Fortunately, from the viewpoint of our machine design, that `flipping' of flux direction is avoided in the solid portion of the rotor and is very much reduced in the stator owing to the magnetization cycle being centred on a flux density of 12,500 gauss. Hysteresis loss which is associated with those spontaneous flips of the magnetism in the domains within the steel is very much reduced under these conditions. So far as the hysteresis loss in the spiral wrapped laminated portion of the rotor is concerned the 8,000 gauss range limit keeps that loss below normal levels prevalent in transformers and dynamoelectric machines. It follows that the primary loss would be the ohmic resistance loss in the main winding, but we have avoided that by using the superconductor in its construction. Note, further, that the strong magnetic flux densities we see in the steel are not required to penetrate the superconductor material and that the use of a `warm superconductor' substance is likely to prove commercially viable as the machine design suggested here is implemented.

It will be apparent to experts in electric motor design who may come to read this Report that the machine depicted in Figs. 5 to 8 does not exploit the feature by which inductance of the magnetizing winding is reduced. Yet it does, in a sense and indirectly. The superconducting winding has to reverse the magnetic flux in the spiral laminar portion of the rotor. This means that we must supply energy as input to match that stored by inductance in the pole gaps of the machine. We intend to use that energy priming condition to develop machine drive torque but, owing to the bias polarization, we intend to draw in some extra energy into that gap, as will be explained in Part III. This augments the drive torque. Now, if we were to wait until the machine had used its magnetic drive fully as its poles reach their in-register condition, before we switch the current off, we would not get much of that input energy back. However, if the machine is operating under `over-unity' conditions, we can target a moment to reduce that current so as to get substantially the whole of that input energy returned from the inductance. In effect, therefore, though we have to contend with the back EMF attributable to inductance, we have in sight the design criteria for a machine which possibly might have the merits of the notional motor arrangement shown in Fig. 4.

It will be easier to understand the technical points involved in this proposition if some of the design details for operation of the multi-megawatt machine are deferred until Part IV of this Report. This is because the analysis in Part III will provide a foundation for understanding the way in which the machine functions to tap aether energy and because there will be some reference to patents bearing upon the subject and these patents warrant inspection for their commercial significance. Accordingly, attention is now turned to the bench-type motor which implements the principle introduced in the above discussion of Figs. 1 to 4.

PART II: The ASPDEN Motor

The ASPDEN motor is based on an evolving design principle which encompasses several technical features implicit in the name just given. Although ASPDEN is this author's surname, it can serve as an acronym for:

Asymmetric Shaded-Pole Dynamo-Electric Negentropy machine.

The expression `negentropy' signifies `over-unity' operation, because the usual expectation in energy science is that entropy, which is a notional quantity representing an amount of heat Q as degraded by temperature T, or Q/T, always increases. The term `negative entropy' or `negentropy' implies the reversal of this process and signifies a regenerative action.

The `asymmetric property' is a subject discussed in Energy Science Report No. 7. It is introduced by tilting the laminar assemblies constituting the stator poles, the object being to cause the machine to operate more efficiently when rotating in a specific direction. The orthogonal relative disposition of the laminar planes as between the stator and rotor poles accounts for the `shaded-pole' aspect, but this is not strictly a shaded-pole design in the normal sense. The reason is that the `shaded-pole' feature aims to preclude magnetic flux from leaving the poles in a direction that retards the drive, whereas the conventional `shaded-pole' design relies on magnetic flux penetration and that generates unwanted inductive heating. The current giving that heat shifts the phase of the emergent flux and creates the drive. The latter is an inefficient process. The former can be quite effective in supplementing the efficiency of the machine.

From what has been said by reference to Figs. 1 to 4 it will be understood that the machine must have a single solenoidal winding mounted externally with respect to the whole operating magnetic circuit, so that it is not restricted in dimensions to the small aperture space that allows it to fit onto individual pole pieces. Furthermore, we want the winding to be so positioned on the machine that it acts only indirectly on the pole gap and lets the magnet system do the work of feeding energy to that pole gap region.

Contrary to the design shown in Fig. 5, we will set the solenoidal magnetizing winding so that when it is powered to oppose flux in the pole gaps it assists the magnetism of the magnet. Alternatively, when it is powered to assist the flux in the pole gaps, it opposes the magnetism of the magnets. This poses no problem, however, because the magnets are virtually immune from the effects of fields of the strength needed to run the motor. By putting the magnets into the rotor assembly, it is the soft iron bridging yokes forming the stator that `see' the power of the field we apply to that magnetizing solenoid. The magnets set up the basic polarization which develops demagnetizing effects in those bridging yokes, making it an easy task then for the magnetizing (or rather demagnetizing) current to reduce the magnetic flux across the poles gaps as they separate. However, running in the alternative mode with current assisting the pole gap magnetization, the effective permeability of the irom in the bridging yokes is still of the order of 100, whereas the effective permeability of the magnets in the rotor is close to unity. It is feasible, therefore, to run a motor by using a single magnetizing winding wrapped around the whole body of the machine so as to surround virtual all of its internal flux path.

Inevitably, of course, since we are not talking about the notional embodiment shown in Fig. 4, we will have some flux leakage that escapes from the winding. Also, there will be a reduction of magnetic flux through the magnet as the poles separate. This will not involve significant eddy-current losses if the magnet is of a composition that is non-conductive, such as a ferrite. It would be a problem if one uses an alloy such as Alnico as a magnet. At least, it is feasible to build and test a small motor that operates by using a single solenoidal magnetizing winding in the manner just described.

Fig. 9 illustrates the second test machine built by the author. It dates from April1995.

It uses loudspeaker-type barium ferrite magnets of 60 cm outside diameter, 24 mm internal diameter and 8mm thickness. The rotor laminations of 90 mm external radius have 8 poles and an internal diameter of 19 mm permitting a tight fit on a slightly reduced 3/4 inch diamter brass spindle. There are 8 bridging yokes which comprise small rectangular transformer laminations of 3 inch by 1/2 inch dimensions.

The machine was fitted with a d.c. drive motor that could serve equally as a generator and was intended to bring the machine up to speed before current was applied to the test machine. The decision to use 8 poles proved to be a problem, because it was not feasible, given the author's circumstances, to assemble a suitable commutator and the author opted to control the machine electronically.

Note that, to operate with the current assisting the drive as the poles close, one can expect the machine to be self-synchronizing with the pulsed input. However, in the

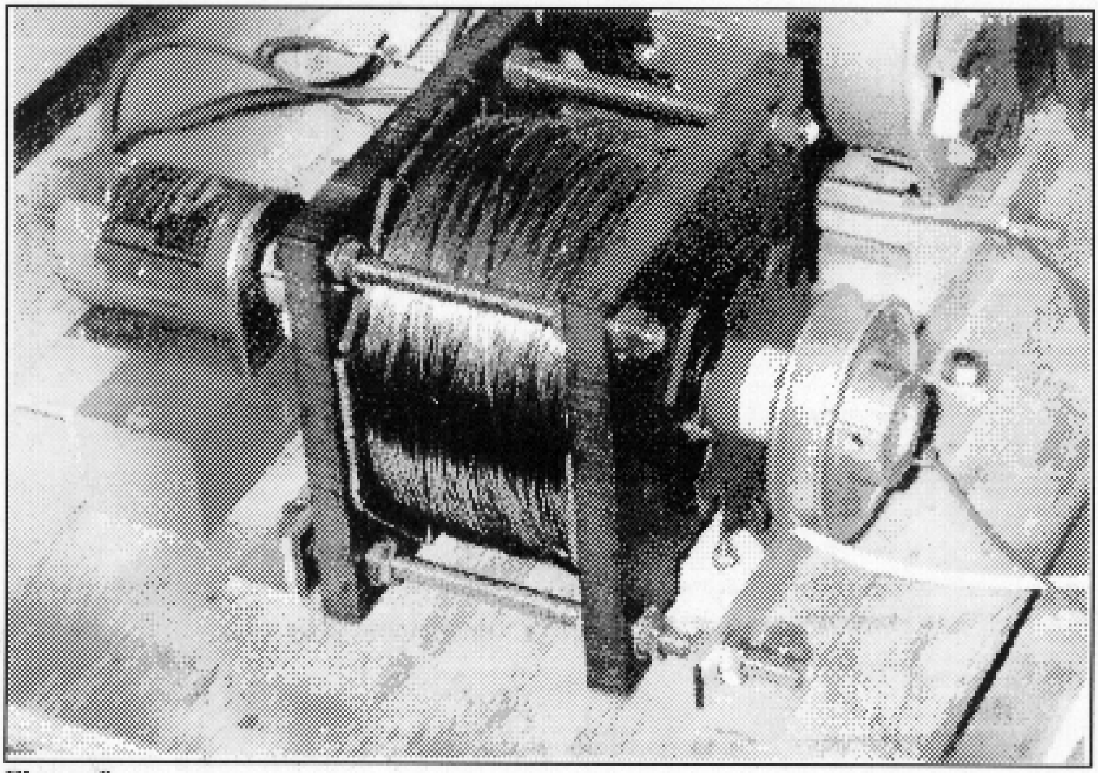

Figure 9

opposition mode, unless the pulses have to be correctly timed according to the position of the motor shaft, otherwise it will lose synchronism.

To the extent that these problems could be overcome, the plan then was to apply power to the test machine and relieve the load on the drive motor gradually to see whether the energy input to the test machine was less the energy saving in feeding the drive motor.

In short, the question was whether any drive at all could be provided by that single external magnetizing winding, because it was quite unorthodox to configure a motor so that the only winding did not link the magnetic circuit traversing the pole gap. Instead, the motor shown in Fig. 9 was designed with a magnetizing winding that was linked only by stray leakage flux and there could be no doubt owing to its outer position on the perimeter of the stator bridging yokes that most of the flux diverted from the pole gaps had still to find its return passage confined within the magnetizing winding.

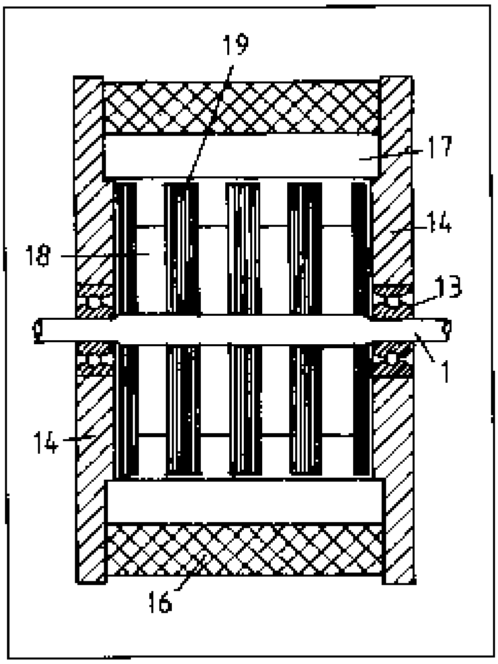

Figure 10

Note further that the essential issue of concern was, not the amount of loss caused in the winding owing to I^2R heating effects, but whether the energy lost as inductive power input to drive the machine was less than the mechanical energy gained. Keep in mind that, whether working in the supporting drive mode or the opposing drive mode, the object is to draw more mechanical power from the closure of the pole gaps than is supplied as irretrievable inductive power input, either to augment the gap flux during pole closure or to weaken the gap flux during pole separation.

One troublesome question faced by the author during these tests of the opposed mode excitation was that of being sure that the current applied did not exceed that needed to suppress the pole gap flux, because if it was too large it could simply divert the flux from the magnet into the ends of the bridging yokes and so through an external leakage closure path. The leakage had, so far as possible, to be from the sides of the rotor poles and confined close to the rotor core. That is why the design of the machine was as illustrated by the sectional drawing shown in Fig. 10.

Note that in Fig. 10 and Fig. 11, which shows more detail, there are numerals which are used because these illustrations are copied from one of the author's pending U.K. Patent Applications.

The assembly comprises a spindle 1 mounted in bearings 13 in end frame members 14. The latter have shoulders which located stator bridging yokes 17 around which there is a helically wound coil or solenoid 16. Mounted on the spindle is an interleaved assermbly of ring magnets 18 and electrical steel rotor laminations 19, the latter having 8 poles uniformly spaced around the perimeter. The angular spacing between the pole teeth is the same as the pole width. The current pulses fed to the winding 16 are assumed in this case to produce a field H acting to oppose the tendency of the magnetic flux developed in the magnets from producing a full measure of magnetic flux through the stator yokes 17. When no current pulse is present then the magnets can promote magnetic attraction between the poles on rotor laminations 19 and the stator yokes 17. Otherwise, when current

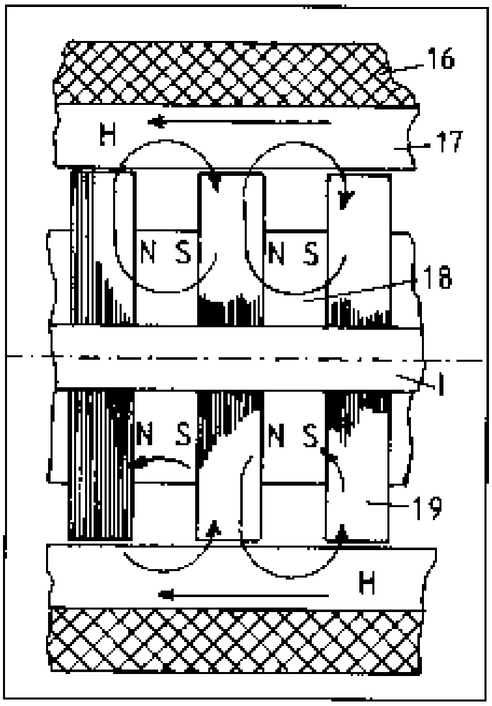

Figure 11

is present, that attraction is weakened. As a result, by pulsing the winding 16 at the right timing, the motor will develop a drive torque. Now, although it is not easy to see from these figures, at times when the current is on and blocking some passage of magnetic flux through the stator, there is a diversionary route for flux closure from the magnet. The inner side faces of the rotor pole teeth allow leakage of magnetic flux lines across the axial gap between adjacent sets of rotor laminations. This is an easier flux leakage route than passage from the ends of the machine and around a path external to the winding 16. What happens is that the intensity of the flux through the magnet diminishes somewhat during the current pulse periods and, of course, at times when the rotor and stator poles are out of register with one another. The magnets, being of ferrite composition, offer negligible eddy-current reaction to such flux change. However, in penetrating across the faces of the rotor laminations the flux from the magnet does encounter such a reaction because currents are induced in those laminations. This has the effect of tending to keep the flux passing through a magnet and reaching the rotor teeth at a constant level. This enforces the flux switching between the leakage paths and the stator and means that the flux across the radial pole gaps varies as the rotor turns in step with the current pulses.

The essential question one confronts is that of knowing how effective the current can be in driving magnetic flux from the stator. The answer to this is best found by experiment and the evidence of operation of the machine.

It is found that the pulsing of that helical winding wrapped around the whole stator assembly will, in fact, impart drive torque to the machine. This means that we can contemplate making the machine larger in size and making the helical winding so large in cross-section that its I^2R loss is very small. Furthermore, if we examine the efficiency of the machine, measured with that I^2R loss discounted, we should find that it exceeds unity or 100%, if our assumptions are correct and much of the flux switching occurs within the confines of the winding, with little flux escaping from the ends.

The following data is an extract from what was reported in the first report on this subject submitted to the DTI, the U.K. Department of Industry in July 1995. The full text of that first report is provided in Energy Science Report No. 7 of this series. As there acknowledged, the DTI have funded the initial stage of this research project as part of their SMART Award system for technological innovation.

"The first test on the machine was a test using half-wave rectified 50 Hz a.c. This meant running the machine at low speed (375 rpm), not enough to test the shaded-pole feature, which was the dominant interest owing to the funding arrangements. These tests were, therefore, of a cursory nature just to see if half-wave current pulses did affect the machine in the manner expected, but more particularly to get a measure of the induced back-EMF and so the level of flux activity across the pole gaps and to see how the pulse input relieved load on the drive motor."

“It proved extremely difficult to get the adjustments of the controls just right with the motor running at 375 rpm for the expected synchronization to establish itself. Then, and only then, was it possible to reduce slowly, stage by stage, the current input to the d.c. drive motor whilst holding that 375 rpm speed. in spite of this, several such tests were performed and the a.c. magnetizing current and voltage were measured as the power input to the d.c. motor progressively reduced."

"Each such test proved very satisfying, because the saving in d.c. power input to the drive motor far outweighed the a.c. input as measured in VA (volt-amps), without regard to power factor. Effort was made to run the system with the test machine driving the d.c. motor as a generator, but with this test arrangement the system lost the 50Hz synchronism once the d.c. input current had reduced to about one third of its original value."

"The problem here arose because the d.c. power supply used was a stabilized voltage supply and it could not drop below 4.5 volts, which is why a load resistor had been put in series with the motor. Although some time was spent in effort to overcome this, the author was more anxious to develop a control system for running the machine at much higher speed and so these 50Hz tests were abandoned."

"One important aspect of the test was, however, the monitoring of the current waveform as supplied to one test machine winding in relation to the voltage waveform induced in the unloaded magnetically-coupled and near-identical second winding." (Note that the winding seen in Fig. 9 is really a two-part winding, each section having 200 turns.) This gave some versatility for testing and operation, even though both windings are wrapped around the same core system. "Together these waveforms gave an insight into the inductive power fed in and returned from the machine over the cyclic period of pole closure and separation."

"It was then very evident that the power factor governing the a.c. power input was such as to indicate a quite significant excess power, even assuming that the d.c. drive motor was only 50% efficient. Ostensibly, it seemed that the test machine had to be operating above 100% efficiency by drawing on thermal heat input."

"The most important observation, however, apart from finding that a pulse amplitude of about 0.8 amps in the single test winding was needed in the test, was that very nearly all of the inductive power input to the machine was being returned by the a.c. circuit. The volt-amp product reversed polarity as the half-wave current decreased. It could do this because the rectifier diode used could sustain current flow by the winding generating a forward EMF."

"Now here was a feature that was important. With the machine driven by the permanent magnet system the inductive power fed in to secure flux switching was not all used in adding power to the machine drive and even in these 50Hz tests, where current was reducing as flux collapsed, most was, it seems recoverable. This had been anticipated, or at least hoped for, in developing the machine design because the relative configuration of the source magnets and the stator pole pieces, but it was gratifying to see this confirmation."

"This then became a reason for examining the prospect of building or procuring an a.c. power source that could operate efficiently at 250-400 Hz to power an inductive load regeneratively through a diode. The attendant problem was also that of assuring sufficient frequency stability to be compliant with the synchronous operation of a motor not receiving its power drive as such from that supply."

"This pursuit tended to run away with the time available for the project, with partially successful results using the same test machine. Eventually, to move the project forward, the author decided to use a simple electronic power drive where one machine winding signalled the control timing needed to put power on the other winding. A pnp power transistor was connected so as to deliver its collector-base current to one winding in its ON-state, and inhibited so as to be in the OFF-state when the other winding delivered a positive polarity signal to the base."

"With such a control system the test results of this Report" (i.e. Report No. 7) "were obtained, but any inductive power returned from the machine winding is necessarily dissipated and detracts from the possible efficiency of the machine. This is because the forward EMF set up by that return of energy causes an unwanted current spike at the end of the cycle. There was the problem with the system under such test that it could very easily be set with its magnetic pole gap flux wasting power in oscillations. Had a capacitor been incorporated without informed design based on test performance then that too could have aided oscillation, rather than helping to suppress such effects whilst storing energy for use in the next machine cycle."

The above excerpts from Energy Science Report No. 7 will show the reader that one cannot just build a motor such as that illustrated in Fig. 9 and expect it to deliver 'over-unity' power on demand. It is essential that one understands how the design features are supposed to function. What was soon evident was the fact that the magnetic flux density across the pole gap was far below the level where 'over-unity' operation can really reveal itself in a dominant way. However, the machine was a prototype that could be scaled up to achieve that result and the tests that could be performed could verify design feasibility.

The fact that the machine could be operated by the control of that external winding was the proof this author needed to see purpose in advancing the project.

As can be seen from Fig. 9, a d.c. motor is coupled to the main test machine, the latter having the all-enveloping helical winding by which it is powered. The 50Hz tests reported above as well as the electronically pulsed tests reported below were done at an early stage. It is only recently that the author has reverted to this early machine version and fitted the vane switch that can be seen behind the pulley. That vane switch comprised a single 8-pole electrical steel rotor lamination as used in the internal construction of the rotor. Its teeth swept through a gap in a sensor device including a small magnet and a Hall effect switch. The latter was used in onward testing to control the commutation. However, it was not fitted at the time the following test data were obtained.

These data were produced with only half of the test machine winding carrying drive current, the other half being used to provide the induced EMF controlling the electronic switching. One can, therefore, see that the I^2R losses in the winding can be halved by using both windings for drive power and using either the vane switch, a commutator, or fitting a winding of a fine gauge wire to produce the induced signal for electronic control. Further, one can have more turns or use much thicker gauge wire for the main winding. Essentially, the I^2R loss can be reduced to a very small value, the more so if the motor is scaled up in physical size. This is because the loss increases as the square of the linear dimension of the machine, whereas the drive power increases as the cube.

The objective is to see if the machine derives any drive at all from the current pulsing of the single helical winding and to get some measure of power gain.

Keeping speeds low, but well in excess of the 375 rpm used in the 50Hz tests, the whole machine combination was run, first at 800 rpm and then at 1350 rpm, just powered by the d.c. drive motor. This means that the test machine was simply a load, as the magnetism fluctuating across the pole gaps would involve some parasitic losses. There would be hysteresis loss and eddy-current loss and the retentive property of the stator bridging yokes would apply a stronger drag acting as a brake during pole separation than was gained as a forward drive during pole closure.

For these speeds the electrical power input was 3.331 watts and 5.255 watts, respectively. Note that the d.c. motor developed a high torque and was rated at 68 watts at a speed of 5100 rpm and a 12 volt input at that speed. It was of a kind used to power model boats. It included permanent magnets and tests indicated that its efficiency was about 50% over its main working range. It could be run in reverse to generate electrical power with much the same efficiency. Indeed, two such machines, coupled back-to-back, were tested to see how much d.c. power input to the drive machine could be recovered from the generating machine and overall the efficiency was between 25% and 30%.

Keeping the d.c. motor drive power on, the circuit feeding pulses to the winding of the test machine was then activated and the power supplied to the d.c. motor adjusted so that the whole machine combination ran at 1350 rpm, as before. The d.c. motor was then taking a power input of 2.618 watts, less than half the power needed to reach that speed without the test machine excited. Of course, there was electrical power input directly to the test machine, but that power was going into the helical winding you see in Fig. 9.

Clearly, the machine could be driven by such a winding, even though it was not linked by magnetic coupling to a flux path through the pole gaps!

Now, these tests were run at low voltage and the transistor circuit was very poorly designed for the purpose, but the oscilloscope waveforms could be analyzed and it was possible to segregate the power fed to the test machine to get a measure of the true power input, ignoring transistor losses. The latter can be reduced to very small proportions by using MOSFET technology. From this analysis the power supplied to the test machine for the 1350 rpm speed was 1.718 watts, of which 1.100 watts was VR loss in that helical winding.

If the latter I^2R loss is discounted, because it can be reduced to negligible proportions with appropriate design, and we look solely at the magnetic activity of the drive, we find that the added 0.618 watts plus the d.c. motor input of 2.618 watts is doing the work which needed 5.255 watts using the d.c. motor on its own. It took 3.331 watts to run the system at 800 rpm before the test machine was excited, but, once excited by magnetic power input of 0.618 watts to the test machine, the 3.331 watts input reduced to 2.618 watts and the whole system increased in speed to 1350 rpm. Ostensibly, to the extent that we can virtually eliminate much of that VR loss in the helical winding, we have a reduced power input of 0.095 watts and the machine runs 69% faster.

Now, even if the test machine were 100% efficient and the d.c. motor were 50% efficient, this could not account for this reduction in power, and so one simply must conclude that there is evidence of 'over-unity' performance.

Although I could, at this point, begin to describe my onward research efforts and other machines that I have assembled, I intend to confine this Report to the basic issue of establishing a scientific basis for the design of an 'over-unity' machine. There are really only two questions to answer when it comes to assessing the prospect of such technology impacting our future. These are: (a) can one build a machine of such large power that we can use it for generating electricity supplied by a utility distribution network and (b) can one explain the design principles in sufficient detail for scientists to understand the true source of power?

I see little point in just building a bench-top machine which runs to illuminate a few light bulbs as if with no input power source, because others who have done that are deemed to be performing tricks and are not heeded by the scientific establishment. As I see it, it should suffice to present the outline of a motor design such as is introduced in this Report No. 9 and as described in Energy Science Report No. 7 and let those interested ponder on my explanation of the scientific principles that I explain. If they can then see the light then, and only then, will they see purpose in building their own machines, guided by what is here disclosed. As with any technological development there is much to learn in the know how of the design and I do not see myself as a one-man R&D operation competing with major industrial power engineering interests. Nor is it my role to educate those expert in that field of endeavour. I will, however, disclose the secrets of that energy world which I have deciphered from my studies, founded as they are on early academic and industrial training in heavy electrical engineering and research in ferromagnetism, and I look only for recognition for my scientific endeavour. This is why I have interrupted my motor research and given priority during 1996 to producing my book 'Aether Science Papers' [1996a].

Accordingly, for those having the necessary skill and background experience in understanding magnetism and electrical theory, especially those versed in power engineering, I will now move on to Part III of this Report.

PART III: The Energy of a Magnetic Circuit

The academic understanding of the way in which energy is deployed within a magnetic core in which there is a small air gap was a mystery some 50 years ago and has remained a unsolved mystery, now ignored by professors of electrical engineering. Professors of physics teach the science of magnetism but are seemingly unaware of the problem. Indeed, by adopting a particular interpretation of a physical phenomenon of no practical importance they have, in effect, blocked the way forward to solving that mystery and in so doing they have not seen the scope for generating power thermodynamically from the aether itself. The mystery is rooted in the phenomenon discovered by Michael Faraday, namely electromagnetic induction.

It is an experimental fact that a closed magnetic circuit formed by a ferromagnetic ring core wrapped within a magnetizing winding will develop a very powerful state of magnetic polarization around the core even when a quite small current is supplied to the winding. However, if you so much as slice a gap in the core no greater than two thousandth of its overall length, then that polarization will immediately lose of the order of 5% of its strength. Make the gap four thousandths of the core length and you lose 10%. Professors will tell you that this is caused by `magnetic leakage'. The core section may have a width of one hundred times that of the gap but those professors will still say that 5% of the overall magnetism in the ring core is `leaking' from the gap and presumably finding a route through air that is far longer than that through the air in the gap.

Now, I say that is simply `rubbish' and I can also say that I have yet to see any textbook present a verified theory of magnetic leakage that explains the phenomenon in a formal scientific way. The nearest one can get to that, so far as I know, is the Oxford Clarendon Press textbook published in their Oxford Engineering Series in 1955 under the title `The Principles of Electromagnetism'. Its author was Professor E. B. Moullin, who was President of the Institution of Electrical Engineers in U.K. when I began my first year of research in the Department of Electrical Engineering which he headed at Cambridge (1950). That is nearly half a century ago. You will find that 5% factor, just mentioned, on page 174 of that work and you may take note of his final sentence on that page:

> "The writer is not able to forecast any relation between the leakage inductance and the size of the magnet".

However he did find it possible to match up theory and experiment in the case where the gap was made extremely large by completely removing the bridging yoke in his experiment. the calculated leakage inductance did agree with the measured inductance in that case, but there was something amiss in the concept of leakage when the gap width was small and of the order of a few millimetres.

Professor Moullin presented experimental data of tests he had performed on a core which was about one metre in overall circuit length and which had a square cross-sectional area of 8 cm by 8 cm. Although he saw the experimental data as representing `leakage' this author sees something far more important in that data. There was more energy in the gap than had been supplied by the magnetizing current!

This was only noticed many years after Moullin's book was published, but it then caused the author to repeat the experiment and confirm that the flux was not leaking to the extent suggested. This was reported Energy Science Report No. 1 in this series, where it was suggested that we might be able to build `over-unity' motors, guided by that new knowledge.

I wish here, however, to enlarge on the academic theme involved in this question of the core with a small air gap. There are other mystery questions involved in this subject. Firstly, how can it be that a coil uniformly wound over a one metre length of core can somehow shed energy confined to a one millimetre length where the air gap is located? You may say that the magnetic core accepts that energy and transfers it to the air gap but, again, apart from doing an accounting fiddle and making the energy books balance, how does energy travel through that magnetic core? We are not dealing with water in a porous conduit having an empty cavity at one position along its length, though some professors may be satisfied with that type of analogy.

No, the answer to this question is something rather startling that will surprise any professor! In fact, what happens when we put electric current through that winding is that it produces a magnetic field around the whole core and in the onset of that field there is electromagnetic induction by which energy is fed uniformly into the whole reacting system, whether the latter is the substance of the core, mere air or even just the vacuum. I am saying also that all that energy input is lost as heat with no time delay since it is fed directly into charge in motion over which we have no control. That moving charge can be in the form of free conduction electrons in a metal or electrons belonging to atomic structure in, for example, a ferrite or be the charges that sustain Maxwell's displacement currents in the vacuum field. The energy is lost as surely as if it were shed in a microwave oven by eddy-current heating. It adds to the entropy of the environment.

The secondary effect of that magnetic field acting all the way around the ring core is to assert forces on the electric charges that are moving freely as part of that world of entropy, whether in the air gap or elsewhere around the core inside that winding. No energy transfer is involved in this steady-state condition because the forces act at right angles to charge motion. However, by Lenz's law which requires an opposing reaction or by reference to the derivation of what is known as the Larmor formula, there is deflection of charge motion into helical paths orientated to set up a reaction field.

The existence of this field even in metals is never mentioned in physics textbooks. On the contrary, the nearest one gets to this is the occasional reference to what is known as `the absence of free electron diamagnetism'. Physicists who studied this problem early in the 20th century were at pains to eliminate it from their thoughts by inventing statistical reasons, such as spins being paired in opposite directions and so cancelling, their objective being to avoid the embarrassing question of why a steady magnetic field could penetrate copper when, in theory, it should be completely suppressed by diamagnetic reaction.

I found those arguments unconvincing and decided that we had to face up to this question and accept that Nature did react to set up a strong opposing field. I went a little further in my interpretation of the reaction and added the rider that Nature would limit its response to the extent that allowed potential energy to transfer into the magnetic energy of the reacting field. You see, my argument is that forces acting on charge in motion are not set up by a magnetic field just because some scientist or other enunciated a form of law. Forces exist only as part of the energy transfer process and are governed by what happens to energy, the latter being subject to that natural `law of conservation of energy'.

Simple analysis told me that the maximum transfer of energy into the reacting field occurred when the reaction halved the strength of the applied field. It further told me that the kinetic energy density deployed from the random motion of that world of entropy and used in the orientation of the reacting orbital motion of charge will exactly correspond to that we associate with the magnetic field. In other words, I had discovered how magnetic energy is stored in the vacuum field and how it is recovered when the field subsides. I had discovered the mechanism underlying the process of electromagnetic induction and I knew that it involved reversible thermodynamic processes.

Back to our magnetic core problem, I knew that the energy fed into the magnetizing winding is all shed as heat and lost to the world of entropy but, equally, I knew that, of the entropy action inside that core, as distributed all along the length of the core and through that air gap, there is an orientation of magnetic moments producing a uniform reaction field. Furthermore, this reaction is not just attributable to the field H set up by the winding. The reaction cannot discriminate between fields set up by windings or those set up by electrons in motion within atoms in a ferromagnet. So the reaction field really is of strength B, the full intensity of the flux traversing the air gap. However, its direction is in opposition to that of the primary magnetization. Now, far from this being a problem, it was truly wonderful to see what all this implied. The theoretical analysis underlying the reaction effect had told me that the reaction field would halve the strength of the applied field. So, if the learned professor tells me that the magnetizing field set up by current in a winding has a value H but there is no diamagnetic reaction in the vacuum, I say "Oh, no!" and declare instead that the field set up is 2H but it is always opposed by the reaction H in the vacuum state and so the measured field is H, but because of that reaction there is reason to understand how the vacuum stores energy as a function of H and how when the 2H influence is switched that energy is returned to the winding by induction.

The professor may say that this adds up to the same result as his interpretation so why complicate things; it is better to keep the argument simple. My answer to that is that it is essential to know the truth where energy is concerned and, furthermore, that it is the physicist who has complicated things beyond all reason. I refer here to the obvious fact that if what I say above is correct the intrinsic magnetic moment of a charge in orbit when measured in relation to angular momentum will be double the value calculated by that professor on his own reasoning. I then appeal to experiment and ask what happens when a ferromagnetic rod finds its magnetism reversed. Will it acquire a change of angular momentum corresponding to its electrons having the gyromagnetic ratio e/mc or e/2mc, where e/mc is the charge mass ratio of the electron in electromagnetic units?

Lo and behold, the textbooks say that the theoretical value for electron orbital motion is e/2mc but the value e/mc is observed! So how does that learned professor explain the anomaly of that gyromagnetic ratio of 2. He invents, or rather Nobel Laureate Paul Dirac invents, the notion of `electron spin' and says that a spinning electron will set up twice the ratio of magnetic moment to angular momentum as applies to orbital charge. The Larmor formula demands the reaction of charge in orbital motion, but Dirac invented spin. What Dirac did not invent was a way of explaining how magnetic induction energy can return to electrons in spin. You see, there is no area described by the motion of a centre of charge and so no scope for flux linkages by which to capture an EMF that can act on the electron to give it energy!

Dirac was wrong to offer `spin' as an explanation for the gyromagnetic properties of an iron rod and because of that error professors of electrical engineering live in the dark when it comes to understanding how energy is transferred to and fro the vacuum by magnetic induction. They live in the dark by not realising that we can take more energy from the entropy of our environment than we release, thanks now to this knowledge presented here.

The question I want now to address is the further understanding of how that, magnetic field set up around the ring core can cause an excess of energy to be fed to the air gap.

From about 1988 onwards I realised that one could see a way to extract energy from the aether by magnetic techniques, but I thought it would involve magnetizing a magnetic core beyond the knee of the B-H magnetization curve. That really means expending energy in setting up strong currents or contriving to incorporate powerful magnets. The Moullin experiments on the core with a small air gap did, however, suggest that something offering energy gain was occurring below the knee of that B-H curve. I now know why.

Essentially it is because we can cause magnetism to turn around corners in a magnetic core. The magnetic flux wants to follow preferred directions in the crystals inside the body-centred structure of iron. If it confronts a corner that is not much of a problem unless there is an air gap ahead around the bend. In that case the magnetism has to get leverage as it were to contend with the demagnetizing effects of the air gap. It has to back-up in some way to build an underlying magnetic field action. Once there is a field H set up inside that iron core then the core is no longer one having high permeability and it develops characteristics that are non-linear which are accentuated below the normal flux density level of the knee of the B-H curve.

To glimpse the reason why that `knee' is so important, imagine you are sitting inside the iron of that core, well away from the air gap. You sense the field H. Now if you are inside a magnetic domain within an iron crystal you are where the iron is magnetized to saturation along one of the three main axes of its body-centred cubic structure. That field H is not going to have much effect unless you are close to a domain wall separating you and an adjacent magnetic domain. In the latter case the wall could sweep right through you as the domain polarization reverses. Very little external energy is involved in this exercise. The field H needed when that air gap is present is far too strong to be wholly absorbed by the lateral shifting of domain walls. Given, however, that the field H exists, those magnetic domains that have the most vulnerable orientation, allow some rotational deflection of their polarization vectors and they will respond as if they have a magnetic permeability of the order of, say, 50 in gauss/oersted units. With no air gap the normal B-H curve can show a permeability of several thousand up to the knee and then, as domain rotation takes over from domain wall movement, the incremental permeability drops to that lower value. With an air gap the need for H to exist at a significant level, even within the core in its below-the-knee state, means that some rotation occurs. Note that rotation in the normal sense begins when all domains have taken up states of polarization along the preferred crystal axes most nearly aligned with the core axis. The sudden instabilities that flip the transitions over lower ranges of magnetization account for hysteresis loss, but once all the triggered transitions are complete and the rotation is smoothly controlled by the strength of the field H, the hysteresis loss reduces. Indeed, rotation regulated by a field strong enough to assure saturation involves no hysteresis loss. This can be a considerable advantage in machines operating with superconducting windings and with limited magnetic flux ranges confined to the above-the-knee region.

Using that arbitrary value of 50 for permeability attributable to flux rotation developing at a flux density of, say, 15,000 gauss, the increment $H\delta B$ which equals $B\delta H$ for the normal linear permeability condition can flip to one where a change of B of 1,000 gauss would make $H\delta B$ 20,000, whereas $B\delta H$ is 300,000. As will become evident from what is reported below, this implies a `free energy' power gain of about half of this 15:1 ratio. The reason, as we shall see, is that $H\delta B$ represents energy supplied by a magnetizing winding whereas $B\delta H$ represents energy fed into the system by the aether which sustains the quantum condition of the polarized atoms in the ferromagnetic core.

The formal mathematical summary of this situation now follows. First, we perform the energy calculations for normal below-the-knee operation, ignoring domain flux rotation.

Let P denote the intrinsic field intensity set up by the ferromagnetic properties of the core, so that:

$$P = B - H \qquad (1)$$

Let I denote the current in the magnetizing winding, which has N turns over a total ring length D. The core has a cross-sectional area of one sq. cm. and an air gap of width g, so that the length of iron core is $D - g$. The winding is tightly wrapped around the core and we can assume this winding also has a cross-sectional area also of one sq. cm.

At this point I explain that I prefer to use a system of units which takes the vacuum state as the base of reference, by which it is assigned unit dielectric constant and unit magnetic permeability, meaning the cgs system. It involves use of 4π but avoids other complications that tend to dominate and confuse formulations where the fundamentals of magnetism are concerned.

The energy input W to the magnetizing winding is then found by integrating the current I in amps times the induced back EMF E in volts. We write:

$$H = (4\pi/10)(N/D)I \qquad (2)$$

and:

$$\delta E = (N\delta B)10^{-8} \qquad (3)$$

We will work in ergs, rather than joules, and this introduces a factor 10^7 in the expression:

$$\delta W = (I\delta E)10^{7} \qquad (4)$$

From (2), (3) and (4):

$$\delta W = (1/4\pi)H\delta BD \qquad (5)$$

By analogy with the derivation of equation (5) one can see that the corresponding amount of work performed by the atoms generating the ferromagnetic state of the core is given by:

$$\delta W_i = (1/4\pi)P\delta BD \qquad (6)$$

From standard physics we know that the energy in the air gap is given by:

$$W_g = (1/8\pi)B^2g \qquad (7)$$

It then follows, from (5) and (8) that:

$$W_g = W \qquad (8)$$

if:

$$B = (D/g)H \qquad (9)$$

because, given this linear proportionality, the integral form of equation (5) becomes:

$$W = (1/8\pi)HBD \qquad (10)$$

It has been the logical assumption, therefore, to accept that energy conservation implies the transfer of the energy input W to the air gap and presume that the action effectively attributes the core-cum-air-gap with an overall magnetic permeability of D/g.

This is in no way a proper physical explanation of the energy transfer phenomenon because the flux density B traversing that air gap exists essentially owing to the polarization by the ferromagnet and must therefore have been powered primarily by the energy represented by equation (6). This equation was not used in deriving equation (8).

To proceed, we may add (5) and (6) to obtain, from (1):

$$\delta W + \delta W_i = (1/4\pi) B\delta BD \qquad (11)$$

which, upon integration, tells us that overall there is a uniform energy density of $B^2/8\pi$, as we expect. However, this can best be interpreted by saying that the energy supplied to the gap comes essentially from the

ferromagnet whereas the energy supplied by the magnetizing winding merely tops up the energy around the whole magnetic circuit to make up for the energy drained into that gap from the ferromagnet.

This leaves us now with a new perspective. The energy supplied to the magnetization winding should not be assumed to transfer to the gap. Instead we should study how the ferromagnet, which delivers energy from the aether by the quantum priming processes that keep it ferromagnetic, can deliver some excess energy which we can use in running our motor.

It is intuitive to examine how the H-dependent energy component is supplied. There are four components of energy of the forms: $H\delta P$, $H\delta H$, $P\delta H$ and $P\delta P$. The first two are power input from the magnetizing winding and the other components are power supplied from the aether. We see that the third term tells us that by applying current to set up the field H we have tapped some aether energy. Now, so long as P and H are linearly proportional, the deployment of energy into the air gap will be approximately equal to the total energy stored by the first component. Also the first and third energy will represent equal amounts of energy when integrated. Note that the four energy components are pooled and distributed over the whole core-cum-gap length D, but it just so happens that H-dependent energy seems to be mainly deployed into the gap. It is then of interest to consider what happens owing to the non-linearity of the B-H curve. At higher flux levels $P\delta H$ will exceed $H\delta P$ and the difference escalates the nearer one gets to magnetic saturation.

The consequence of this is that the H-dependent energy being pooled is drawn progressively more and more from the aether as H is increased. It follows from this that the reluctance motor power that can be drawn from the air gap will be contributed more and more by the aether as we take the level of magnetization to higher H levels.

The strict assumption that the energy supplied by the magnetizing coil all goes into the air gap is clearly incorrect. The energy is lost as heat, but we can recover it from the aether owing to the inductance effect and the half-field reaction explained above. More than this, however, we can recover energy well in excess of the amount supplied to the magnetizing coil because, owing to the curved higher range of the B-H relationship of the core, the aether sets up a stronger inductance field than applies for a linear B-H characteristic.

It will now be understood why a high level of magnetizing current and the use of a superconducting winding can make this technology commercially viable. It will also be understood why the energy in the air gap exceeds that supplied to the magnetizing winding, as was shown by the experiments reported in Energy Science Report No. 1. Remember in that connection that, whereas Professor Moullin had measured the magnetic flux in the core legs conveying magnetism to the air gap and found that the current needed to drive a given amount of flux across the gap reduced in relation to the gap thickness, I have argued that was not due to magnetic leakage. I say it is attributable to the aether feeding, in effect, its own magnetizing current to keep that flux on track through the gap. I proved this in the experiment I reported by testing the level of flux reaching the bridging yoke.

In summary, therefore, there can be no doubt that what has been disclosed above explains how aether energy can be tapped by astute design of a magnetic reluctance motor and the use of superconducting windings to avoid I^2R heating.

There is good reason to expect a machine of such design to operate with at least a 5:1 power gain by polarization bias to a basic flux density of 1.5 tesla (15,000 gauss) and operating over a cyclic flux density range between 1.5 tesla and 2 tesla in the ferromagnetic core. Note that such flux densities are commonplace in superconductor magnet technology where there is no ferromagnetic core to assist in developing that level of magnetic flux.

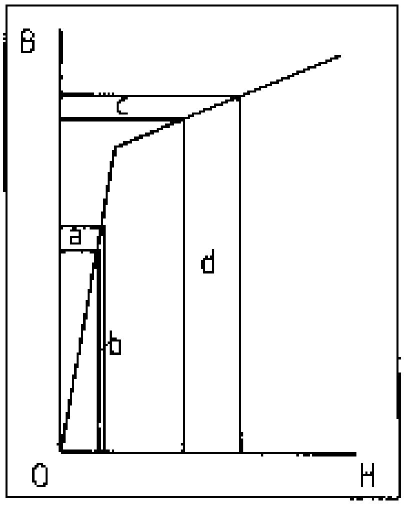

Figure 12

To underline the point just made it helps to consider what is shown in Fig. 9. Readers who are familar with the general curved form of the B-H magnetization curve will realise that the curve has been `idealized' in a straight-line form to facilitate analysis. The B-H relationship is shown to define four separate areas a, b, c, d which represent, respectively, HδB and BδH over a range of low flux density and then HδB and BδH over a range at higher flux density. It can be verified by geometrical analysis that the areas a and b are equal. This is because the straight line which separates them passes through the origin at O. However, the area c is between 4 and 5 times smaller than the area d, because the slope of the straight line separating those areas is much reduced and the line intercepts the B ordinate at a high B level. The difference is of vital significance in our `over-unity' motor design. First of all do keep in mind that B and H are not different physical effects acting at right-angles to one another. They act in the same direction. Secondly, note that our forebears who coined the B and H expressions really deceived us. They disguised the formulation by writing it as B equals H plus 4πI, where I was stated as being the `intensity of magnetization'. Yet all that was meant by this was that H is the effect of the ampere-turns per cm that we apply to develop the state of magnetization and B ! H or B ! 4πI is the effect of the ampere-turns that the ferromagnet itself contributes to the state of magnetization. That source of I in this latter expression is current sustained by the quantum activity which keeps the ferromagnet alive as a source of magnetism.

Now, if you were an electron sitting in the core of that ferromagnet or some aether charge form positioned to absorb energy as inductance in the pole gaps associated with that core, you would not know the difference between the ampere-turns producing H or the ampere-turns producing B ! H. So, since those areas a, b, c, d are really energy expressions, as we have seen from the above analysis, you confront the evidence that at low flux densities, where a equals b, the equal sharing of energy between core and air gap offers you no power gain helping to drive your motor. However, over the higher flux density range, where d exceeds c by a very substantial margin, that equal sharing of energy puts more power into the air gap between the motor poles than you supply to the magnetizing winding. That is why it is possible to design and run an electric motor which extracts power from the aether. It is simply a matter of understanding your a, b, c and d alphabet as applied to what is shown in Fig. 12!

The only problem you have in designing such a motor is one of devising a machine that does not run away with your input power in setting up the strong currents needed to reach the near-to-saturation level of magnetism. It is not the input power needed as inductance energy that is the problem. That is the energy a or c just mentioned. No, it is simply the ohmic heat loss that arises from the resistance of the magnetizing winding, but that is a loss we can eliminate as superconductive windings come to be used more and more in the design of electrodynamic machines. Machines have been devised in the past using superconductive windings, normally in the rotor of an alternator, but the object is to produce the d.c. magnetic field and that application has no bearing upon the `over-unity' machine proposed in this Report. However, the feasibility of using superconductivity in a multi-megawatt machine is established and the way forward towards power generation using the `over-unity' performance of the electrodynamic machine described in Part II of this Report seems now open and welcomes development.

PART IV: Commercial Development of the Invention

Readers will now see that I have introduced the expression `invention'. This is because the technology is the subject of patents involving the author as inventor. The chances are that the corporate industrial world which has the capacity and the duty to replenish our power generating equipment will not heed the new technology represented by these patents. That world does not yet recognize that `over-unity' is a realistic possibility. So, it seems likely that the patents will serve only the primary purpose for which they were originally filed, namely to show to future historians that we 20th century mortals are part of society which, in spite of its vast knowledge, has still much to learn, but is unwilling to `unlearn' false doctrines to make way for truth.

We belong to a world which was created and which evolves as it is recreated and as energy is recycled. The machine described in this Report can capture energy as it is being recycled by the processes which underlie the aether. I have explained how the end-product of that recycling activity is the creation of electrons and protons throughout space using energy shed as radiant heat and lost to what we term `entropy'. That was the reason I wrote `Aether Science Papers' [1996a]. In this Report I have sought to prove that we can intercept energy as it meanders through that process and capture it through the quantum coupling that sustains ferromagnetism in steel cores.

The high energy physicist stands aloof from such proposals, even though the physics involved is clear and conclusive in showing how the precise value of proton mass is determined in relation to the fundamental constants of the space medium. Accordingly this Report is offered as a way forward to those in search of a non-polluting new source of power and the patent rights, so long as they stand in force, may have some commercial value in support of that prospect. Otherwise, as the rights lapse, their specifications stand of public record in testimony of missed opportunity in a technological era when we could ill-afford to turn our backs on such inventions.

That said, I will now revert to the onward design details pertaining to the multi-megawatt machine, making reference to a patent which relates to what has been disclosed.

As will be appreciated, the commercial viability of an 'over-unity' power generator does not just depend upon whether it can operate with a saving on the cost of fuel. It depends upon the investment, the scale of the machine and its reliability. Therefore, it seems appropriate to evolve the design by taking the existing technology of the turbo-alternator power unit as a basis for reference. The future technology proposed here will involve those same alternators as the electrical power generator. They run at 3600 rpm when developing 60Hz. The prime mover, the turbine, however, is replaced by a dynamoelectric machine such as that described by reference to Figs. 5 to 8 above. It needs no nuclear heat source to generate the pressurized vapour powering the turbine. All it needs is an electrical input to excite its pulsed operation and that can be produced regeneratively once the system is set rotating at its synchronous speed.

Thus, whereas in a conventional power plant the alternator is brought up to its synchronous speed by starting the turbine, we do need, in this new technology, to provide some kind of drive motor or small turbine unit which can initiate operation. Otherwise, one needs to look to the output alternator or exciter alternator of the system as serving a motor role during start-up. The exciter alternator generates the pulses for the main winding on our machine, as we shall see from Fig. 13, but the overall function, given 'over-unity' performance, is that the exciter alternator puts, say, one unit of electrical power into the winding of the main machine and the latter generates, say, four units of mechanical power, one of which feeds back to drive the exciter alternator and the other of which feeds the output alternator or applies mechanical drive as to a ship propeller.

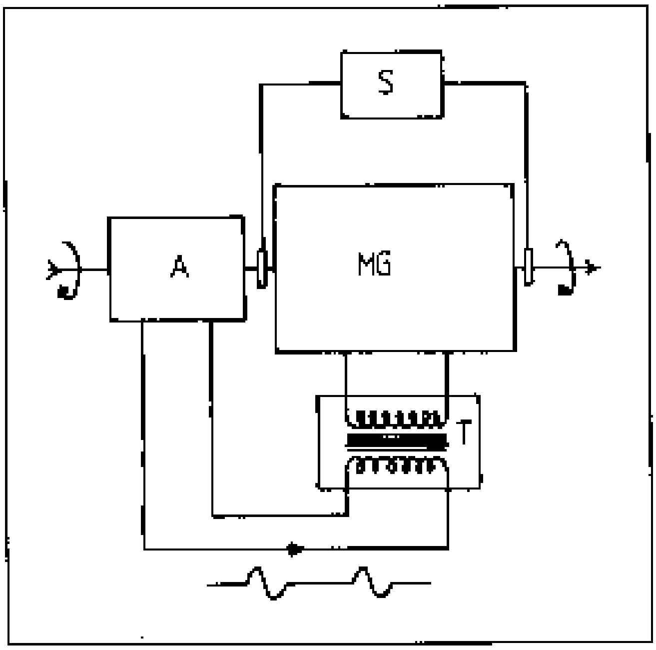

Figure 13

The patent covering what is here proposed does not require use of a superconductive winding and can avoid that requirement by sacrificing efficiency, but it is assumed that future technology will use the new warm superconductors.

In this respect, it should not be assumed that superconductivity is used as a substitute for a ferromagnetic core, that being the normal objective in existing machine technology. The problems of developing very high magnetic fields in warm superconductors not yet overcome. Fortunately, in the technology considered here, we need only moderate fields of a few hundred ampere-turns per cm. to penetrate the superconductor, because the primary magnetic flux that drives the machine is confined to a ferromagnetic core. Our objective here is really one of avoiding unwanted loss, both the VR loss in that main winding and any inductive power loss in exciting the machine. The objective of the patent is specifically directed to the recovery of induction energy and overcoming commutation problems.

By having the magnetizing winding on the stator at the outermost position around the rotor of the machine it is easier to keep it cool enough to assure the superconductive state. The primary design problem arises from the high induced voltage per turn of the winding, which could be 1,000 volts in a 100 megawatt installation. For this reason and to provide thermal isolation for the magnetizing winding, owing to its superconductive state, a transformer having a ferrite core is needed. This has one primary winding and several secondary windings, each serving just a few turns of the superconductive winding on the machine. Referring to Fig. 13, the main generator, denoted MG, is coupled to an exciter-alternator A, which feeds a commutated sinusoidal a.c. to the primary winding of the transformer T. this has superconductive secondary windings feeding the turns of the superconductive helical winding on MG. Cooling is via the transformer tank housing T, where the primary winding is thermally insulated, as the metal of that winding can be cooled owing to its conductive connection with the exciter-alternator A, where normal features can be incorporated to cool that machine.

The d.c. power supply S connected to sliprings on MG provides the low power input needed to polarize the core, though this may prove unnecessary in practice because of the unidirectional current surges in the winding of MG.

The rather special feature of this design, as covered by the patent, is the way in which the a.c. input to the transformer is chopped into complete full-wave cycles, say one in three, in order that the EMF fed to the superconductive winding is pulsed in a timed phase with the stator-rotor pole positioning in MG. In an ideal case, where there is no magnetization loss in the machine (current in phase with EMF) as opposed to just inductive reaction (current in phase-quadrature with EMF), the superconductive winding will allow the magnetic flux change to conform with the a.c. time-integral of the voltage waveform.

It will be pulsed unidirectionally with a simple harmonic profile and if this is timed according to the position of the poles so as to assist pole closure, then the machine will operate in the manner already described. Note that the magnetization loss should be much smaller than it is in a normal alternator of similar size and so, having regard to the current strength supplied to pulse the superconductive winding, the phase should not differ too much from the zero-loss condition.

There is no electronic commutation or switching in the superconductive circuit. The only commutation is in the exciter-alternator A which supplies the chopped waveform shown in Fig.13 and interrupts the current flow to the primary of the transformer only at moments when the current is zero.

It is important to note again that, although there is extensive reference to the prospective use of superconductivity in the main windings of the generator described, it is not essential to ‘over-unity' operation. It is, however, an inevitable development, once warm superconductivity comes to be used in standard design of main power generating equipment.

The above technique of using the chopped a.c. waveform with a magnetic reluctance machine biased to polarization close to saturation, all with the objective of running a machine with 'over-unity' performance is already the subject of the author's U.S. Patent No. 4,975,608 dated December 4 1990. The design features involving the single helical winding have evolved since and are the subject of independent patent applications.

The abstract title page and claim pages of that U.S. patent were reproduced in the Appendix attached to the first version of this Report published in 1996, but since such the full copy of that patent specification can be see by accessing the U.S. patent office website, http://www.uspto.gov/ , it is not included here in these pages.

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ENERGY SCIENCE REPORT NO. 10

CYCLOTRON RESONANCE IN HUMAN BODY CELLS

by

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CYCLOTRON RESONANCE IN HUMAN BODY CELLS

PART I: INTRODUCTION

There are times when it is necessary to wander slightly from one's field of expertise to trespass briefly and as a stranger in a discipline that is sending signals into one's own territory.

It has been suggested from evidence in the medical field that overhead electric power lines and electric blankets can be harmful to one's health and there are those expert in the science of electrical engineering who argue that low frequency electromagnetic radiation cannot possibly have any harmful effects.

Self-appointed in the quest to reconcile differences of opinion in this debate, I once dared to express my opinion as an academically-trained electrical engineer as to why overhead electric power lines and electric blankets can pose a health hazard. My case was based on a combination of two circumstances.

Firstly, I have contended for many years that the whole of our empirical knowledge concerning electrodynamic interactions is founded on evidence collected from experiments in which the main field reactions are set up by the motion of electrons. My thesis has been that, where reactions to electromagnetic fields are seated in heavy mobile ions, rather than electrons, then anomalies do arise. Indeed, there are anomalous forces set up in some instances, as reported in scientific periodicals of high repute, which exceed by a thousand fold the theoretical expectation based on electron theory.

Secondly, given that the medical community now suspects that fields set up by overhead electric power lines can stimulate unwanted activity in human body cells, I ask myself whether the ions in our body fluids that must react to those fields are electrons as such or are of heavier molecular form. In the latter case, taking the ions found in water, namely the hydronium ion H_3O^+ and the hydroxyl ion OH, I can see that we are dealing here with the same electrical territory as that in which one experiences those high force anomalies mentioned above. Clearly, therefore, since the electrical engineer has failed to give account of the anomalous energy activity witnessed in plasma discharges where heavy ions are the reacting charge carriers, that engineer has no right to declare that the electromagnetic fields he is producing cannot be harmful. He simply does not know.

All he can be sure about is that people working in the electrical power generation and distribution industry have no reason to worry about electricity affecting their health, so long as they keep well out of reach of live wires and their high voltages. He is, incidentally, all too aware of the characteristic smell of ozone owing to the ionization of air produced by an electrical discharge. It is a warning that something may be wrong and that he is getting too close to an electrical hazard. However, without such a warning the question is whether there is a less obvious influence which puts us at risk if we get close to electrical cables which are spaced apart, one carrying current in one direction and the other carrying current the opposite direction.

That, by the way, is the feature which overhead power lines and electrical blankets have in common. In the electrical wiring used in the domestic power supply to electric cookers, electric fires, lighting etc. the current is not something that flows one way. It has to enter an appliance, do its work and then go back to its source. In the wiring system wires carrying current to the appliance are twisted closely around the wires carrying the return current flow. This means that their field effects cancel and the normal domestic power cable poses no hazard problem so long as the insulation in the cable is sufficient to withstand the voltages used and the current, which generates heat, is obliged to restrict its damage to blowing an occasional fuse in the protection system. Our health hazard concern, however, is with those overhead power lines and electric blankets.

Remember here that the professional electrical engineer who maintains overhead power lines has expert knowledge of how electricity carried through metal wire by one set of electrons can interact with electricity carried through metal wire by another set of electrons. That is his trade and he knows it well. What he does not know anything about is how electricity flowing in the human body and carried, not by electrons, but by ionic particles, may interact with other such ionic particles in the human body and how their interaction can be aggravated by the electrical and magnetic fields which that engineer creates by his power distribution apparatus.

Of course, he will say that he too is human and that his body is exposed to such effects, but then I urge him to consider whether he really does spend his working days close to overhead power lines which are energized. If he does, then I wonder how he contrives to do anything useful. Again I stress that here I am not referring to an energized cable which carries current along conductive strands in close proximity but in opposite directions. I am referring instead to a situation where he may sit close to, and virtually between, two widely-spaced electrical power lines each conveying uncompensated currents, as otherwise there is little field exposure.

Dare I then point out that a baby's bottom, which is commensurate in size with the spacing between metal wire strands in an electric blanket, is the kind of exposure to unbalanced field effects of the kind which that engineer rarely, if ever, encounters in his power line work. He is wise enough to switch the power off before climbing up between those overhead lines.

On the broader subject of electromagnetic fields, we all have exposure to the electromagnetic wave spectrum, which ranges through its radio and television frequencies, the infra red frequencies and on through optical frequencies and beyond. We know that if such radiation is concentrated to high intensities then we can suffer. Physicists know that at the high frequency end of the spectrum, as one progresses through the ultra-violet range, there are X-rays and -rays which can be very harmful. However, for the very low frequencies used in power cables and the very weak electromagnetic fields they produce, electrical engineers and physicists see no reason for concern about a radiation hazard.

Yet, as I say, since the basis of electrical science is founded on electrical activity seated in electrons and our body fluids involve activity seated in ions that are very much heavier than electrons, there is reason for doubt.

Now, the stimulus for writing the text of this introductory essay of this Report No. 10 comes from a Letter to the Editor in the July/August 1996 issue of Electronics World (page 590). It was authored by Dr. David Fisher of Cardiff in Wales and was a declaration framed in an accusative context directed at anyone who believes in 'anti-gravity and perpetual motion (free energy)' with the finger pointed in my direction. Quoting from it:

"I was, in fact, thinking of Dr. Aspden who, readers will recall, believes in this nonsense and has also proposed a 'cyclotron' theory in order to 'explain' the so-called link between electromagnetic fields and disease."

This was probably a result of an article of mine published by Electronics and Wireless World, pp. 29-31 (1989). It was entitled 'Anti-Gravity Electronics'.

The latter article had also attracted similar criticism, expressing doubts as to my wisdom as a professionally qualified physicist, for my views on the gravity theme. My attacker was C. Hellingman writing in Physics Education, **27**, 112-115 (1992). In rallying to defend my case I wrote another article which was published by the Institute of Physics in U.K. in that same periodical, Physics Education, **28**, 202-203 (1993). It was entitled 'The Law of Perpetual Motion'. As to my `cyclotron' subject that had featured in an earlier article of mine in EWWW, pp. 774-775 (September 1991). The title of that article was 'Power Lines, Cancer and Cyclotron Resonance'. Note that EWWW, or Electronics World + Wireless World, represents a staged period of gradual transition as the publishers of Wireless World decided to rename their periodical Electronics World. I am tempted to note here that the word `wireless' has gone out of fashion, along with the word 'aether', but remind you that Nature still needs the aether to sustain those wireless waves and no amount of electronics can eradicate its existence!

This being Report No. 10, the final Report in this Energy Science Series, and the other reports all being concerned with energy matters in the context of electrical power and the fundamental physics involved, I am now going to digress somewhat in this introduction. Indeed, I have decided to present this Report in three parts, this Introduction being the first part. If the reader's interest is restricted to the health hazard issue posed, as by power lines, then the next few pages of this section up to page 9 should be skipped.

I planned to publish and, indeed, did compile, a 28 page document bearing the title of this Report No. 10, some 7 years ago, in 1990. I was, however, distracted at the time by other pressing interests, such as the research matters discussed in Energy Science Reports 2 and 3 in this series. The text of that 1990 document does, I now believe, warrant publication as it does add something of significance to the energy theme of the early Energy Science Reports. Also, I find I am obliged to react to the criticism, such as that of Dr. Fisher quoted above.

Accordingly, I have decided to publish that 1990 document unamended as Part II of this Report and add a Part III which is really an Appendix comprising other items that have appeared in print and some that I have now published on Internet. These include a new commentary on Schumann Resonance, owing to recent input from A. G. Callegari of Much Hadham, Hertfordshire in England. Also there is a paper I wrote in 1988, as published in October of that year, which dates from a little before I became wedded to the relevance of the cyclotron theme. It is entitled 'The Proton Factor and its Unknown Effects'. I believe it will interest some readers, but I include it especially because my research on the energy theme tells me that energy in our universe is being recycled.

Energy which finds its way into space as part of what cosmologists see as the running down of the universe as it expands into oblivion is really being repackaged and put into order in the quantum underworld that pervades all space. From that quantum sea of energy, protons and electrons, the components of the hydrogen atom, are being created to restore that lost energy in matter form, meaning that we are part of a universe that is a steady-state system.

My interest in energy from a power generation viewpoint arises because I can see a way of intercepting the energy in a phase of the regeneration cycle, after it has become quantized but before it is released in proton form. As a side issue I then wonder whether the ongoing creation of protons (accompanied by the demise of protons) within atoms forming our body cells can imply a health hazard.

If you, the reader, share Dr. Fisher's view and suspect that this is all nonsense, then do defer your judgement, at least until you know enough about my research to see the strength of my case. The physics involved has allowed me to deduce by pure theory the proton/electron mass ratio to the part in tens of million level of precision measurement. The 'proton factor' must not be overlooked in the study of potential health implications.

If such ideas, which are rooted deeply within the discipline of physics, go beyond the scope of your interest, then it is time to jump on now to page 12. Otherwise, and particularly if you, the reader, are well versed in theoretical physics and so are ever ready to challenge an intruder who questions the state of that art as a sound foundation on which to go forward, then let me try to shatter your confidence.

Do ask yourself why it is that all the fundamental particles known in physics decay and have a short lifetime, with the exception of the proton and the electron. The electron, however, can, within the period of one ten millionth of a millionth of a second jump from one side to the other of a theoretically-impenetrable potential barrier. It is called 'electron tunnelling', but who is to say that that the electron does not decay on one side of that barrier only to find that its energy and its charge are given to a newly created electron on the other side of that barrier? We can all live forever if physics can contrive to rejuvenate us by a recycling process! What I am really saying here is that the proton and the electron are the basic forms in which matter is newly created from spent energy shed into the quantum underworld of the aether. Therefore, the proton and the electron can have finite lifetimes and suffer decay, but such events pass unnoticed because they are recreated in close proximity to their demise. They have a life after death!

However, if protons shed from atoms in a molecule in DNA reappear in different atoms, not necessarily within that same DNA structure, might not that have some effect upon our health?

I want simply to point out that physics, being an exact science, even in its interpretation of quantum mechanics, tends to see things as all 'black' or all 'white'. (Physics can 'see' Black Holes even though, if they exist at all, they are invisible and they can 'see' space in a contrasting light because they 'know' there is no aether even though something governs those wireless waves which ripple through it.)

The proton has an immeasurably-long lifetime. The assumed age of the universe is not even as long as one trillionth of the mean lifetime of the proton. Yet, for all we know, the proton occupying a certain region of space may have a characteristic age measured in minutes or days, but not years.

I believe the proton and its decay have a significant bearing upon our human condition but I am not here urging you to believe what I say, but rather just to suspect that physicists err by ignoring this possibility. The truths will emerge if we study the effects that proton demise and recreation may have and the appropriate arena for such study could well be the biophysical world where isotopic transmutations and molecular changes can have `knock-on' effects. It may not be easy to prove but the task will be all the more difficult if physicists cling too tightly to their textbook training and do not seek out the questions that they have never before asked and so have never answered!

Quantum Field Theory

It is generally supposed that physicists know all that there is to know about electromagnetism and the related field theory, at least concerning the phenomena which intrude upon our immediate environment. Field theorists claim great achievements which can bewilder and, indeed, outclass the concerns of the scientist or engineer who has to deal with real problems faced in our daily routine. Field unification, the quest to understand the nature of the force of gravity and its link, if any, with quantum field theory and exotic high energy particles, as well as the creation of neutron stars and probing the physics of the Big Bang and Black Holes, are the territories that they see as warranting exploration.

So, let us take a look at the overview presented by Victor F. Weisskopf in the November 1981 issue of Physics Today (pp. 69-85) under the title: 'The Development of Field Theory in the last 50 Years'. I refer to that because it describes the history of quantum field theory and, unlike most articles written on that subject, it actually exposes the weaknesses and uncertainties as they stood in 1981 and, indeed, as they remain today.

I have a personal reason for referring to this Weisskopf article, because, as a young electrical engineer interested in electromagnetism as a research pursuit, I was 'put in my place' repeatedly as I tried to publish my findings on topics which trespassed onto the territory of quantum electrodynamics. I was told that Einstein and Dirac had covered that ground and there was no chance that my research, which obliged me to think more and more about an energy form pervading the aether, could warrant the slightest attention.

Eventually, in frustration, and having solved the mystery of unifying the electromagnetic and the gravitational force, I published my own books on the subject, including 'Physics without Einstein' in 1969 and 'Modern Aether Science' in 1972 and, later, 'Physics Unified' in 1980. Thereafter, and mainly because I took early retirement in order to return to academic research in the university in my home town, I was able to get a stream of scientific papers published but many of the more important papers are not to be found in the mainstream periodicals. The editors of those periodicals avoid anything controversial that might ripple the oceans of 'relativity' and 'quantum field theory' by introducing a sea of aether energy.

However, in July 1996 I decided to publish 'Aether Science Papers', collecting together a selection of some of my more important published papers. It being impossible to argue theory to get the theoretical physics community to see the need for a `modern' quantum electrodynamic insight into the `aetherial' world of the vacuum state, I am taking my efforts forward by seeking ways of tapping energy from that 'aether'. This, in the main, is the reason I have written this series of Energy Science Reports. This final Report No. 10, however, is more concerned with energy transfer processes that are anomalous in electron-based physics, but which can affect the fluids in human body cells.

So, what does Weisskopf have to say about the weaknesses of quantum field theory? Well, it seems that it all began in 1927 when Paul Dirac gave birth to the theory of quantum electrodynamics. Already by then "Albert Einstein had put an end to the concept of aether" and already by then "the field-free and matter-free vacuum was considered as truly empty space." The quotations are of text taken from the Weisskopf article.

Electromagnetic radiation posed problems but Max Planck had delivered the quantum theory as, without it, "total energy density becomes infinity; empty space would be an infinite sink of radiation energy". With the introduction of quantum mechanics "the vacuum gradually became populated...there must be zero-point oscillations of the electromagnetic fields in the vacuum state".

Under the heading "Triumph and Curse of the Filled Vacuum" Weisskopf then writes "Dirac's daring assumption had most disturbing consequences, such as infinite charge density and infinite (negative) energy density of the vacuum". "These ideas seemed incredible and unnatural to everybody". "Even if we consider the filled vacuum as a clumsy description of reality, the existence of virtual pairs and of pair fluctuations shows that the days of fixed particle numbers are over".

Here Weisskopf is referring to the ongoing electron-positron pair creation and annihilation activity that features in quantum electrodynamics. Note the use of the word 'virtual', which is a convenient way of referring to something aetherial that is there but yet is not real in matter terms.

It seemed then that the 'infinities' were posing problems, but that these were solved, as by arguing by symmetry that two theoretical systems coexist in the same space, one involving infinite negative energy density and the other involving infinite positive energy. "There remains, however, the unpleasant fact of the existence of vacuum fluctuations without any energy". "The infinities of the filled vacuum and of the zero-point energy of the vacuum turned out to be relatively harmless compared to other infinities that appeared in quantum electrodynamics when the coupling between the charged particles and the radiation field was considered in detail".

Then it seems several assumptions were made to avoid problems connected with an infinite electron mass and some numbers pertaining to the anomalous g-factor of the electron began to fit what was measured. Here were "the signs of victory in the war against infinities". [A reader having a copy of my book 'Aether Science Papers' should refer here to pages 48-53 for a simple 'aether-based' account of the electron's anomalous g-factor that is superior to the QED derivation].

Weisskopf continues: "In spite of these victories there remain nagging problems in quantum electrodynamics. There are definite indications that we understand only a partial aspect of what is going on." "Will there be a theory that avoids renormalization by using non-perturbative methods? Or will a future unification of electrodynamics and general relativity heal the disease of divergences? There is no way to understand and derive the mass of the electron within today's electrodynamics. The problem has become even more acute since heavier electrons such as the muon and the tau-electron have been discovered. There is not the slightest indication why electrons with different masses should exist."

[Again, I say, read my book 'Aether Science Papers' and you will see all the answers to all these issues, save that I do not unify electrodynamics and general relativity, but show instead that electrodynamic forces and gravitational forces are unified by the role played by an aether which has quantum electrodynamic properties. Indeed, the virtual muon form is the primary aether energy. It is seated in a central inertial frame intermediate the counter-balanced jitter motion oscillations of the matter frame (electrons and protons) and the graviton frame (tau-particles). The phenomena which are purported to support Einstein's General Theory of Relativity are also fully explained in terms of that same aether.]

Later in his article Weisskopf ventures into the realm of the heavy bosons, notably the neutral Z boson. [This is high energy territory which concerns the 'supergraviton' of my theory and which I shall mention briefly at the end of Part III of this Report.]

Concerning such theory, Weisskopf then mentions "spontaneous symmetry breaking". "It has the following remarkable property: Its energy is such that it has a minimum, not when the field is zero, but when it has a finite value...that would mean that the vacuum has a certain fixed direction in isospace." [I could not get my early papers on the aether theme accepted by orthodox journals because such a `fixed' direction was implicit in a dynamic system that has two-dimensional linear harmonic oscillatory motion (i.e. circular) in its zero-point state of minimal energy. Einstein's theory did not predict the need for such a direction! You will soon see why that feature also has some bearing on the subject of this Report].

Weisskopf continues: "The situation is like that of a ferromagnet, in which a direction in real space is determined as long as the energy transfers are smaller than the Curie energy."

[This was precisely the foundation on which I developed my aether theory, based on my research at Cambridge University in 1950-1953. I was testing energy anomalies in electrical sheet steels under varying mechanical stress conditions. Besides magnetization loss anomalies I knew there were stress energy anomalies to consider, but the standard theory of the ferromagnetic state, which relies heavily on Dirac's electron spin concept, needed to be adapted to have the 3d electrons of adjacent atoms sharing a component of synchronous motion. This model, which ran counter to the Dirac philosophy, was adopted as the basis of my aether theory which I began developing as soon as I left Cambridge. The aether itself is a 'crystal structured' system of aether charges in synchronized motion, a 'ferromagnetic' system in a sense, but the forces of attraction set up by the presence of matter are gravitational forces which are really electrodynamic forces characterized by the frequency of that synchronous motion, which happens to be that at which electrons and positrons are created. The embryonic form of this theory as it stood in 1959 is presented in my first publication on this aether theme 'The Theory of Gravitation', which I published in January 1960.]

Weisskopf then moves on to QCD, `Quantum Chromodynamics', an effort to parallel QED, quantum electrodynamics in the realm of the proton, but the story advances relentlessly to a summary of the unresolved problems. "Is the renormalization procedure sound?" This is the name given to the trick used in QED to solve the problem of the infinities. "The answer to this question may save or condemn field theory". "The large value of the effective coupling constant of quantum chromodynamics at small momentum transfers causes serious problems as to the nature of the vacuum itself. The field fluctuations may turn out to be very large and may require new conceptions of the nature of the vacuum."

"The present theories contain arbitrary constants. In QED it is the coupling constant $2e^2/hc$ at large distances and the masses of the different electrons. Today three such electrons are known, but there may be more. There is no way visible at present to explain how their mass values may emerge from the field theories."

"We have no explanation for the mass of the electron, that is the smallness of the ratio (1/1836) between the electron mass and the proton mass."

"Our present view of elementary particles is plagued by the following problem: Nature as we know it consists almost exclusively of.. quarks (the constituents of protons and neutrons), and of ordinary electrons. ...But there definitely exist higher families of particles...They appear only under very exceptional circumstances that are realized during the early instances of the Big Bang, perhaps in the centre of neutron stars, and at the targets of giant accelerators. What is their role in Nature, why do they exist? Rabi exclaimed when he heard of the first of those 'unnecessary particles', the muon: "Who ordered them?" Again, field theory does not seem to contain the answer to this question."

"We will find out sooner or later whether field theory is able to clear up some of these outstanding problems. It may be that a very different approach will be required to solve the questions for which field theory so far has failed to provide answers. ... We have not yet been able to make sense of much of what Nature says to us."

"Looking back over a lifetime of field theory, it seems obvious that we have learned much since 1927, but there is a great deal more that is still shrouded in darkness. New ideas and new experimental facts will be needed to shed more light upon the deeper riddles of the material world."

This ends my quotations from Victor Weisskopf's 'Physics Today' article. Looking back over my own lifetime (I was born in that year 1927) I can but say that Weisskopf failed to realize that answers to almost all of those mysteries were of published record before 1981. My book `Physics Unified', published in 1980, gave the update as of that time. It tells you how to unify gravity and electromagnetism and validates the argument by showing how G, the constant of gravitation can be deduced in relation to the electron's electromagnetic charge to mass ratio by pure theory. The derivation of the mass of the virtual muon is a major feature of the theory and it is shown on pp. 115-116 of that book how from that one deduce the mass of the proton in electron mass units. It is found to be slightly greater than 1836.152. That coupling constant used in QED is a dimensionless physical constant measured to part per million precision. Using the aether theory disclosed in 'Physics Unified' that value is derived at p. 112 in full accord and with the same degree of precision.

As to explaining the mass of the electron, that too is found in my published work, but mass is not a dimensionless physical quantity and so it cannot be derived by theory except as a ratio to other physical quantities. The task really boils down to explaining inertia and understanding why the electron is a favoured state of matter, given that the creation process of the proton is already explained.

Finally, to conclude this digression into the world of the orthodox theoretical physics and its many mysteries which (dare I say it?) only my aether theory can resolve, I did not, at the time I wrote 'Physics Unified' in 1980 have a way of determining the mass of the super-heavy electron, the tau particle. I was then still busy working in my Director capacity in IBM's European Patent Operations, but my theory (see pp. 118-122 in my 1980 book) was yielding explanations for the creation of those short-lived `higher families of particles' mentioned by Weisskopf. It was only when I retired and began developing my theory further from a university base that the tau emerged in a rather beautiful form. It is vital to the gravity process, but to read about that requires reference a 1989 paper of mine, the eighth of the 14 papers reproduced in my book 'Aether Science Papers'. Weisskopf could not have written a better article from my point of view to set the stage for a presentation of my aether theory. But a stage and a performance need an audience and physicists are all too busy to pay attention. You must, however, now picture all those theoretical physicists in academia still trying to solve those mysteries and overcome the weaknesses of quantum field theory, whilst, I, knowing the solution, proceed here to address the real mysteries of physics, such as why overhead power lines pose a health hazard.

I would not write in such a strident style with its risk of offending the sensitivity of the elders of the scientific community were it not for the fact that at the age of 69 I feel I am obliged put my case with some force in order to claim attention. If that is seen as an excuse for ignoring the physics underlying my theory, then I lose nothing, as that is the way it has been for four decades now. If I can arouse interest amongst those who have to find a worthwhile future in researching theoretical physics, as in the student community, then that will be some gratification.

However, to proceed and before coming to the documentary account in Part II of the initial version on which this Report is based, I will get this Report back on the track of its title by reverting briefly to that cyclotron question.

Introducing Cyclotron Resonance

One perplexing question for any such student is that posed by claims that a strong permanent magnet strapped in close contact with the stomach can have a beneficial effect but only if it is correctly mounted with its north and south poles properly positioned. Why should a north pole of a magnet held against the body exert any action different from a south pole? As far as I know, the human body is not magnetically polarized, so if the action depends upon ions and their reacting motion in that field, the only factor of difference concerns whether those ions in our body fluids respond by moving clockwise or counterclockwise relative to the magnet's polar axis.

This means that the response depends upon the perspective of whoever is viewing the action, whether from in front or from behind, and that surely does not solve the problem.

There is, however, a topic I can discuss and one which features in my other writings that can be relevant here. See, for example, my Energy Science Report No. 8. I call it 'vacuum spin', but mean 'aether spin', knowing that this can induce electric polarization and, owing to that rotation, develop a magnetic field. The governing axis involved in this 'aether spin' is that needed for a 'fixed direction in isospace' which Weisskopf mentions.

The very symmetry of the magnetic field set up by a magnet offers no scope for seeing the north and south poles as exerting any difference in their energy influence. The physicist's notion of the vacuum state gives no reference frame work that we can apply in trying to solve this problem. However, if we bring into play an aether with a preferred direction, then there can be differences in electrical induction arising from positive and negative ions reacting to the field set up by a magnet. I can see that `aether spin' will develop in a stronger or weaker sense according to the orientation of the magnet relative to the `aether spin' axis.

This subject, however, is something that needs a great deal of evidence from observations which compare effects at corresponding latitudes in the northern and southern hemispheres. My information on this topic was mainly gleaned from casual conversation with participants at various conferences dealing with other matters. Therefore I can only offer these tentative remarks on this magnet anomaly theme at this time.

I am now going to jump ahead a little way by mentioning that I once ventured into a conference forum on the subject of the health hazards of low frequency electromagnetic fields to say why there is a problem. I spoke about this basing my comments on the paper reproduced later in this Report (pp. 16-22). My case was that there is a resonant reaction as our body fluids respond as if tuned to the 50 Hz or 60 Hz fields of the electrical power industry and that resonance is attributable to those hydronium and hydroxyl ions already mentioned.

Water, incidentally, features in several other scientific anomalies involving unusual energy properties, but we will concentrate here solely on the theme of my talk at that conference.

I declared that there was a kind of resonant effect similar to that produced by the cyclotron, the cyclotron being a device in which charged particles describe orbits when subjected to a steady magnetic field and pick up energy from a superimposed alternating electric field. Cyclotrons are used in high energy particle physics to pump enormous amounts of power into those charged particles.

A physicist might find it amusing to hear the suggestion that our bodies can operate as cyclotrons but I believe the proposition is far more tenable than some of the other beliefs held by the physics community. I find it not only amusing but totally ludicrous for physicists to waste their time imagining what happened in the first 10^{42} seconds following the Big Bang, when the temperature of the universe was supposedly so high as to be equally meaningless.

The operating frequency of an electron cyclotron can be more than 10,000,000 times that of the power frequencies of our domestic environment and the magnetic fields used in the cyclotron can be 1,000 times greater, but it is the ratio of these two large numbers that relates to the mass of the resonant particle. So, if there is a cyclotron reaction in the cells within the human body, the resonant ions would need to have mass of the order of 10,000 times the mass of the electron, which is the case for the molecular ions found in our body fluids.

However, the point I wish to make here is the answer to a point put to me after I delivered my paper at that conference. The questioner stated that the theory of the cyclotron cannot apply to our body cells because it requires the orbital radius of the motion of ions to be about one metre.

The radius r of charge motion in a cyclotron is determined by the balance of the force Hev/c and the centrifugal force mv^2/r, from which the r is mvc/He. The cyclotron frequency in rad/s is He/mc. Here e/mc is the charge/mass ratio in electromagnetic units, v is the speed of the charge and H is the strength of the magnetic field. To find r, assuming it applies to ions moving at speeds set by the thermal activity with two degrees of freedom, we equate kT and $mv^2/2$, where k is the Boltzmann constant and T is the body temperature in Kelvin. From this we can estimate v and find r by dividing by 314 rad/s, assuming resonance at 50 Hz. Since m is of the order of $3x10^{26}$ kg and kT is $4x10^{21}$ joules we can estimate v as being 500 m/s. When this is divided by the power line frequency expressed in radians per second one sees that r is of the order of one metre.

This is, I presume, one reason why those physicists who are attentive to the weak field health hazards of electrical power sources have not considered the cyclotron resonance hypothesis as relevant.

In order, therefore, to defend my case I had but to muster the mathematical skills of my schooldays to come to the following argument, but I will present the result without using any mathematics. Imagine a particle to be enclosed in a confined space no greater than, say, 10 microns from boundary to boundary. Can that particle, in bouncing from the boundary walls as it proceeds on its course from one wall to the other, many thousands of times per second, have a motion that follows an orbital path of one metre radius? By this I am simply asking whether, if that particle is an ion constrained to follow a helical path of radius r centred on an axis parallel with the direction of a magnetic field, it can describe small arcs of that path between its collisions. The answer has to be: "Yes".

Now, how does this differ from the cyclotron situation? The answer to that question is that in the cyclotron the ion is allowed freedom to describe a full circular orbit unimpeded so that, as it moves over one half of its orbit, it is accelerated by the electric field acting in forward direction and, as it moves over the second half of its orbit, it is still accelerated in its forward direction because by then the electric field has reversed its direction. There is phase-locking owing to the resonant tuning of the cyclotron frequency and the charge to mass ratio of the ion.

As an aside here, it is noted again that the real mystery of this human cyclotron effect is that of understanding how one can have a resonance for a person situated under an overhead power line (or resting on a live electric blanket) in North America where the frequency is 60 Hz and also have resonance affecting a similarly situated person in Europe where a 50 Hz frequency is used. That was the formidable question that had to be answered! Explaining that was really why I was willing to stand before a conference audience to make my contribution to a discipline outside my main field of interest.

Before coming to that detail in the main text, this matter of the scale of the cyclotron orbit has to be dealt with, because the ions in their thermal motion in our body cells simply cannot describe full orbits in synchronism with the weak field oscillations generated in homes close to overhead power lines.

Well, imagine you are looking from above at a school playground and see thousands of schoolboys all rushing around and bumping into one another, bustling with energy and all moving at speed but all tending to veer to the right between collisions as they follow curves of the same radius r. What you will see might seem to be a state of chaos, but if you were to be viewing that from a platform which was rotating about your sighting position at an angular velocity exactly equal to that of the motion of the boys on the ground, only then you would be looking at the chaotic state of normal thermal motion. You see, there is a state of orderly circular motion superimposed upon the normal motion occurring when colliding particles travel in straight lines between collisions.

In other words, the ions moving in their basic thermal activity in the fluids in your body cells have a component of orderly rotary motion owing to the presence of the ambient magnetic field set up by body Earth. The fact that the mean free path, the distance travelled between collisions, is much smaller than that radius r, as determined by what is termed the Larmor formula, is irrelevant. It becomes relevant only in so far as we need now to consider how a pulsating electric field can have an effect. The main fact involved is that the angular frequency of that motion is the same, whether the cell housing the activity spans 100 metres or 10 microns. Suppose first that such a field were to be a steady electric field acting with a component directed in the plane of the orbital motion, that is at right angles to the direction of the magnetic field. The positive and negative ions would be displaced in opposite directions until there is equilibrium by the field reaction set up by charge displacement. Now suppose that the electric field oscillates in direction at precisely the angular speed at which the whole system of ions turns owing to the effect of that magnetic field. You will then see that the charge displacement is sustained. The charge displacement is not oscillatory in the sense that it passes through a zero value twice per cycle but is instead represented, in effect, by a dipole system rotating at the resonant frequency with its kinetic energy increasing progressively as the dipole spacing extends.

The point of all this is the clear message that the combination of the Earth's magnetic field and the weak electric field effects of an overhead power line can induce a resonant response setting up a rotating electric dipole state within human body cells. There is a resonance condition and in the cyclotron used in high energy physics this pumps energy steadily from a weak field to build up high energies in particles which accelerate outwards as that radius r grows in proportion to particle speed.

The same process applies to our dipole system formed by numerous charges in each of our body cells. The presence of an ambient electric field alternating at power frequency will pump energy into those cells, energy which sets up pressure across membranes at the cell wall.

For experts, whether concerned with cyclotrons or with electrical power distribution, to deny that cyclotron-type resonance can occur in the human body, solely on the grounds that the cells in our bodies are too small, is, in my opinion, quite irresponsible. I make this assertion deliberately and with a conviction that stems from an analogous problem concerned with the nature of the magnetic field reaction in something as simple as a lump of copper! I will now digress briefly onto that subject before reverting to the health hazard theme.

In simple terms, I ask the electrical engineer who denies cyclotron-type resonance in human body cells to tell me whether he has ever understood how a d.c. magnetic field can penetrate a lump of copper. There is one fast moving free electron in copper for virtually every atom present and, by the laws of electromagnetism, those electrons should all be deflected by that magnetic field to act in concert in setting up an enormous reaction field. The reason they do not cancel the field is because the energy deployment optimizes to permit them only to halve the magnetic field. Yet, even that halving effect is not recognized, so the electrical engineer lives on in ignorance of the truth, whereas the physicist sees only an anomaly in experiments comparing the magnetic moment set up by the electron reaction and the proportional angular momentum involved. The physicist refers to it as a g-factor (its value being 2), but what the physicist cannot see is that all primary magnetic fields are really of double the strength assumed but they are invariably halved by that reaction of the electrons in orbit in their reaction to the applied field.

Lacking such insight, it is then no wonder that those electrical engineers and physicists cannot cope with the more advanced problem of the ionic reactions in a human body fluid, where the reacting ions are not all electrons of the same mass and polarity. Instead, we are dealing here with a mixture of positive and negative ions having different masses.

This introduces a recipe for a type of cyclotron reaction which is not governed by a single resonant frequency determined only by the mass of the ion and the frequency of the pulsating field. There is scope, given the extra parameters introduced by the dual ion composition, for a self-tuning action over a range of frequencies, which can develop that resonance which feeds power into the human system drawn from those weak fields that pulsate at power frequency.

Explaining that is really is my main contribution in this Report, but I will aim to include other topics by which anomalous electrical phenomena can intrude into the health domain.

For example, consider a facet of science where the space we occupy comprises something that is electrically charged, but neutralized by the displacement of ions in our body. Ostensibly, there is no net electrical field effective inside us, because everything is cancelled and is in equilibrium. However, now suppose that underlying space charge arises from a kind of induction process of cosmic origin and is liable to change over a period of time. Again, there need be no problem, because the ions in our body will adjust to neutralize the overall effect. Go now just a little further and suppose that for, say, six months of the year, the background space charge is of increasing strength, whereas during the other six months its diminishes in strength. The human body ions have to somehow find a surplus of one polarity for half the year and a surplus of the other polarity for the other half of the year. May it then not be that the body exhibits different responses to treatment in one such period from those experienced in the other such period?

How do scientists cope with such anomalies, given that they pin their faith and their whole knowledge of electrical science upon empirical data confined to experiments on electron currents in metal wires?

They will, of course, not have heard of a phenomenon which I call 'vacuum spin'. I believe that there is an aether capable of storing energy by developing a spin condition. That involves electrical charge displacement. Let me now speculate.

There are in science phenomena referred to as 'Earth Lights'. Something can emerge from mountain sides, for example, which sets up a glow, as if a gaseous object exuded from the mountain side is burning away. Imagine that is a spherical aetherial form that has, within it, a radial electric field, because its core has electric charge. The air coextensive with that aetherial sphere will become ionized and so there will be a glow, wherever that aether sphere goes, until it disperses its energy by decay.

Now, that is a rather extreme manifestation of something that may be latent, almost everywhere where there is a source in which ions in motion interact with the weak magnetic field of the Earth to develop a rotary motion, leading in turn to that aether spin situation.

The Earth itself may well have, internal to its structure, an intrinsic electric charge system associated with the induction of the geomagnetic field. Then a flow of water inside the Earth may become the seat of ionic displacement so that, for example, a stream of water may emerge from a hillside with an electrical charge transfer. I say: "may", well knowing that I am speculating here, but I did wonder about such a possibility when I read, quite recently, something sent to me by Dr. E. Larson of Northglenn, Colorado, USA.

It was the text of a book by Owen Lehto entitled 'VIBRATIONS: A Practical Study of the Forces that Affect our Health', published in 1992 by Nutritional Research Center, P.O. Box 308, Keller, WA 99140, USA. Between pages 12 and 15 there is the story about putting two calves out to a field to graze. "The first calf was taken to a small knoll, where it started to eat contentedly. The second one was staked lower down on a flat piece of ground. The grass was slightly wet from rain the night before. I drove a metal stake into the ground and from this stake was a metal chain that went around the calf's neck. Instead of eating it began to run around in circles until it was able to pull the stake loose. It then ran up to where the other calf was eating and began to graze." Investigations to determine the reason for the calf's discomfort indicated the presence of something electrical. The author found that if he stood in the lower area of the pasture and allowed his right arm to hang like a plumb bob and held his left arm with his palm facing downwards, his right hand started to swing with a rapid counterclockwise motion. If he did this test at the top of the knoll the swing was clockwise. Further tests described in the book led to the conclusion that water in motion under the ground was somehow responsible for this phenomenon. Static electricity was in evidence.

Now, I could dismiss this as being attributable to the Earth's electrostatic field. A field that can be as high as 500 volts per metre, particularly at night, exists and is a phenomenon long recognized by physicists. I have discussed this in my book 'Modern Aether Science' in Chapter 15 entitled 'The Earth's Electricity'. Contrary to orthodox belief it arises, not from the charging of body Earth by the periodic lightning discharges, but from solar radiation pressure which is absorbed by electrons. Although these electrons are in atoms that are electrically neutral overall, there is a displacement effect which puts the Earth's surface in a negatively charged state. The heat absorbed by the atmosphere during the day is sufficient to sustain this radiation pressure, even at night. The direct sunlight during the day can, however, partially ionize the air and cause the stored charge to leak a little then, which is why the fields are stronger at night than during the day.

So, one could presume that such a field could be the cause of the distress of that calf. However, why do we all not experience such effects on a regular basis and why does the motion of water play a role? Well, I can but speculate. The feature of that knoll suggests an action which might involve what I referred to above as `vacuum spin'. A spherical aether form developing a spin condition inside a knoll and in some way attributable to a flow of water within that knoll could develop an aether charge distribution of one electrical polarity balanced by a charged state of the water having opposite electrical polarity. This 'vacuum spin' could well also develop turbulence in the aether, resulting in the shedding of weak and invisible versions of those 'Earth Lights' I mentioned and that could the problem. The water flow would carry some of that electrical charge with it in its passage underground. Then one can glimpse a way of linking physics with what is claimed by those who practice dowsing.

Our bodies are inevitably affected by all such extraneous electrical conditions that pervade the atmosphere and the very space we occupy. Indeed, as I shall indicate in Appendix VI on pp. 54-57, there could be activity within our body cells that involves a kind of electric motor action with superconductivity being in evidence. Also, there could be a low frequency field effect set up in the ozone layer which can further aggravate our existence (see Appendix III on pp. 40-41), but most of this Report concerns cyclotron resonance and the overhead power line and electric blanket problem.

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The pages which now follow from here until the Appendix section constitute PART II of this Report and comprise a slightly edited but otherwise unamended collection of separate articles compiled by the author in 1990.

THE HAZARD RISK

A U.S. PERSPECTIVE

The following are excerpts from 1988 and 1989 articles by Thomas F. Valone of Integrity Research Institute*, who has devised a 60 Hertz Magnetic Dosimeter expressly to measure exposure risks of weak but dangerous field conditions.

"Since the New York State Power Lines Project, Scientific Advisory Panel's Report was released, (`Biological Effects of Power Line Fields') in July 1987, there has been an increased awareness of the potential health risks of 60 Hertz magnetic field exposure from power lines."

"The study of Savitz confirms the results of previous studies to some extent and adds to the credibility that exposure to extremely low frequency magnetic fields might be the cause of childhood cancer" (Ahlbom et al, 1987)."

"Another study which has also generated public concern is the finding that heating blankets and heated waterbeds are correlated to excessive miscarriages among pregnant women (Wertheimer and Leeper, 1986). This study has caused the manufacturers of these items to look into ways to design their products to reduce the magnetic field exposure for users. The average magnetic field ranges from 4 mG for heated waterbeds to 15 mG for heating blankets (Becker, 1985)."

These concerns "have also sparked manufacturers to reconsider their designs of these products, though only one manufacturer is currently advertising reduced magnetic exposure."

"With its implication in childhood leukaemia (Wertheimer & Leeper, Am. J. Epidemiol., **109**, 273, 1979), childhood tumours (Wertheimer and Leeper, J. Bielectro. Soc., **7**, 273, 1986) and, recently, learning disabilities (Wall Street Journal, p. B6 11 October 1988), the biological effects of electric power lines, both in the house and outside, are discovered by researchers."

"The latest finding by the former president of the New York Academy of Sciences, Kurt Salzinger, indicates that rats exposed in utero to extremely low frequency (ELF) radiation showed signs of learning disabilities...a problem, he says, that 'didn't go away as rats got older'."

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MOLECULAR MECHANISMS OF MAGNETIC MEDICINE

The following is a quoted excerpt from an article of the above title which appeared in the April 1988 issue of U.S. Periodical MAGNETS. Its author is Lynn A. Surgalla of Department of Biophysical Sciences, School of Medicine, State University of New York at Buffalo in U.S.A.

"ION TRANSPORT ACROSS CELLULAR MEMBRANES:

A number of researchers have reported effects of time varying magnetic fields on the ion flux through membranes. Blackman et al (1982) reported that a 16 Hz sinusoidally varying magnetic field caused increased efflux of calcium ions from chick brain tissue in vitro. It has been purported in recent papers (McLead and Liboff, 1986; Liboff, 1985) that the influence of externally applied, low-level magnetic fields on biological ion transport can be explained by cyclotron resonance theory. The cyclotron resonance frequencies for several biologically important ions such as calcium, sodium, potassium, magnesium, etc., all fall in the 10-100 Hz range when the static magnetic field is in the amplitude range of the earth's field. There is experimental evidence that cyclotron resonance in cells exists (Thomas et al, 1986). The calculated cyclotron resonance frequencies of the various ions were found to coincide with the experimental frequencies which induced ion flux through cell membranes (Liboff, 1985)."

References

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Liboff, A. R. "Cyclotron resonance in membrane transport" in "Interactions between Electromagnetic Fields and Cells": (Chiabera, Nicolini and Schawn (Eds.) Plenum, London, p. 281 (1985).

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CYCLOTRON RESONANCE OF HADRONIC IONS IN LIQUIDS

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ABSTRACT

Although cyclotron resonance is believed to be the cause of harmful effects on the human body when subjected to weak low frequency electromagnetic fields, a crucial problem is why evidence in America and Europe gives similar concern, bearing in mind that a frequency resonance is involved and the power frequencies of 60 Hz and 50 Hz used on these continents are different. A possible solution to this scientific problem is presented and, in addition, a simple practical solution which should eliminate the health hazard from electric blankets and, by analogy, underfloor electric heating systems is proposed.

INTRODUCTION

A major problem now developing in biochemistry is that posed by the harmful effects of weak electric and magnetic fields, evidenced by the higher incidence of cancer and leukaemia in the vicinity of overhead electric power lines and even from proximity with underfloor electric heating systems and certain electrical appliances such as electric blankets.

It has been suggested that cyclotron resonance effects in the body fluids and particularly the bloodstream causes a build up of ion energy which promotes unwanted penetration or rupturing of cell membranes. On the other hand, in a healthy body suffering from a bone fracture, the accelerated actions caused by these fields might even aid the healing process.

It is, therefore, important that we develop a better understanding of the cyclotron process involved.

CYCLOTRON RESONANCE

What we mean by 'Cyclotron Resonance' is the concerted action on charged particles of two independently acting fields known to the electrical engineer. Firstly, there is the steady field which constrains the thermal motion of the particles so that it has a cyclical or oscillatory component at a frequency governed only by the field strength and the particle mass. Secondly, there is an alternating field which, with the cyclotron resonant state, is in tune with that frequency. The cyclotron is a machine used in high energy physics to accelerate charged particles which move in circular orbit about the axis of a magnetic field whilst an alternating electric field having a frequency equal to the orbital cyclic motion of the particles pumps energy into them to cause them to go faster and faster. A weak A.C. field in voltage terms can produce particles with energies equivalent to those obtainable using enormous D.C. voltages and what is now to be discussed is the replication of this process in the ionized liquid in a human body which is ever subject to the Earth's magnetic field and can, under certain circumstances, be exposed to harmful weak A.C. fields at mains power frequency.

THE ION FREQUENCY

It is clear that the primary factor in producing cyclotron resonance in our bodies is the Earth's magnetic field. This has a steady value wherever we are on the Earth's surface and differs little from a 50 μT (microtesla) (0.5 gauss) field. Its direction does vary with both latitude and longitude owing to the angle of dip of the Earth's field and the fact that the geomagnetic poles are offset from the geographic poles. This direction is not relevant so far as the active random motion of ions in our body fluids is concerned. By a gyromagnetic process these ions will, in some measure, share in responding to that geomagnetic field to set up a reaction field by moving in helical paths about the field axis.

It is characteristic of this cyclotron reaction process that the angular frequency of the response in the helical orbits is simply Hq/m, this being the product of the field strength H and the electromagnetic charge q to mass m ratio of the ion involved. The ion mass which matches a 50Hz power frequency is approximately that of the ions dissociated in aqueous solutions, namely the positive hydronium ion or the negative hydroxyl ion. The extraneous oscillating fields, whether electric or magnetic, can pump energy into a resonance building up the penetration power of the ions, but only if that power frequency is a good match for the particular cyclotron frequency of the ions present in that Earth field.

The awkward question then faced is why there should be problems arising from power frequencies which can be precisely 60Hz in USA and precisely 50Hz in U.K. If 60Hz has harmful effect in the geomagnetic field in USA, then why should 50Hz be harmful in U.K. where the geomagnetic field has the same strength? This question is the main thrust of this paper.

THE HADRON-LEPTON GYROMAGNETIC REACTION

Our electromagnetic theories have been established on the basis of experiments performed by using electron currents or magnets which owe their magnetic field to internal electron motion. Electrons are leptons which means that they can interact with a field by creating and annihilating charge pairs of their own lepton form. The heavy positive ion nucleated by an atomic nucleus owes its net charge to a different particle form known as the hadron. The question arises as to whether hadrons interact magnetically as do leptons.

Now, there are sound theoretical reasons for understanding how the electromagnetic interactions with which we are familiar can apply to the lepton-lepton interaction and the hadron-lepton interaction. However, there is equal reason to suspect that the hadron-hadron interaction is different and this seems to be indicated by experiments involving discharge currents in aqueous solutions.

What this means to our cyclotron problem is that, if the Earth's magnetic field has its source in hadron charge and the reacting ions are hadrons, then the hadron-hadron interaction is affecting the cyclotron reaction and it is not truly determined by a formula based on the Lorentz force law.

In general terms it must be realized that an applied steady magnetic field will develop reactions in ionized liquids which are partly produced by negative ions (lepton charge) and partly by positive ions (hadron charge). Thus if these react differently the resultant magnetic field which determines the forces on the reacting ions may effectively have a different strength from that deemed to apply in determining the cyclotron resonance frequency. More to the point, if the resonance can deploy energy between the two types of ion to optimize the action, then that effective field strength can adjust within limits so as cause the cyclotron resonant frequency set by the ion mass to conform precisely with the driving power frequency.

This is the basis on which the damaging effects can stem from the same ion type, whether we have a 50Hz power frequency or a 60Hz power frequency. The task is, therefore, to analyse this proposition and to see how those limits are set, so that remedial design techniques can be found for eliminating the dangers involved.

PRIOR RESEARCH ON GYROMAGNETIC REACTION EFFECTS

A consideration of magnetocaloric effects and gyromagnetic reactions leads one to question whether the basic g-factor of 2 is really due to Dirac's mathematical concept of electron spin. There are very sound reasons (including the fact that positrons in an electron gas respond as if they have twice the mass of the electron) for accepting that there is a half-cancelling field reaction. What this means is that, when we measure the gyromagnetic reaction and find that it is twice the value we had expected from basic theory, we should not look for new physics by formulating `spin' as an abstract concept. Instead we should realize that what we assume to be the magnetic field is not just that we apply by powering an electromagnet. It is really the difference between the field we apply and the natural field reaction of the free ions present. It seems probable that the field reaction invariably halves the primary field action and that we have not realized this and related what is measured to the primary action only.

This is justified by the simple expedient of matching the reaction component of the kinetic energy of the reacting ions with the field energy of the resultant magnetic field. For optimum energy deployment the primary field action is invariably halved by reaction of Maxwell's displacement charge in the vacuum or by conduction electrons in copper. The question, however, is whether that halving effect applies to the positive, as opposed to the negative heavy ions in electrically dissociated liquids. The action of the negative ion is likely to be dominated by the surplus electron, whereas the action of the positive ion will be dominated by the surplus charge of the proton. In physics, the proton, as a hadron is different in properties from the electron, as a lepton. They do respond differently and anomalies are showing up in certain experiments involving electrical discharge through water. Hence there is a serious doubt about reaction effects in dissociated aqueous solutions. Subject to the latter doubt, and concerning the field strength halving effect just mentioned, all this means is that the calculation of any magnetic field action of current must introduce that g factor of 2 to enhance the field strength before it is halved by the inevitable offset reaction.

The physical process involved in the interaction of moving charges is that of retarded energy transfer and this can be affected so as to enhance the primary magnetic field if a reaction field sets up effects which transfer energy in the reverse direction. This is all embraced by the inductance property of the primary circuit and it will be understood that, except where the core is ferromagnetic, the magnetic field energy calculated in the normal way in terms of the magnetizing current is a measure of that energy fed into the inductance. However, the actual magnetic field determining the Lorentz force on an ion in a liquid may be different or, if we prefer, the Lorentz force may not be that prescribed by use of the formula as it applies to interactions in free space.

In order to understand the lepton-hadron involvement in this process we will perform an analysis assuming that the primary field is leptonic in nature and that the reaction is partially leptonic (by an energy share factor β) and partially hadronic (by a factor $1-\beta$). Hadron-hadron interactions should not, it would seem, then be regarded as contributing or even present and yet this is not so. First, imagine that β is zero.

We suppose that there is a primary field of strength gH_p produced by a solenoid surrounding the test substance. We think the field produced is H_p but it is really gH_p. H_p is that expected from the current action. g is an unknown factor involved in the inductance reaction. The net field strength, allowing for the reaction field H_r is denoted H. Therefore:

$$gH_p - H_r = H \text{ .... } (1)$$

Now, the Lorentz force acting on the reacting leptons of charge q and mass m sets up an equation of motion:

$$Hqv = mv^2/r \text{ .... } (2)$$

where r is the helical orbit of the reacting lepton and v is its speed in orbit in the plane normal to the field axis.

The reacting magnetic moment is g times the reacting lepton density summation of qvr/2 and this translates into a reacting field component if, in the gaussion units used, we multiply by 4π. Using equation (2) to express $mv^2/2$ as Hqvr/2, the reacting field component becomes:

$$H_r = 4\pi g(E/H) \text{ .... } (3)$$

where E is the kinetic energy density associated with the orbital reaction v motion components.

It was suggested that energy deployment was optimum, meaning that E will tend to a maximum as potential energy minimizes. Therefore the task is to substitute (3) in equation (1) to see how H adjusts.

$$4gE = gH_pH - H^2 \text{ .... } (4)$$

$\delta E/\delta H$ is zero when $gH_p = 2H$, but we imagine that, apart from a minor diamagnetic or paramagnetic reaction in a non-ferromagnetic substance, there is really no recognized diminution of the field strength owing to the gyromagnetic reaction. We then see that H_p and H are equal and this means that g must be 2. Thus the g-factor of 2 evidenced by gyromagnetic experiments is explained without recourse to the abstruse formalism of the relativistic Dirac formulations.

Note, however, that E is then equal to $H^2/8\pi$, which is the magnetic field energy density stored electromagnetically. Clearly, it is the reacting orbital ion or other reacting charge that is the agent for feeding inductance energy back into a magnetizing solenoid when it is demagnetized. Also, instead of adopting this energy optimization argument we could simply have declared that E was $(H_p)^2/8\pi$ and put this in equation (4) to find that if g = 2 then $H = H_p$.

The question now faced is what happens if that reaction field is partly attributable to hadrons, meaning that β is not zero. To proceed, we will assume, pending further discussion, that the g = 2 factor applies for fundamental reasons. We examine the situation where there is a mix of single polarity (negative) lepton-related ion reaction and a single polarity (positive) hadron-related ion reaction.

Note that we are not here discussing what is known as 'nuclear magnetic resonance', where the resonant spin states are set up inside the atom. Instead we are dealing with the case in which the atom has become ionized and is in free motion.

The lepton-produced component field H derived from equation (1) is:

$$H = gH_p - f[\beta]H_r \text{ .... } (5)$$

and this is further offset by a hadron reaction component $(1\text{-}f[\beta])H_r$. Here $f[\beta]$ is a function of β representing reaction field strength apportionment, whereas β is field energy density apportionment.

However, the $f[\beta]H_r$ term can be written as $4\pi g\beta E/H$, because the lepton interacts normally with both the lepton and hadron components of H. On the other hand, the $(1\text{-}f[\beta])H_r$ term can be written as $4(1\text{-}\beta)E/H_p$, because the hadron interacts in the normal electromagnetic way only with the lepton component of H specified by equation (5).

Put g = 2 and $E = (H_p)^2/8\pi$. Then we obtain:

$$H = 2H_p - \beta(H_p)^2/H - (1 - \beta)(H_p)/(2) \text{ .... } (6)$$

Evidently, if $\beta = 1$ then $H = H_p$, as expected, but if $\beta = 0$ then $H = (3/2)H_p$.

In other words, if the leptonic ion reaction predominates the effective H field governing cyclotron action is close to that normally expected, but if the hadronic ion reaction predominates the cyclotron action can occur at a frequency up to 50% larger than that normally expected.

Evidently, if this ion reaction process has been correctly interpreted, there is then reason to understand how the power frequency that perturbs the cyclotron action in a liquid can influence the apportionment of the reaction energy density E between the two types of reacting ion to seek out a cyclotron resonance intermediate that of the two ion types. The energy exchange optimizes to assure maximum energy transfer. There is no need for a perfect frequency tuning with the specific individual ion mass properties and the background D.C. field.

The only condition is that the positive ions involved must have masses which for the power frequency used need, for cyclotron resonance, a D.C. field that lies between 66.7% and 100% of that given by the cyclotron formula. Typically, therefore, the hydronium ion at 50Hz requires a D.C. field of between 41μT and 60μT, whereas at 60 Hz the field has to be between 49μT and 74μT.

For the hydroxyl ion the 50Hz range is 36μT to 54μT and the 60Hz range is from 44μT to 66μT.

Bearing in mind that the geomagnetic field is of the order of 50μT we then see that the 50Hz and 60Hz power frequencies are virtually the ideal frequencies for activating the harmful effects of cyclotron resonance. Conversely, if these frequencies were to be doubled and the ion types specified are the ones which really are the prevalent variety causing the problem, then these field requirements would double and cyclotron resonance in the geomagnetic field could not occur.

It is not suggested that A.C. power frequencies, as such, should be doubled. Rather, the proposition is that the powering of harmful heating appliances, such as electric blankets, should involve the use of an unsmoothed full-wave rectified version of the normal A.C. power frequency supply. This would eliminate the harmful frequency and leave a double frequency and higher harmonic frequency power supply with much weaker current amplitude. The main heating effect would be that of the D.C. component and no cyclotron resonance with the hydronium or hydroxyl ions could occur.

CONCLUSION

This paper has discussed cyclotron resonance in relation to the harmful effects of weak A.C. fields. Electric blankets are particularly prone to such problems because the electric current is carried by wires which are spaced apart. In a normal electric flex the current flows one way in one wire and returns through another wire twisted around the first wire. The result is that there is really no resulting electromagnetic field to worry about because the field of one wire cancels that of the other. This is not the case for the electric blanket, where the wires can be several cm. apart and therefore result in a field which penetrates well into a body resting on that blanket.

The paper has addressed the key issue of how cyclotron resonance can apply both to the 60 Hz and 50 Hz environments. The explanation has brought to bear fundamental theoretical issues which the author has been studying and advocating for many years but which theoretical physicists will regard as controversial. However, less controversial is the belief that the health hazard is connected with cyclotron resonance and the practical remedy need not depend upon acceptance of the author's theoretical proposition.

Certainly manufacturers of electric blankets would be well advised to provide suitable power converters in their blanket switches which eliminate the 50 Hz and 60 Hz frequencies. The cost of such a modification would only be a few percent of the cost of the blanket and this is seen as the first and easiest step forward that one can take in facing up to the real health hazard problems posed by the weak low frequency fields to which we are all exposed.

REFERENCES

The following references are not identified in the above text but they will give background to the matters raised above.

F. Ogden, 'Killing Fields', Electronics World and Wireless World, p. 3 (January 1990).

A. Philips, 'Killing Fields - Introduction', Electronics World and Wireless World, pp. 96-97 (February 1990).

S. Best, 'Killing Fields - Epidemiological Evidence', Electronics World and Wireless World, pp. 98-111 (February 1990).

R. Coghill, 'Killing Fields - Biophysical Evidence', Electronics World and Wireless World, pp. 112-119 (February 1990).

A. Philips, 'Killing Fields - The Politics', Electronics World and Wireless World, p. 120-124 (February 1990).

APPENDED NOTE CONCERNING THE g-FACTOR

Why should g be 2? Although physicists tend to view this as something relying on the mathematical analysis deeply involved with the relativistic-quantum electrodynamics of Paul Dirac, this author believes that the true answer probably arises from the energy transfer processes as charges in motion interact. The point is that energy supplied to activate the charges producing a magnetic field has to find its way into the orbits of the reacting ions. The energy makes this journey via the Coulomb field interactions of charge. Energy does not travel from one charge to the other along an infinitely thin line drawn between the two charges and the energy cannot travel at faster than light speed. Were we to assume that energy does travel directly along that line at the speed of light, then it can be shown that g = 1. However, the real journey is a mean distance to the distributed Coulomb field system of exactly the intercharge distance and this is followed by a second leg of travel of identical mean distance from the Coulomb field to that other charge. This doubles the journey time and so the Coulomb retardation which accounts for the Lorentz force and thereby makes g = 2.

It is beyond the scope of this paper to give a full analysis of this action, but it can be understood by first reviewing how the Lorentz force can be deduced from the Coulomb interaction, as shown in detail elsewhere by the author, and then taking account of certain arguments used by the author to explain aspects of the gravitational interaction. The latter is not simply a propagation of energy to give basis for the deployment of magnetic field energy, but is one step advanced from this, since the gravitational interaction is a magnetic interaction and the magnetic energy redeployment with changing mass positions is an onward iteration of the primary process. The essential point is that there is a retardation effect that is greater than that assumed by line of sight propagation between the interacting charges.

KILLING FIELDS - SOLVING THE PROBLEM OF OVERHEAD POWER LINES

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The health hazard posed by living in close proximity to overhead electric power lines and attributable to cyclotron resonance induced in human body cells by weak electromagnetic fields can be eliminated but only if we cease to use our 50 Hz or 60 Hz frequencies and rely on D.C. exclusively or double the operating frequency to 100 Hz or 120 Hz.

INTRODUCTION

The fact that cancer has been linked to electromagnetic radiation from power lines and appliances has now been recognized by the US Environmental Protection Agency [1]. A recent editorial in Electronics World [2] reports how, in 1974, epidemiologist Dr. Nancy Wertheimer established a connection between child leukaemia victims and 7600 volt feed lines to pole mounted transformers feeding house supply systems. This was later followed by a sequence of articles including 'Killing Fields' in their titles [3, 4, 5, 6] giving a devastating account of the risks posed by living under the influence of the effects of what are, in fact, weak electromagnetic fields.

The problem has been traced experimentally to a resonance effect akin to what is known in physics as 'cyclotron resonance' [7, 8, 9]. In a cyclotron a modest cyclic field can be caused to accelerate a moving ion to enormous energy levels by a gradual resonant build up process which taps energy from the weak field pulsating in harmony with the orbital frequency of ion motion in a steady magnetic field. In the human body that steady field is the Earth's magnetic field and the ions in motion are those chemical ions in solution in our body fluids and present within our body cells. The activating field conducive to resonance is that extraneous electric or magnetic field set up by an overhead power line or an appliance such as an electric blanket, where the wires carrying compensating currents are well spaced. It is this spacing that is crucial to the existence of those small but hazardous weak fields.

The question we now face is not so much that of understanding the cause, but rather one of eliminating the problem. Pending a discovery of a solution, those expressing responsible opinion on this matter are cautiously pointing out that, assuming electromagnetic radiation does have an effect, it can only be to help to proliferate cancers already present. This, however, is not a convincing assertion, given that we probably all have a latent capacity to develop cancer cells if exposed to fields which can accelerate transmutations.

This article addresses directly the straightforward issue of eliminating the possibility of cyclotron ion resonance brought about by A.C. field influences in a domestic or normal commercial environment, where the only prevalent D.C. magnetic field is that provided by body Earth itself.

Concerning electric blankets or underfloor heating, these can be remedied by the expedient of using D.C. power excitation or even full-wave unsmoothed rectified A.C. as by using what the author terms the `Harwen switch' [10]. This is simply a two pole switch having a bridge rectifier incorporated in the switch housing on the output side. However, the solution to be applied to overhead power lines, short of conversion to high voltage D.C. transmission, is not so easy in view of the very substantial voltages and currents involved and the heavy capital investment in existing structures.

THE HAZARD FREQUENCY RANGE

Cyclotron resonance cannot occur if the hazardous frequency range lies outside that of the exciting field. We are singularly unfortunate in that the 50 Hz or 60 Hz frequencies, which relate to the two-pole structure of the magnetizing rotor fields of synchronous alternators running at a sensible design speed of 3,000 or 3,600 rpm, happen to be close to that of ions in our bodies responding to the Earth's 50 μT magnetic field.

The cyclotron formula requires that the angular frequency of the resonance should be simply Hq/m, where H is the strength of the geomagnetic field and q/m is the charge to mass ratio of the ion. For unit atomic mass on the C 12 scale q/m is 96 million coulombs per kg. Therefore, if H is 50 μT, an ion of unit atomic mass and the normal unit charge will have a cyclotron angular frequency of about 4800 rad/sec or about 760 Hz.

Table I shows the resonant cyclotron frequencies of single ions of different forms when subject to the steady geomagnetic field.

TABLE I

Ion	Mass	Frequency
hydroxyl OH	17	45-67
hydronium OH_3	19	40-60
sodium Na	23	33-50
magnesium Mg	24	32-47
chlorine Cl	35	22-33
potassium K	39	19-29
calcium Ca	40	19-28

The lower frequency expressed in Hz is that at which a single presence of such ions in solution causes the thermal or Brownian motion of the ion to build up pressures by virtue of the transfer of energy as the ions accelerate to higher and higher speeds in weak but sustained perturbing fields having that resonant frequency.

Independently, this author has shown that the inter-reaction processes involved when two dominant forms of ion are present can cause one ion form to develop its own field and so coact with the geomagnetic field to bring about a resonance at a frequency up to 1.5 times higher than that for a single ion, by a self-tuning of the system. This is indicated by the higher frequency listed. In other words, over a limited frequency range above that of natural resonance of the single ion form, there will be perfect resonance of one of the ion forms even though the external frequency is not exactly as required for that form assuming that H is exclusively the geomagnetic field strength.

Whilst it is then easy to picture cyclotron motion of the positive and negative ions individually there are problems in imagining how they can build up their energy and set up pressures owing to their reacting orbital motion in the earth's weak magnetic field. The question at issue is that of why the oppositely charged ions, which travel clockwise and counterclockwise, respectively, do not simply collide to share their energy. That is the puzzling facet to the experimental evidence supporting the cyclotron resonant effects. To overcome this, in a simple pictorial sense, it may suffice to consider the positive and negative ions as grouping, respectively, in a sequence of alternate parallel planes defining their freedom of action by restricted motion about the field axis. This will minimize collision probabilities. The result is then equivalent to having two concentric solenoids producing augmenting reaction fields, with the ion type of larger mass constituting the outer solenoid.

The author is aware of the extensive experimental research which has focused on ion forms involving Ca, Na, etc, but what may have been missed in this prior research is the appreciation that water forms its own ion form in that it dissociates into hydroxyl and hydronium ions as listed in Table I. It would seem, at least to this author, that the prevalence of such ions and their rather special relationship to the 50 Hz and

60 Hz frequencies, both of which they encompass by their combined effect, and as illustrated in Table I, has to give the underlying basis for field-induced activity in body fluids.

However, this is not a critical point. What is critical is the need to realize that no normal free and prevalent ion form in our body fluids has a resonant condition which corresponds to 100 Hz or 120 Hz. Only lithium of atomic mass 7 if it were present in solution as a free single-atom ion could come near to satisfying the resonance requirement.

In this situation, bearing in mind that the very prevalent hydroxyl and hydronium ions, which are the natural dissociated ions of water, are probably the dominant cause in the hazard risk at 50 Hz or 60 Hz, it can reasonably be presumed that a hazard free situation prevails at 100 Hz or 120 Hz. Therefore, as a simple expedient, the object should be to eliminate the 50 Hz or 60 Hz basic frequency and operate instead at twice this frequency.

Now, this is may not seem to be a feasible solution, except for the electric blanket or underfloor heating situation where full wave rectified unsmoothed 50 or 60 Hz A.C. will allow heating to rely on a mixture of 81% D.C. and 19% A.C. mainly at 100 or 120 Hz.

In the case of the overhead power line, unless one can think in terms of screening power lines, which seems uneconomic, or using normal closely wound cable forms, as used underground, the most appropriate, but drastic, remedy long term is to adopt a new standard frequency for power generation and supply, such as 100 Hz.

THE FUTURE

Given that weak electromagnetic fields at the power frequencies 50 Hz and 60 Hz do pollute our environment in the sense that they make it hostile for the chemistry of our body functions, there is no real choice other than making sure we live well removed from power lines or accept the higher incidence of cancer and leukaemia as tolerable.

Hopefully the future will see technology advance, perhaps on the warm superconductor front, to the stage where overhead power lines will carry D.C. in preference to A.C. To the extent that converters are then used to generate A.C. domestically or industrially for special purposes, that conversion can be to 100 Hz to avoid risk. More likely, however, since appliances needing to be powered by A.C. are not like underfloor heating or electric blankets with well-spaced current and return currents productive of stray fields, the hazards of the latter can be avoided by powering by D.C.

In the meantime, this author has considered taking the precaution of adapting the switches on his electric blankets to include, on the output side, a full-wave bridge rectifier to eliminate heating the blanket with hazard-producing current at 50 Hz, even though the power is drawn from a 50 Hz mains supply.

On reflection, however, the best course seems to be not to use an electric blanket at all, an action which, if followed by many others should spur manufacturers to cause them to add such a hazard-eliminating feature to their blankets. As things stand they prefer to ignore the problem until its solution becomes an industry standard.

Table II below shows how the power supplied to a purely resistive load is divided between the frequency components of an unsmoothed full-wave rectified sinusoidal 50 Hz voltage source.

TABLE II

Frequency	Power
0	81.0569
100	18.0127
200	00.7205
300	00.1323
400	00.0408

Finally, the author is all too conscious that the personal views expressed in this article concerning the simple remedy of using a modified electric blanket switch is more a matter of opinion than something easily supportable by test data. All that can be said is that if those many researchers who point to cyclotron resonance are correct, then it makes sense to power those field producing appliances, and particularly the electric blanket, with a frequency that lies outside the possible hazard range.

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EXPLANATORY NOTE

A contracted version of the above article has been published in Electronics World + Wireless World, at pp. 774-775 in the September 1991 issue. The U.K. Patent Application of reference [10] was deemed by the U.K. patent examiner as constituting two inventions and eventually published by the U.K. Patent Office on November 27th, 1991 as Serial Nos. 2,244,393 and 2,244,394 but neither were followed through to grant. On the other hand, a corresponding U.S. Patent Application was granted on September 29th, 1992 as Serial No. 5,151,577 (see Appendix V below), but the author has decided that commercial restrictions on the use of such an invention are not warranted and has allowed that patent also to lapse. It is hoped that the invention will be used freely by manufacturers of electric blankets.

The author at the time this 1990 section of text was written had formed a company in U.K. named HARWEN LIMITED to take forward research on various inventions in the new energy field, including the device to be used to avoid the hazard risk with the electric blanket. At the outset it was also sought to register in U.K. the name HARWEN as a Trademark on Part A of the U.K. Trademark register. The examiner accepted that HARWEN was an `invented word' which qualified for registration, but imposed the proviso that I secured a sanction from Harwell, the seat of the atomic research activity sponsored by the U.K. government. I then discovered that the U.K. Atomic Energy Authority had taken extreme precautions in themselves registering a series of trademarks, virtually as a defensive action, to block anything external which might possibly seem connected with Harwell. In these unexpected circumstances and knowing that I would be mounting efforts to encroach upon the power generation field by my patent filing, I thought it prudent to abort my use of the name HARWEN and not solicit the sanction from Harwell that would allow me to proceed with trademark registration. It was for this reason that I then changed the company name to THERMODYNAMICS LIMITED.

I hope this note will therefore explain the use of the word HARWEN as used in the next item in this Report and, incidentally, and for the record, as used a 1990 paper in Speculations in Science and Technology [**13**, 295-299 (1990)] entitled 'The Harwen Energy Radiation Regenerator'. The latter is a subject unrelated to the electrical blanket theme.

THE HARWEN BLANKET SWITCH

A remedial design aimed at eliminating harmful electric effects.

While scientists are still struggling to understand how the very weak electric fields set up by electric blankets can possibly be linked with miscarriage or leukaemia, the HARWEN switch offers a safeguard against the likely cause, which is `cyclotron resonance'. The switch includes a converter which converts all the power into a form which excludes the harmful frequency range before the electricity reaches the spaced wires which set up the fields that can act on the user's body cells.

Question: What is cyclotron resonance?

Answer: The cyclotron is a machine used in high energy physics to accelerate charged particles which move in circular orbit about the axis of a magnetic field whilst an alternating electric field having a frequency equal to the orbital cyclic motion of the particles pumps energy into them to cause them to go faster and faster. A weak A.C. field in voltage terms can produce particles with energies corresponding to enormous voltages.

Question: What has that to do with the human body?

Answer: The replication of this cyclotron resonance process can occur in the ionized liquid in a human body which is ever subject to the Earth's magnetic field and can, under certain circumstances, be exposed to harmful weak A.C. fields at mains power frequency. The enhanced activity resulting from the consequent energy transfer sets up pressures which can cause penetration of cell walls and thereby produce abnormalities.

Question: Why are electric blankets singled out as being harmful?

Answer: There are stray field effects at mains frequency because manufacturers find it safer to space the wires carrying currents in the forward and reverse directions, whereas in normal power supply cables the wires lie close together.

Question: What is so special about the mains frequency of 50 Hz?

Answer: It is characteristic of the cyclotron reaction of a moving electric ion that the angular frequency of the reacting motion is simply Hq/m, this being the product of the field strength H and the electromagnetic charge to mass ratio of the ion involved. The ion mass which matches a 50Hz power frequency is approximately that of the ions dissociated in aqueous solutions present in the human body, as in the blood stream, namely the positive hydronium ion or the negative hydroxyl ion. The extraneous oscillating fields, whether electric or magnetic, can pump energy into a resonance building up the penetration power of the ions, but only if that power frequency is a good match for the particular cyclotron frequency of the ions present in that Earth field and 50 Hz is critical in this regard.

Question: Does not the problem arise also in U.S.A. where the mains frequency is 60 Hz?

Answer: Yes, but there is reason to understand how the power frequency that perturbs the cyclotron action in a liquid can influence the apportionment of the reaction energy density between the two principal types of reacting ion and so seek out a cyclotron resonance intermediate that of the two ion types. It can be argued that cyclotron resonance will occur when the ions involved have masses which, for the power frequency used, needs a D.C. field that lies between 66.7% and 100% of that given by the cyclotron formula. Typically, therefore, the hydronium ion at 50Hz requires a D.C. field of between 41μT and 60μT, whereas at 60 Hz the field has to be between 49μT and 74μT. For the hydroxyl ion the 50Hz range is 36μT to 54μT and the 60Hz range is from 44μT to 66μT.

Question: Is the Earth's magnetic field in the danger range for both 50 Hz and 60 Hz power supplies?

Answer: Yes. The geomagnetic field, which penetrates into our houses and our bodies, is of the order of 50μT. This means that the 50Hz and 60Hz power frequencies are virtually the ideal frequencies for activating the harmful effects of cyclotron resonance. Conversely, if these frequencies were to be doubled and the ion types specified are the ones which really are the prevalent variety causing the health risk, then these field requirements would double and cyclotron resonance in the geomagnetic field could not occur.

Question: So how does the Harwen switch work?

Answer: It incorporates a semiconductor device which converts the mains power into an unsmoothed full-wave rectified version of the normal A.C. power frequency supply. This eliminates the harmful frequency, puts 81% of the power into D.C. and the rest of the power into a double and higher harmonic frequencies of much weaker current amplitude. No heat is wasted and no cyclotron resonance with the hydronium or hydroxyl ions can occur.

Question: Does this mean that the switch offers guaranteed assurance that there will be no harmful effects arising from the blanket?

Answer: No. It will be quite some time before scientists can be sure about this matter and the risks are small anyway. The Harwen switch is a simple and cheap way of taking a precautionary measure, bearing in mind that the evidence points to a problem with normally powered blankets. The problem is elusive and, though the design of the Harwen switch is based on physics, scientists generally are very slow to respond to changes which involve revising existing theory.

Question: Will all electric blanket manufacturers need to offer some such precautionary measure aiming to reduce the health hazards?

Answer: Certainly manufacturers of electric blankets would be well advised to provide suitable power converters in their blanket switches which eliminate the 50 Hz and 60 Hz frequencies. The cost of such a modification would only be a fraction of the cost of the blanket and this is seen as the first and easiest step forward that one can take in facing up to the real health hazard problems posed by the weak low frequency fields to which we are all exposed.

The following paper by H. Aspden was published In volume 12, the 1989 issue of Speculations in Science and Technology at p. 17.

EXTREMELY LOW FREQUENCY ELECTROMAGNETIC RADIATION AND BIOLOGICAL EFFECTS

ABSTRACT: Although there is a vast amount of evidence to show that extremely low frequency electromagnetic (ELF) radiation is a health hazard, there is no currently accepted physical reason why this should be so. One possible explanation is presented, based on an existing theory for the gyromagnetic reaction anomalies.

INTRODUCTION: The analysis in this paper brings together three separate physical phenomena in an attempt to explain why ELF radiation is harmful to health. The phenomena with which we are concerned are:

(a) The well-researched and documented evidence that ELF radiation can cause leukaemia, enhanced DNA synthesis, mechanical vibration of brain tissue, tumours, calcium transport across cell membranes, chronic stress and other disorders.

(b) The gyromagnetic oscillations which exhibit the resonance of an atmospheric field cavity enveloping the Earth.

(c) The gyromagnetic reaction that opposes any magnetic field that penetrates through ionized gas plasma, ionized liquid solutions or even the vacuum if the latter contains active charge that can be displaced according to Maxwell's equations.

It is already established that there is a link between (a) and (b), as discussed in a review paper by T. F. Valone [1]. The seriousness of the connection between ELF radiation and health is such that Valone reports on the development of a special ELF Spectrum Analyzer the object of which is to provide an instrument capable of detecting and analyzing electromagnetic fields having frequencies ranging from 10

Hz down to 0.01 Hz.

In Valone's paper there are more than 20 references that support the statement in (a) above. Here, however, we present just one such reference besides the Valone reference itself. This is to a paper in SCIENCE by A. R. Liboff et al. [2] entitled `Time-Varying Magnetic Fields: Effect on DNA Synthesis'.

So far as the (b) phenomenon is concerned this relates to what is called the 'Schumann resonance' [3]. There is a fundamental frequency of about 7.8 Hz arising from the time it takes for electromagnetic radiation trapped within the ionosphere-earth cavity to propagate around the body Earth. 186,000 miles per second and a wavelength of about 24,000 miles, corresponding to the Earth's circumference, gives the 7.8 Hz frequency.

This resonance is known to regulate in some way the timing of the biocycles. Valone states:

'It has been noted that the basic oscillation frequency of the brain (alpha rhythm) is the same as the Earth's fundamental resonant frequency.'

THE GYROMAGNETIC REACTION: In reading Valone's fascinating review of this subject the author's attention halted at:

'ELF magnetic fields on the other hand pass right through the body without any appreciable attenuation but ironically have been found to have many significant biological effects.'

It is this statement which is, indeed, an accepted proposition in established physics that this author finds can be challenged. The reasons are of record in the first volume of Speculations in Science and Technology in a 1978 paper by the author entitled 'Crystal Symmetry and Ferromagnetism' [4]. The reader will, of course, see no connection between ferromagnetism and the human biocycles. However, the point is that the author gave very good reasons for suggesting that a steady or low frequency magnetic field acting an a medium containing charge in motion would cause that charge to react to the extent that the reaction kinetic energy density was equal to the magnetic field energy density.

In a fuller treatment of the theory involved it is argued that it is this reaction that feeds the inductive energy back to the magnetizing system as it is de-energized. Furthermore, in asserting priority to deploy kinetic energy to match the magnetic field energy density, the reacting ions having the greater mass will take priority in asserting the reaction.

It is not proposed here to enter into the full physical support for this contention, as reference [4] should suffice to sustain the proposition. However, what we can do is to show why this reaction effect is very relevant to the ELF hazards.

The crucial formula governing the reaction is that associated with the cyclotron notion of a charge reacting to a steady magnetic field of intensity H. In the cgs system of units the cyclotron angular frequency is given by Hq/m, where q is the electromagnetic unit of electron charge of a typical ion and m is the mass of that ion.

Therefore, if we are looking at the effects of the field H on a saline solution, for example, we will find that there is a characteristic frequency of reacting motion for each type of free ion in that electrolytic solution. Consider the chlorine ion as one prevalent in a resonance attributable to the presence of sodium chloride. This has a mass of very nearly $6x10^{23}$ gm, whereas q has the numerical value $1.6x10^{20}$. It follows that the angular frequency of the motion will be 266(H) rad/s or, as a frequency, about 42(H) Hz.

Already, therefore, we have reason to see that there is the possibility of resonance between this frequency and that 7.8 Hz fundamental of the Schumann resonance, but that such a resonant condition will only occur at or very near to a specific value of H, which in the case of the Cl ions is (7.8)/(42) or 0.19 gauss.

THE ELF RADIATION INTERACTION: Now the Earth's magnetic field has an intensity of about 0.5 gauss (i.e. 50 μT) and, though this is not the same everywhere on the Earth's surface, a value of this order is the steady field applicable wherever we choose to be. Consider then the effect of a slowly varying magnetic field that is of sinusoidal form and has an amplitude of, say, 0.4 gauss. In this context 50 Hz is slow. The excursions of the combined field will pass very slowly through that critical value of 0.19 gauss twice per cycle. This means that the electric field pulsations at 7.8 Hz associated with that geomagnetic cavity resonance will combine with the rhythm of the reaction ion motion at exactly the same frequency to build up resonant lateral pulsations at exactly that 7.8 Hz frequency.

On the other hand, if the disturbing field has a high amplitude or a very rapid cycle of change, the passage through the 0.19 gauss threshold will be very rapid and there will be no progressive build-up of oscillations. Even allowing for the fact that the opportunity for resonance occurs more often, owing to the increased frequency, the progressive build-up has no opportunity to establish a strong concerted cyclic displacement of the ion population in, for example, the human blood stream.

What this amounts to is that strong electromagnetic radiation at power frequencies or weak radiation at high frequency will excite no ion resonance with the 7.8 Hz field. However, ELF radiation of small magnetic field amplitude can be a cause of pulsations that might well promote such resonance and affect cell behaviour in our bodies. This seems consistent with the evidence presented in (a) above.

There is, of course, scope, based an the theory presented, for examining how the type of free ion present in a reacting medium might be sensitive to different critical magnetic fields. The use of controlled ELF signals of different amplitudes might then operate selectively in developing the resonance under discussion.

CONCLUSIONS: Thus, given a physical basis for the way in which ELF radiation operates to affect our health, such as that just presented, we have then the means by which to devise verifying tests and even equipment that can reduce or eliminate the hazards.

We will not speculate on that here. The author does, however, believe that there is something of basic scientific importance in this biomedical connection with the gyromagnetic reaction.

Generally, physicists believe that in a metal conductor, where the electrons are the free ions, there is no such thing as `free electron diamagnetism'. They argue this on statistics but with the hindsight knowledge that there seems to be no attenuation whatsoever of the applied magnetic field. The author has reason to believe that the magnetic fields produced by isolated charge in circuital motion are twice as strong as predicted on conventional theory. This affords the scope for a reaction effect that normalizes the net field at its unity value. The optimum reaction in terms of energy deployment leads to that factor of 2 and ensures that just enough ions react to half-cancel the primary effect. This is why experiment shows that there is an anomalous g-factor of 2 when the angular momentum change in a steel rod is related to the change of magnetic moment of the orbital electrons deemed to account for the change of magnetization of that rod.

The orthodox theory has led to the notion that a point charge can set up magnetic moments by spinning but it takes a specific and somewhat abstract mathematical treatment to give basis to such a proposition. One would not normally be able to make sense of a statement that a point can spin. However, this could be an erroneous interpretation, in which case we see scope for using the cyclotron theory to explain the ELF-resonant ionic reactions in, for example, the human blood stream.

In a strange way, therefore, the mysteries of the health hazards of ELF radiation might be connected with the mysteries of the ferromagnetic or gyromagnetic state. The anomalies may well have a common solution on the lines indicated above.

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NOTE ON SCHUMANN RESONANCE

H. Aspden

The Schumann resonance ELF hazard discussed in the previous section does not apply to problems connected with electric blankets or proximity with overhead electric power lines. It is an action which occurs wherever one is positioned on Earth, because it derives its power from oscillations in the ionospheric cavity enveloping the whole of body Earth.

It is in the category of the ever present cosmic radiation which, to some extent, must contribute to our limited life expectancy. It is therefore a natural hazard, rather than one which man has created by design of electrical appliances or distribution systems.

However, we must recognize that the hazard effect from this Schumann resonance relative to that of electric blankets or overhead power lines is small, bearing in mind that it provides the statistical background or data norm on which the hazard risks of electric blankets and power lines are measured and found to be excessive.

While one could think in terms of neutralizing the Earth's magnetic field and any extraneous D.C. field in our homes and workplaces, that is a formidable proposition which lies outside the bounds of practicality. However, we can, as has been shown earlier in this report, take simple precautionary measures to overcome the blanket problem. Concerning, the effect of overhead power lines, this is a topic already discussed on pp. 22-26.

[Added Note: More will be said about Schumann resonance on pp. 35-37 (Appendix I). It is suggested that in the upper atmosphere in the region of the ozone layer, where oxygen molecules are ionized, there could be cyclotron resonance activity developing effects which are superimposed upon the basic Schumann resonance phenomenon.]

DEBATABLE ASPECTS OF CYCLOTRON RESONANCE IN IONIZED LIQUIDS

H. ASPDEN

Although there is a developing belief that cyclotron resonance of ions in body fluids plays an important role in biological systems, and this is claimed to have experimental support, certain other experiments aimed expressly at detecting such resonance are reported to give a null indication. Thus Durney et al [1] attempted to measure the effects of resonant magnetic fields on transport of ions across simulated cell membranes. They used an electrolyte containing either calcium, potassium or sodium ions and varied the field strengths at 100 Hz or lower. They measured membrane capacitance and electrical conductance only to conclude that, as these did not vary by as much as 1%, there was no evidence of any resonance.

One must, therefore, ask the question as to why the cyclotron action is presumed to be evidenced by discernable electrical displacement. One should not assume that the resonance process is the same as that of free electrons in solid conductors. In this latter case the positive ions are not free to move as they are in a liquid.

In so far as the cyclotron action stimulates cell growth or cell damage in biological systems this can presumably be attributable to the concentration of thermal energy into the ions as opposed to the neutral molecules in solution. In a sense, since there are positive and negative ions which must neutralize one another macroscopically, there can be no significant electrical displacement, but that does not mean that there is no enhanced activity by the ionized components of the system.

The effects could be those we associate with temperature, as if some molecules are at a much higher temperature than the mean value applicable to the body as a whole. Of course, a critic will argue that the ions will collide and the heat become dispersed by being shared according to conventional thermodynamic principles and statistics. However, here one must remember that the cyclotron action involves ordering of motion so that collisions are less likely and, furthermore, there is a case for saying that the usual three degrees of freedom applicable to thermal interaction is reduced to two. If that were so then in the ultimate situation, and without adding any heat energy, the effective temperature could rise dramatically by tens of degrees.

We need then to be mindful of the possibility that temperature anomalies can present themselves where ionized aqueous solutions are tested under conditions conducive to resonance. This author has suggested [2] that resonance can involve a band of frequencies, including 50 Hz and 60 Hz, for mixed ion mass conditions such as must always apply because the positive ions are always matched to negative ions and their masses are always different. This, in itself, will make detection of a resonance peak virtually impossible. Looking then for temperature anomalies one could even suspect that weak environmental fields at the laboratory power frequency could excite some very curious effects in water which contains an ionizing agent.

The cold fusion scenario comes to mind here, but one needs also to take note of research on force anomalies discovered by various researchers. Zinsser, for example, using a signal generator of special design [3], found that pressure across the plates of a capacitor having water as a dielectric decayed very slowly when the system was switched off after being primed to resonance by an oscillatory field.

The purpose of this note is to warn against genuine research endeavour becoming polarized by null findings which merely disprove a particular hypothesis. In the cold fusion world, the orthodox nuclear physicist cannot abide the thought that there can be atomic fusion without neutron emission. Since no neutrons are found, the cold fusion discovery is discredited. In the case of cyclotron resonance in ionized liquids, we must not presume that this can be sensed by direct electric fields effects. What matters in cold fusion research is whether there is a true excess of thermal action and what matters in the weak field hazard research is whether there is enhanced action that can damage our body cells.

Theory can also get in the way of the truth. A critic of the cyclotron resonance theme could say that the radii of the ion orbits would need to exceed by far the mean free path of the ions, pointing out then that collisions must occur because positive ions orbit one way and negative ions orbit in the opposite sense.

This brings us to a debatable issue. It could be the ordering of the collective motion of the opposite polarity ions that puts their motion about the magnetic field axis in different planes orthogonal to that axis and in an alternating sequence along that axis. As to the orbital radius involved, that can simply apply to the small arcs traversed by the ion motion between collisions. Whatever the reason, our theory must adapt to the truths of experiment pertaining, not to ion acceleration in a cyclotron as such, but to the activity in an ionized liquid in reacting to a magnetic field. If accepted theory is given a God-like reverence and applied to overrule what we might propose then we cannot progress in our research.

We must therefore begin to take more interest in how resonant cyclotron effects in ionized liquids can be sensed, possibly in terms of such resonance being used as a catalyst in aiding chemical reactions.

Much may depend upon the containing cell and particularly its cross section in relation to the cyclotron ion notion. One may also wonder if this research can be extended to the broader technological fields, where anomalous energy-related actions supposedly occur in aqueous solutions.

This author finds it very difficult to credit the claims of those who try to run car engines on water by using engine power to generate electricity, in turn used to excite resonance by which water molecules are dissociated to yield hydrogen and oxygen to then power the engine by combustion. However, it would be foolish to ignore such claims completely merely on academic principle. After all, someone might well find that there are creative forces in our body chemistry by which the chaotic field energy of our body heat and the environment can produce that dissociation which precedes combination to grow new cell structure.

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[2] H. Aspden 'Power Lines, Cancer and Cyclotron Resonance', Electronics World and Wireless World, pp. 774-775, September 1991.

[3] R. Zinsser, U.S. Patent No. 4,085,384.

APPENDIX I

The following Research Note dated March 31st 1997 was published in the author's Web pages on Internet.

BRAINWAVES AND ALPHA RHYTHM

Schumann Resonance

Did you know that there are electric field effects in the atmosphere that affect your brain? We need to solve the mystery of why it is that your alpha rhythm, as measured by detectors sensitive to brainwaves, has a frequency equal to that detected by the study of weak electric field oscillations in the atmosphere. The frequency is 7.8 Hz, about one sixth or one seventh of the frequency of electricity supplied to your home. It was Tesla who first discovered those atmospheric oscillations. He even embarked on research to exploit the phenomenon, aiming to transmit power to homes everywhere around the world by low frequency 'radiowaves'. That was deemed to be a venture that could put power companies out of business. How would they be able to charge for the service? So now we have to concentrate instead on the power of our own brainwaves to progress in the world of `free energy'.

It was Schumann's research reports which gave formal scientific recognition of this physical phenomenon of our atmosphere and so it has the name 'Schumann Resonance'. When I first heard about this from Tom Valone at a conference I attended in Canada in 1988 I was mildly interested. I was there to air my views on how one might be able to generate power using magnetism as a catalyst in tapping aether energy. I was told not to use the expression 'free energy' in the title of my talk as that might destroy my credibility! So I was a little restrained in my pursuit of the technological implications of my `brain child' and atmospheric resonance effects were not uppermost on my mind - or so I thought!

What I did learn was that the Schumann resonance was deemed to be a phenomenon occurring as electromagnetic waves travelled around the Earth in the concentric spherical cavity between the Earth's surface and the ionosphere. If one takes the circumference of Earth and compares it with the speed of light then one finds that electromagnetic waves travelling around body Earth would set up a kind of standing wave resonance effect at 7.8 Hz. This is the alpha rhythm frequency. So we, meaning our brains, may be phase-locked in some way with body Earth and its atmosphere. The expression `phase-locked' means that everything in this merry electrical dance is in step and moves at the same frequency.

Aspden Resonance

Dare I now put my name on another interpretation of this resonance phenomenon? I leave it to you to judge. Firstly, as background I note that in 1988 my interest in aether theory led to contacts between me and Dr. P. E. Rowe of Mashpee, Massachussetts, USA . I had a theory which explained how protons were created from the aether. Dr. Rowe had experimental evidence that protons were created inside his electrical discharge tubes which he operated at 50,000 volts and he too believed the aether was the source. It seemed to me that he had found a way of focusing the work done by the aether in creating matter so that, in a sense, he was harnessing the power of Creation! I saw in this also the danger of effects on our bodies if we were near enough to electric power lines to be in the 'proton creation zone', but far enough away not to be electrocuted. I then wrote the 1988 paper 'The Proton Factor and Its Unknown Effects' here reproduced in Appendix IV.

I had forgotten 'Schumann Resonance' because my mind was on my own theory and protons, deuterons, neutrons etc. There was not much I could do anyway, even though I was aware that if protons could be created inside my body in existing atomic nuclei I might suffer some consequences. I wondered about DNA and whether its chemistry took account of isotopes. It may have been A. A. Berezin, an academic researcher in Canada, who pointed out that there were more people in the world than possible DNA combinatons of atoms in the DNA molecule but yet we were all different. The implication I saw in this was that there could be different isotopic combinations in the DNA structure. Maybe the odd deuteron replacing the proton in the hydrogen atom in DNA can make a difference! If so, then the odd proton causing a transmutation to a deuteron could make the odd DNA molecule a misfit in our composition. Would that promote cancer? I do not know but I do know that someone somewhere should be researching that possibility.

I may have done no more on this theme if it had not come to my attention that an electric blanket manufacturing company had sought certain assurances from staff members of the Electrical Engineering Department at my local University. They wanted to be assured that the electrical and magnetic fields produced by their blankets were so weak as to be non-harmful to health. I was a Visiting Research Fellow in that Department pursuing my own research on energy from a technological viewpoint, but I was not consulted on that question, nor was there any reason for such consultation. Measuring those electric and magnetic fields is quite straightforward, given the necessary test equipment. In my opinion, thinking about the matter privately, it was not sufficient just to measure the strength of those weak fields and assume that they could do no harm. If the medical world said there was evidence of a problem, then there was a problem!

Now an electric blanket and an overhead power line have something in common. Unlike the cables which come into your home and in which the forward current carrying wire is wrapped around the return current carrying wire, the overhead power line and the electric blanket have these wires well spaced. In one case it is to reduce the risk of bad contacts causing hot spots and so a fire hazard. In the other case it is because the voltages are so high that the wires need to be well spaced to preclude arcing. The point neverthess is that, if wires are well spaced, they do set up stray pulsating electromagnetic fields at the power frequency. They may be too weak to matter in normal physical terms but they may be too strong to be tolerated in biophysical terms!

The reason for this is 'resonance'. Now, I like to think that I am not stupid. I also have an aptitude for understanding something new, otherwise I could hardly have spent my working life in the world of invention. As a corporate patent attorney in the high technology world of electronics and power engineering one needs to be able to grasp what is new and find a rational way of describing it in terms meaningful to a patent examiner. So, the obvious question, if resonance is involved, is why electric blankets and overhead powerlines have harmful effects in U.K. and in USA, where the electric power frequencies are 50Hz and 60Hz respectively.

To answer this I asked myself what was different about the human body versus action in a metallic conductor when it came to reaction to a low frequency alternating magnetic field. Now, although I was experienced in patent attorney work, I happen to have a Ph.D. for experimental research on the energy anomalies involved when metal reacts to such fields. I was aware of a kind of resonance in copper or iron when subjected to a magnetic field, what is termed a diamagnetic reaction, which occurs even in a steady d.c. field. In copper or iron there are free electrons moving about and setting up that reaction. In our bodies, in our blood, there are instead relatively-very heavy ions that set up that reaction. If there are two types of reacting ion present then, within a limited range, one can screen the field of the other to the extent needed to adjust the effective field to the optimum resonance of one or other of the ion masses. I knew this could explain the 50Hz-60Hz resonance question.

The expression 'Aspden Resonance' refers to my suggestion that the field oscillations in the Earth's atmospheric cavity, as bounded by the ionosphere, are encouraged by cyclotron resonance involving ionized oxygen or ozone. Now, I say cyclotron resonance here, but I must qualify that statement. In physics there are two Larmor formulae. The first, which is called the 'Larmor formula', is the one applied to the cyclotron. It applies to the effect of fields which pump energy into the ion motion. The second formula, that termed the 'Larmor precession', applies to an action in which the motion in orbit is perturbed, with the result that the plane of the orbit alters the direction of the axis about which the ion moves. This sets up a radiated field disturbance at the precession frequency, which is half that of the cyclotron resonance frequency given by the 'Larmor formula'.

Now, owing to the Earth's magnetic field, the 'Larmor precession' frequency of the ionized oxygen molecule, which comprises two oxygen atoms, would be about three times that attributed to the basic Schumann resonance. Also the ionized ozone molecule, which comprises three oxygen atoms would imply a precession frequency that is about twice the frequency of the basic Schumann resonance. In short, therefore, there would be harmonics of the basic cavity resonance set up and the relative strengths of the components observed in the harmonic spectrum of radiation should tell us whether this interpretation is viable.

To take this further I need to deflect your attention along different routes according to choice. You may choose to follow my account of the basic cyclotron resonance theme, which may hold the secrets of the hazards we risk from using electric blankets or living too close to overhead power lines. Alternatively, you may be more interested in the question of those brainwaves and the Schumann resonance and Aspden resonance topics. The latter has a special interest from the viewpoint of my aether theory. A feature of my theory is that there is a phase-lock throughout domains in space set by the range of gravity force. The phase-lock merely implies that electric charges are all moving in a common rhythm, keeping their separation constant and so not exchanging energy. I predicted long ago that this was an ongoing state in the aether. As can be seen also from the pattern of electron field cavity resonance illustrated on page 51 of my 1996 book 'Aether Science Papers', the phase-lock action is at work in containing the electron's energy in a way which explains what is known as the anomalous g-factor of the electron. Therefore the Schumann resonance theme, which involves a phase-lock having a much smaller frequency than that of the aether or the electron, has a special significance in defining an enclosing boundary, not just for a weak form of radiation, but also for the aether system which is carried along by body Earth.

Already, in the bulk of this Report we have concentrated on the basic cyclotron resonance theme, which is about the hazard risks that can be avoided. The other theme linked to the Schumann resonance will be discussed further in the following pages in Appendix III.

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APPENDIX II

The following Research Note dated January 22nd, 1997 was published in the author's Web pages on Internet.

POWER LINES AND HEALTH

The above is the title of an article in the November 1996 issue of Physics World. Its authors are John Swanson, David Renfrew and Nigel Wilkinson, who belong to the Technology and Science Division of the National Grid Company in U.K.

They conclude that, though it would be arrogant and rash of physicists to argue that, because we have not yet been able to think of a possible physical mechanism, it is impossible for there to be an effect.. however, the absence of a mechanism and reproducible laboratory results inevitably means .. scepticism'.

I note that in their article they say that various resonant mechanisms involving the Earth's static (magnetic) field have been proposed, for example ion cyclotron resonance of the calcium ion. Of this they declare that such cyclotron resonance cannot actually occur in a cell as the orbit of the ion would have to be more than 1 metre (in radius).

This shows that they have not understood the physics of cyclotron resonance as applied to ionised liquids. To pump energy from a pulsating electric field into a system of ions moving in a magnetic field the only governing condition is that the pulsating frequency is in or near to resonance with the natural frequency of the ion in orbit in that field. The cyclotron as used in high energy particle physics pumps energy into an ion by increasing its speed and so it orbital radius. If we are not seeking to put that energy exclusively into an ion output stream, it matters not if there are collisions limiting the mean free path to sub-micron-sized dimensions. There is still energy transfer from that field to the ion system.

To understand this it may be that a mathematician will be required to supplement the "skills of physicists alongside those of biologists, epidemiologists and engineers" (quoted as the last words in the referenced article). You see, if there were no magnetic field, the ions in collision in the fluids in our body cells would merely move in straight lines between those collisions. A straight line is a curve of infinite radius! If, however, a magnetic field is present, then that same rectilinear motion would apply if the system of ions in motion could be viewed from a reference frame rotating about the magnetic field axis at the cyclotron frequency. Each and every positive ion would share a motion as if the whole of the fluid in the cell were rotating at the same angular velocity. Collisions would not cause a clockwise moving ion to take up anti-clockwise motion. It follows therefore that the superimposition of a 50Hz or 60Hz pulsating electric field attributable to an overhead power line will act selectively in pumping energy into those ions moving with the field.

The ions on one side of a cell will gain in speed in their cyclotron orbit (or rather, minute arcs of such an orbit), whereas those on the opposite side of the cell will reduce in speed. However, owing to the rotation, if there is a match between the cyclotron frequency and the frequency of the pulsating field, the ions on one side of the system which gain energy will have moved around to the other side as the field reverses direction and so will continue to gain energy.

This is an escalating effect in which the ions gaining in speed acquire more energy than is lost by those losing speed. Overall, there has to be energy transfer and a net heating effect concentrated by the cyclotron resonance process. Note further that, if a mathematician amongst those ions were to run around in circles, speeding up on one side of the orbit and slowing down on the other side, but yet keeping a steady angular velocity about a central point, his mean position would have to be displaced in the plane of motion owing to that constraint of a fixed angular velocity. Cyclotron resonance ensures that the angular motion has a constant rate, notwithstanding any changes in kinetic energy. Angular momentum of ions is not conserved in a cyclotron situation, because as the ions are accelerated to faster speeds they spiral outwards.

Now, there is research in new energy physics which points to anomalous energy inflow from the field environment if electric charge can be held displaced in stable concentrations inside an electrically conductive medium. This is found in systems involving rotating magnets and in plasma discharge devices. There is clearly a scientific mechanism by which one can predict the setting up of electric fields in human body cells primed by the pumping of energy by cyclotron action. For my part I have, some years ago, addressed the more difficult question of why there can be similarly-harmful cyclotron resonance in U.K. and U.S.A. where the power frequencies are 50Hz and 60Hz, respectively. Explaining that is the primary question, but there is an explanation based on the dual presence of positive and negative ions of different molecular masses. Understanding how the cyclotron frequency adapts over a limited frequency range in such circumstances raises fascinating questions of basic importance, but directly connected with the gyromagnetic reaction phenomenon found in ferromagnetic substances.

I shall be writing more on this subject in due course, but I emphasize here that the authors of the above Physics World article have not understood the cyclotron mechanism as it can apply to human body cells and they must rethink their views on the way in which weak electric fields from power lines can interact with a weak geomagnetic field to pump energy into the resonant ions in our body fluids.

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The following Research Note dated March 31st 1997 was published in the author's Web pages on Internet.

APPENDIX III

IONOSPHERIC RADIATION

It was in August, 1996 that I received a communication from A. G. Callegari of Dane Bridge Nursery, Much Hadham, Herts SG10 6JG, England. It was dated August 2nd and concerned his experimental findings on the measurement of 'Schumann Resonance'.

What he had to say led me to look up the comments expressed by Tom Valone in his paper "Powerline EMF Radiation and Your Health" (Proceedings of United States Psychotronics Association Conference, 1990), my copy being a pamphlet version issued by Tom Valone from the Integrity Research Institute, 1377 K Street NW, Suite 204, Washington, DC 20005, USA.

I began to make sense of a figure (Fig. 2 on p. 15 of that pamphlet) which gave a radiation intensity spectrum of the frequency pattern for the observed Schumann resonance. My concern was that the fundamental frequency component peaking at roughly 8 Hz was about 10 per cent weaker in strength than the second harmonic component which peaked at about 15 Hz, whilst the third harmonic at 20 Hz was about 85% of the strength of the fundamental component. The fourth and fifth harmonics seemed to be at 26 Hz (55% strength) and 33 Hz (30% strength).

Now, this simply should not be, unless there is some factor at work other than the action setting up the fundamental oscillation.

The Callegari communication indicated that he was using a frequency counter model WFC 308 made by Wisher in Taiwan. It specified that no antenna was used, by which I inferred that there was no resonant circuit which could distort the frequency spectrum of the signal to be analyzed. It then stated:

"Frequencies in the range 7.06 to 8.45 Hz have been measured continuously at this site since January 1993, except in February 1996, when values increased suddenly to a temporary range (13.4 to 14.25 Hz) which lasted for about half a minute before falling back to the saturating value. Relaxation from that value appears to be semi-asymptotic of the order of 15 minutes. Analysis of existing data shows strong correlations with Schumann resonance, atmospheric and Telluric temperature changes and discontinuities, brain-wave frequency band limits (theta to alpha and alpha to beta), ... "

The letter then added the comments:

"I've just acquired a second WISHER 308 counter in which frequencies have displayed mostly (90%) in the range 15.5 to 16 Hz, with occasional jumps (10%) up to about 17 to 19 Hz - rarely below 15.45 or above 19.5 Hz."

This suggested to me that with the newer equipment he was getting a more reliable measure of the stronger signals in this low frequency range, possibly supporting the indication in Tom Valone's paper that the second harmonic of the Schumann resonance was stronger than the fundamental component. I wrote to him, expressing my thought that the oxygen and ozone in the ionosphere might be a radiating source supplementing the basic Schumann resonance, thinking also that variation in concentration of a different mix of O(18) and O(16) isotopes might account for the anomalous frequency shift. At the time, it was on my mind that the London newspaper, The Times, had in their August 8th issue just declared that life had been discovered on Mars, the evidence being a fossil-containing fragment which came from that planet and contained the heavier form of oxygen, O(18).

Then, by letter dated August 26th, Callegari reported his investigations on his new equipment used in a test run between 4.00 pm and 4.11 pm on that same day. He had a reading every 2.56 seconds and the measurements showed little variation about a mean of 15.79 Hz.

Now, based on the Larmor precession formula, $w = Hq/m$, the angular frequency resulting from motion of an ion in a magnetic field H of strength 0.5 gauss (the Earth's magnetic field), would correspond to 768/N rev/s, where q is the unitary electromagnetic charge of an ion and m is the mass of the ion, which mass is also N atomic mass units. N is 16 for an isolated oxygen atom, and 48 for ionized ozone. Since 768/48 is 16, this tells us that ozone in the ionosphere could be a source of electromagnetic radiation at 16 Hz. Now this is virtually that second harmonic frequency, bearing in mind that the 0.5 gauss Earth's magnetic field strength is only a close approximation.

However, there is the very clear message here that this could explain why there is a dominant second harmonic in the radiation intensity spectrum associated with the Schumann resonance. Going even further, we can look at the oxygen molecule in its ionized condition in the ionosphere and expect that to produce radiation at the frequency 768/N Hz, where N is 32. This would indicate radiation at 24 Hz. This would be the third harmonic frequency associated with the Schumann resonance. A strong fourth harmonic could then arise as a second harmonic of the ozone radiation, but a fifth harmonic of the Schumann resonance is not so easy to explain.

I do, however, feel that I have made out a good case for asserting that the ionosphere, besides providing a cavity for setting up the Schumann resonance, has another way of generating ELF radiation. If tests were made in polar regions where the ozone layer is absent, then that second harmonic associated with the Schumann resonance should fall off in strength. That would confirm this theory.

In conclusion, identifying this new interpretation of the anomalous strength of that second harmonic by the name 'Aspden resonance', I express the opinion that neither the Schumann resonance nor the 'Aspden resonance' warrant concern from the hazard risk point of view. Unlike cyclotron resonance in our body cells attributable to overhead power lines and electric blankets, there is really nothing we can do in any event by way of a preventive measure.

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The reason this Research Note is dated 31st March 1997, bearing in mind that what has been presented dates from August 1996, is the deferment of its preparation to the time when this Energy Science Report No. 10 is ready for publication.

APPENDIX IV

The following paper was published in The Toth-Maatian Review at pp. 3725-3734, vol. 7 (1988)

THE PROTON FACTOR AND ITS UNKNOWN EFFECTS

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ABSTRACT:

By speculating on a theme related to the proton, the mysterious appearance of hydrogen gas in high voltage electric discharges and the proton structure of atomic nuclei, it is shown that we have reason to doubt the way in which experts portray atomic nuclear structure. There are uncertainties as to how protons can migrate through solid matter and how they can suddenly appear in a discharge environment and possibly disappear from nearby substance to keep a balance. These uncertainties can cloud our knowledge of how our body cells might be affected in physical environments in which this proton factor is of concern, and particularly the danger to health should one live in close proximity to overhead high voltage electric power lines.

INTRODUCTION:

There is a developing concern that people living very close to high voltage overhead power lines can suffer from medical problems related to those specific environmental conditions. This has been the subject of research that does give reason to believe that there are health hazards associated with the near presence of such power lines. The general assumption is that the problems arise from the effect of the magnetic fields that penetrate into the dwellings closely adjacent to these high current sources. However, though there is some evidence that magnetic fields, and particularly weak or low frequency magnetic fields do have some effects on our body chemistry, the general expert opinion is that such fields are not harmful. Furthermore, those who work near powerful electrical power generators or in electro-chemical plants should be equally subject to hazards associated with magnetic field effects.

The difficulty with any investigation on this subject is that it involves several professional disciplines and this makes any objective research dependent upon an interaction between several scientists of very different skills and training. It takes an exceptional person in any one such field to make any progress in dealing with an unknown phenomenon and the chances of bringing the right people together in the several fields involved are very small. One needs the knowledge of the electrical power engineer, the physical chemist specialist in electrical effects on matter, the relevant medical experts and, perhaps surprisingly, the nuclear or atomic physicist familiar with isotope transitions.

It is the latter proposition that is the basis of this paper, because whilst we think that the magnetic fields account for the hazards of living in proximity to an electric power line, it might well be that there are certain atomic transitions some of which are induced in the atmosphere if not directly in our body cells, so affecting the air we breath and, indirectly, our health.

A general comment that is often made is that the weak magnetic fields set up at tens of metres from an overhead power line can be little different from those arising from power equipment in the home, including fluorescent lamps, and that any electromagnetic radiation effects can hardly be different in intensity from those set up by television tubes. Indeed, they may be little different from the strength of the Earth's magnetic field and there is no escape from that, however far we might live from an overhead power line. This magnetic field consideration does not apply, however, to the chemical effects, such as the action of the corona discharge which occurs continuously around the power line. One well-known effect of this is to convert atmospheric oxygen into ozone in the open air. The gases in a fluorescent lamp and a television set are contained within sealed tubes so even if they are affected by a discharge of current they will nevertheless be contained and so cannot be harmful. However, in making this comparison it should be kept in mind that the voltages employed in such domestic appliances are far below those of the primary transmission lines used by the electrical power industry.

However, the task of investigating the effects of ozone is not seen as a primary problem warranting our attention in this paper. What we wish to discuss is a more `way-out' possibility that stretches our insight into physics to the limit or, as some might say, beyond the limit and into the realm of pseudo-science. Where health considerations are concerned we cannot afford to confine our minds to what, in science, is practical and proven. We know all too little about what it is that causes our bodies to deteriorate with age and if pseudo-science can give us a tentative insight into `aetherial' processes that can have a physical effect on our body cells, then such research can be of value.

The thoughts outlined in this paper are based upon some disconnected observations that might come together to offer us a totally new insight into a more basic cause for the medical upsets that stem from the proximity of the electric power line. It is stressed that what is proposed is speculation and that the views are aired here only so that those who make decisions as to what research should be funded can decide whether to include this subject in their list of options. The general reader can, of course, make his or her own judgement as to whether any such research can possibly be conclusive if it does not extend into the field to be described below.

THE BASIC PROPOSITION

The activity in an electrical discharge that is powered by some 50,000 volts has been found to lead to the mysterious appearance of what seems to be hydrogen having no clearly determined source. This is an experimental observation in the laboratory and those researching this subject have tended to the view that the hydrogen comes from hydride compositions formed by the metal substances that comprise the electrodes associated with the discharge. There are, nevertheless, problems with this interpretation, problems which have led one experimental investigator Dr. Paul E. Rowe [1] in U.S.A. to urge that the vacuum is itself a source of the protons which, together with electrons can account for the anomalous appearance of hydrogen.

It needs little imagination then to ask how it can possibly be that a proton, which has an intrinsic energy that we know from the formula $E = Mc^2$ to be equivalent to the power of one electron accelerated through 938 million volts, can be created by the action of a 50,000 volt discharge. One answer to this could be that the proton is not created in isolation. Just as electrons can tunnel through potential barriers which, in theory, they should not cross, so it may be that the proton can be transposed in some way from a position A to a position B by an influence far weaker than that needed to match the rest-mass energy. Protons, like electrons, if left alone have no measured lifetime. They seem to live forever and yet electrons paired up with positrons can be annihilated and recreated in the vacuum field.

Whether such a process is involved in the barrier tunnelling is a matter of speculation but the fact is that electrons can 'tunnel' mysteriously through barriers that should keep them contained. Therefore, given that it is an experimental fact that hydrogen does appear, as it were, from nowhere, it does not seem at all outrageous to suggest that a proton can appear at B accompanied by the demise of a proton at A. Whether the aether is the source of that proton at A is debatable, but if it is not the aether then the source must be the nucleus of an atom of matter in the near vicinity. Therefore, thinking of that medical problem, if a proton can appear mysteriously in the corona discharge close to an electric power line, a proton in matter, possibly in human cells nearby will disappear.

An atomic transmutation, an isotopic transition, may well initiate activity in that human cell that could initiate cancer, but this is where one needs that specialist knowledge. What do we know of the effects of substituting isotopes of the same atom in a living cell? Research on this must have been performed but this author, being more a specialist on electromagnetic actions in the context of physics or engineering has no knowledge of any research literature in this field. In particular, research must have been performed on the effects of consuming heavy water, meaning water in which the hydrogen atoms have atomic nuclei that are constituted by deuterium rather than the proton.

As far as the author is aware it has been suggested by Berezin [2] that different isotopic combinations in a DNA molecule are essential to give basis for our human differences since the number of such possible combinations is vast, whereas the basic molecular chemical composition of DNA does not offer a sufficient variety of human forms. This suggestion comes from an electrical expert rather than a bio-chemist or medical specialist and so it must be viewed as mere speculation. However, if the generation of

DNA involves the replication of the exact isotopic combination in each of our bodies, then any isotopic transmutation that occurs in a spurious way, as by an atom shedding some of its mass to become a different isotope, must initiate a mismatch that could signal trouble medically.

The point of the above discourse is merely to show that a research theme pursued by Rowe, which involves an interest in a fundamental chemical problem, may have relevance to the medical concerns that arise from living close to an electric power line. Yet, no amount of research on the adverse effects of a magnetic field on our bodies can possibly lead to the proton transmutation that has just been suggested. Hence, if there is anything in this proposition, such research effort will be looking in the wrong direction and will not resolve the problem.

THE UBIQUITOUS NEUTRON

We will next digress into the field of the atomic nucleus to ask whether we really know enough about the composition and structure of such a nucleus to pass judgement on the thoughts expressed above. The idea that a free proton can appear suddenly in an electric arc as an event corresponding to the demise of a bound proton elsewhere is likely to attract scorn from a nuclear physicist. There is the question of the binding energy involved in such a transmutation and such energy is not by any means minute. It certainly involves energy quanta that we associate with powerful gamma radiation, that is, energy far in excess of that of X-rays.

The nuclear physicist would ask how enough energy is fed to the atom in a human being to cause it to release the proton, especially if the only source of energy we are considering is the electric voltage of a power line several metres away from the affected atom.

Now, we must respect the knowledge of the nuclear experts, bearing in mind that they have successfully harnessed the nuclear energy of the atom in their atomic reactors and they have had at their disposal some very powerful tools for probing atomic structure. However, there is something very simplistic in the way the nuclear physicist looks at an atomic nucleus and the non-specialist in these matters should find it interesting to take what could be a rather cynical look at their picture of the atom.

Firstly, the atomic nucleus has an electric charge that comes in units of the positron charge, the positron being like an electron but positively charged instead of negatively charged.

Secondly, the atomic nucleus has a mass which indicates that it is assembled from a number of `nucleons' that are roughly of mass equal to that of the proton. The proton is, in fact, the nucleus of the most prevalent isotope of hydrogen. Thirdly, the radioactivity of some heavy atoms involve powerful emissions which can induce an artificial radioactivity in other atoms and lead to the appearance of a neutron. This is a very penetrating particle, just a little more massive than the proton. It has a limited mean lifetime of 898 seconds and no electric charge. It is a particle that can have lethal effects and it is, of course, the catalyst that jumps from one atom to another and stimulates fission in atomic reactors.

Now, given the above facts, is it not surprising that our nuclear physicists were satisfied by a very simple algebraic calculation which said that if an atomic nucleus has Z units of charge and A units of nucleon mass, it must comprise Z protons plus (A-Z) neutrons? Why should we suppose that all matter and, indeed, our very body substance is full of those lethal neutrons that somehow only live for 898 seconds when they escape, but yet, for some reason that no one bothers to explain, are happily enjoying a much longer lifespan as part of our personal atomic substance. One would think that we should be exuding tremendous amounts of radiation if we were so full of neutrons. We should be intensely radioactive.

Moreover, would one not think that, if neutrons have a dominant presence in atomic nuclei, the atomic elements that are naturally radioactive would emit neutrons, rather than the alpha particles. Alpha particles are, in effect, the nuclei of a helium isotope?

Dare we venture to suggest that there are no neutrons in the atomic nucleus of any atom? Let us say, instead, that the neutron is a particular excited form of the antiproton (a proton that has a negative charge) that has an electron-positron entourage that includes a surplus positron to assure overall electrical neutrality. Such a neutron only exists outside the atomic nucleus because it comes into being as an antiproton in the nucleus is driven out.

The reason we are discussing this is simply that we are striving to understand how our body cells can suffer transmutations at the level of the atomic isotope. The word isotope merely signifies the forms of different atomic nuclei that have the same charge (Z value) but different masses (A values). If we have to talk about neutron exchange to discuss isotopic transformation then we are not speaking from the same energy criteria that apply if we really should be speaking about proton or antiproton substitution.

The proposition put here in this paper is that there are no neutrons in the atomic nucleus. This is the independent research theme that this author brings to this study for combination with the findings of Dr. Rowe.

INSIDE THE NUCLEUS

Physicists cannot be sure what there is inside an atomic nucleus. If they bombard it with other particles to see how these scatter then it takes some very powerful particles to detect anything and then they cannot be sure that the energy of those particles has not caused its own transmutations and made the atomic nucleus something different from its natural self.

So let us just consider the options if we look for a different solution to that simple algebra mentioned above. Firstly, Z could be the measure of the number of positrons that have clustered together to form the core charge of the nucleus and there could be A neutrons in a surrounding cloud. The problem with this is that the basic hydrogen nucleus is not seen as a positron plus a neutron, but is in fact a proton. Hence the logic of building atoms from protons and adding some neutrons.

Now let us try a second line of argument. This time we will take note of the theory that Dirac advanced according to which the vacuum itself contains sites occupied by charges that cancel one another. When an electron is removed from such a site, the `hole' that is left behind is a positron. So, we take out Z electrons to form a 'hole' of Z units of positive charge. The electrons go to form the atomic shells of electrons surrounding the nucleus. Then how do we account for the mass number A? Well, all we need to do is to substitute A antiprotons for the negative charges that occupy sites close to the centre of the nucleus. This may sound very speculative and it still does not quite fit our picture of the isolated proton when Z = 1 and A = 1, but it is a possibility.

Note that in this latter case we avoid the presence of neutrons in the nucleus, but recognize that, if an antiproton escapes as an electron moves in to take over its site, the antiproton can jump into the site vacated by the electron and be seen to move through space in similar successive jumps, just as if it were an antiproton in company with a positron. This is similar to the form of neutron envisaged above.

Still speculation? Well, let us take note of the fact that the neutron might be electrically neutral as judged by its electric field seen from a distance but it exhibits a magnetic moment in spin that implies that it has a negative charge. The model of the neutron advanced above has, in fact, been used as a basis for calculating the neutron mass, the neutron magnetic moment and the neutron lifetime [3]. All three of these quantities were found to be in full agreement with their measured values, even to the precision of the part per million measurements of the magnetic moment and mass.

So there is an extremely good case for saying that the nuclear physicists have got it wrong. Instead, the atomic nucleus with Z greater than unity does comprise a halo of A antiprotons neutralized by occupancy of positive sites in the vacuum field. Given Z, what then determines A? Physicists have no answer to this on conventional theory. However, we have a simple argument that develops the link. In developing this argument it is preferable to regard the nuclear charge as a true charge cluster. Firstly, suppose that we have a single spherical shell of A antiprotons seated at a radius r around the central positive charge Ze, where e is the magnitude of the unit electron charge. The potential energy, according to Coulomb's law, is then $-AZ(e)^2/r$ for the antiproton-nuclear charge interaction and $(Ae)^2/2r$ for the interaction between the antiprotons. The sum of these energies is crucial to the stability of the atom. The positive energy term cannot exceed the negative term if the atom is to be stable. The reason is that an additional antiproton coming into the nucleus would sense the full attractive force of the Ze charge of the core acting along a radial line from the centre of the nucleus, but it would only sense a half effect from the 2Ze repulsive shell of distributed antiprotons. These act from side directions or from a further distance, so weakening their force action, but at the critical threshold even the weakened force can outweigh that of the central core and preclude increase of A. So far as the action between the antiprotons and the positive `holes' is concerned, this appears not to affect the stability of the nucleus. It is as if the `aether' involved at such close quarters cannot set up or withstand the short range forces that are under consideration. In any event, there is an argument that the single shell of antiprotons can contain twice as many units as the central charge core.

Should the atom have a large A value then the distribution will be more nearly uniform over a solid sphere of radius r. Then the first term becomes $(3/2)(AZ)(e)^2/r$ and the second term $(3/5)(Ae)^2/r$.

It can be seen from these considerations that the value of A must increase with Z over a range from A = 2Z to A = 2.5(Z), excluding Z = 1. Above this range the atom is unstable. Now, as anyone can see by inspecting the periodic table applicable to atoms, the argument just presented does hold true for actual atoms. Starting with the more abundant isotope of Helium, with Z = 2 and A = 4, we progress to Bismuth before encountering unstable atoms. Bismuth has a Z value of 83 and its abundant isotope has an A value of 209. This is just on the threshold of the 2.5 factor.

This theory of the atomic structure is published elsewhere [4, 5], but it does serve to show that there is a very good case for saying that what appear to be antiprotons form a neutral cloud around a nuclear core charge by occupying positive `holes' in the vacuum field.

To allay the criticisms of the nuclear physicist, it should be mentioned that there are two atomic elements in the mid range of the periodic table that do not exist naturally on Earth. Technetium (Z = 43) and promethium (Z = 61) are only identified by the fact that they are created by unnatural processes as by-products of atomic fission reactions in atomic reactors. These two atoms are short-lived for reasons that actually verify the theory underlying the 'aether' physics advocated by the author, as explained elsewhere [6, 7]. Even so, their A/Z relationship strictly conforms with the theory just presented. It is just that technetium and promethium have an instability that has nothing whatsoever to do with the overloading of the nucleon number A in relation to Z.

PROTONS IN THE BODY

Our next problem, if we are to suppose that protons can be created by transfer from nuclei in our body cells is to explain how the antiproton can possibly become a proton. The answer to this is quite simple. Once the antiproton is free it really has captured a positron to become a neutron and we well know from experiment that a neutron decays into a proton and an electron. These are the ingredients which constitute the hydrogen atom.

Apart from this, however, there is the clear possibility that a source of protons exists by the actual migration of protons or even antiprotons through the metallic conductors that form the electrodes or power lines setting up the arc discharges into which these particles penetrate. A free proton and a free antiproton would annihilate one another but we are not here concerned with a mix of matter of this kind. However, imagine that such annihilation could occur in some limited sense. That would constitute an energy source and set up a neutron field. It may even explain some of the incredible anomalies reported in powerful electric discharges studied with the object of measuring the electrodynamic force reactions involved.

There is reported evidence that the forces on the heavy ions can be several thousand times greater than any expected from conventional electron interaction theory [8, 9 10]. There is definite evidence that protons gain more energy when involved with a powerful electron field than they should, by a factor of thousands of times [11]. Physicists are still researching this subject, but their interest lies in fusion reactors or the star war scenario of powerful railgun accelerators for launching missiles into space. Of particular relevance is the discovery that the most powerful anomalous forces can be developed by an electric discharge in water, this being a direct indication that the protons in the hydrogen constituent in water can become involved in the process [12].

Surely, there may be some effects triggered by such anomalous power amplification that can cause the 50,000 volt discharge of an overhead power line to induce the sporadic activation of protons to levels which could cause isotopic change in, say, the oxygen atoms in the ambient air or in the moisture of that air. If a free proton is created to produce, with an electron, a hydrogen atom and ultimately a molecule of hydrogen gas, the trade-off could be the demise of a nucleon from an oxygen atom, changing the oxygen-17 or oxygen-18 isotope into oxygen-16. A similar alternative trade-off could involve a hydrogen-2 isotope in a water molecule converting to hydrogen-1 or, in a carbon dioxide molecule, carbon-13 converting to carbon-12 or nitrogen-15 converting to nitrogen-14.

One could think that by breathing such specially activated air the human body could develop a contamination that would manifest itself in due course as the activated atoms reverted to their original state. However, this proposition must be ruled out because the lower-nucleon valued isotopes are by far the most prevalent and, in a sense, one could think that, in normalizing more atoms, this would work beneficially from a health viewpoint.

THE PROTON CREATION THEORY

However, yet another possibility emerges from the consideration that in space, whether we consider outer space, the space within our body or that close to an overhead power line, there could be certain activity of what is known as the zero-point field that actually is trying to create protons constantly everywhere. The zero-point field is a reality that features in what is known as stochastic electrodynamics. It is an energetic field that exists everywhere even at absolute zero temperature, 273 degrees centigrade below the freezing point of water. According to Dr. Harold E. Puthoff of the Institute for Advanced Studies at Austin, Texas:

"The amount of energy associated with this (usually unobserved) background is conservatively estimated to be of the order of nuclear energy densities or greater. ..... One example is a unique zero-point quantum force between closely spaced metal plates, known as the Casimir force, which results from unbalanced pressures in the zero-point energy due to the presence of the plates. .... Now yet another indication of the reality of this ubiquitous energy density has turned up, while at the same time resolving a long-standing mystery from the early development of quantum theory. (Puthoff here refers to his paper in Physical Review [13] which explains why electrons in atoms do not radiate their energy) ... The significance of this observation is the understanding that the very stability of matter itself depends upon, and verifies the presence of, an underlying sea of electromagnetic energy of almost inconceivable magnitude, a vast reservoir of random energy that is universally present throughout space."

With this as the active situation today how can we believe that research on the harmful effects of electric power lines based on the orthodox teachings of electromagnetism, meaning an absence of energy when no detectable field is present, can possibly focus on the truths of the effects involved?

Suppose that the proposition that the aether is trying to create protons everywhere all the time is true. A full theoretical basis as to why this should be so is given elsewhere [14, 15], but that need not concern this speculative enquiry. The reason that protons are not materializing all the time is simply that there is a limiting energy threshold that has been reached. The aether tries to create protons but any that are created in the zero-point energy field immediately decay. Their existence is very transient, but sufficient to account for the missing matter that cosmologists believe pervades the universe and sufficient to provide the attenuation of radiation that we associate with the Hubble redshift, the basis of the Big Bang theory [16].

Now suppose that we do provide that local stimulus that can momentarily upset the energy balance. Maybe we can create protons and this will lead to that mysterious appearance of hydrogen found by Dr. Rowe in the electric discharges. However, the zero-point energy balance of the vacuum field might reassert itself and cause the overall number of protons (or antiprotons) to be kept constant. Then there would be a proton decay in the near vicinity and possibly in the substance of the human body, especially if the hydrogen atom was the favoured source. Organic substances and water contain hydrogen and so protons with their full unbound rest-mass energy, corresponding to the energy involved in their creation.

Again, a nuclear physicist will say that protons are stable and do not decay, but so he will tell you that electrons also are stable and do not decay. Yet electrons can vanish on one side of a potential barrier and reappear on the other and they can be annihilated with their antiparticle to yield 1.022 million electron volts of energy. So who is to say that a proton cannot behave in much the same way? The fact is that the number of protons in a vast tank full of a special organic chemical can reduce as neutrinos are intercepted, but the protons are upgraded to neutrons which decay back into protons. This does not mean that the protons cannot decay, especially if they can eventually reappear elsewhere inside or outside of that same tank or even appear ab initio by some zero-point energy fluctuation to be followed by a balancing decay. It is only if we make the right assumptions as to what phenomena occur during such events that our means of detection of decay are of any significance.

THE WAY AHEAD

It has to be conceded that as yet our scientific knowledge, especially on matters of fundamental importance, is incomplete. We have probably encountered all the obvious scientific phenomena by now and, in the main, have theories that are adequate for our practical needs. However, there are surely phenomena that have yet to be discovered and it may be that we are not looking for such discoveries because they do not fit what we regard as obvious patterns based on accepted theory. In these circumstances it is going to be very difficult to make further progress. We cannot, under any circumstances, afford to ignore the occasional and possibly accidental exposure of any unusual phenomenon. Nor should we be too complacent about what is regarded as established theory, bearing in mind that much of the theory evolved very rapidly as a matter of expediency before the fullest facts were assimilated. In particular, we must stand ready to change our theories. Experts on existing facts and theories are not authorities on what may be future more embracing theory based on new discoveries.

How can we be sure that an atomic nucleus contains Z protons and (A-Z) neutrons, especially when we know that neutrons live for an average of 898 seconds and decay into electrons and protons? Why not say that there are A protons and (A-Z) electrons in an atomic nucleus, bearing in mind that this gives the atom the same overall condition? The author prefers the Z group positron core with A antiprotons occupying positive `holes' in the structured vacuum field surrounding the core, but the way ahead is to find the true answers.

Also, and of more importance, is the basic question of determining whether those mysterious hydrogen atoms that Dr. Rowe has detected in electric discharges come from the vacuum medium or are fully accounted for by a flow through the metal circuit feeding the electricity. This is straightforward experimental work that needs funding to get at the truth.

If Dr. Rowe is proved correct and the protons and accompanying electrons do come from the vacuum medium, the 'aether', then that will be an Earth-shattering discovery that would penetrate the complacency of our scientists in authority. They would respond to such a discovery, if it were fully verified, and we could expect to see progress on the subject of our discussion.

If, on the other hand, the mysterious hydrogen source is traced to the flow of protons through the metal then we may still need to urge for that extra research. Firstly, we would need to establish whether the flow is a true flow similar to the migration of electrons through the metal conductor. If it were to be a chemical effect of hydride compositions merely exuding hydrogen then there is little basis for any hazardous condition such as we have contemplated.

However, apart from what Dr. Rowe says, it does appear that there is some evidence that there is a true flow of proton-sized charge carriers. Tests by Winchester [17] show that hydrogen gas continues to be produced provided the voltage of the discharge is high enough and the damage to the cathode leaves sufficient cathode to act as an electrode. Winchester's research, therefore, leads us to suspect that there is a flow through the circuit rather than a mere surface effect of release of hydrogen from hydride compositions.

Skinner [18] went further in his research. He confirmed the mysterious appearance of hydrogen and was led to state:

"This experiment repeated at various times since and with different metals showed beyond doubt that the source of gas was solely in the cathode."

This is an intriguing factor because, if we are thinking of positively charged protons being supplied as part of the current flow, these should come from the anode and not the cathode.

Here, then, we have evidence that it is a flow of antiprotons that we are considering.

Skinner then referred to further experiments of which he said:

"Experiments described below indicate that in this case the anode absorbs at the same rate as the cathode evolves hydrogen."

This was further confirmation of a flow that could be taken to involve antiprotons. Skinner's paper then proceeded to show experimentally that the quantity of hydrogen involved obeyed Faraday's law:

"All metals show that the hydrogen is liberated for a time at a rate sufficient to carry, as negatively charged atoms, the whole current between cathode and gas."

Yet, though this was Skinner's experimental conclusion, it is difficult to believe that the full-bodied hydrogen molecule has acquired an extra electron and is literally dragged through the metal circuit in preference to a simple flow of electrons. The antiproton is something else. It is very small in physical size and could well respond with a preferential conductivity in flowing through the interstices of the metal. The antiproton once within the arc discharge would suffer the anomalous energy transfer from the electron gas in the discharge, as already mentioned [11]. It could easily acquire sufficient energy in a 50,000 volt discharge to combine with a positron produced in company with an electron by the zero-point field fluctuations and so form a neutron. The latter survives for an average of 898 seconds before decaying into a proton and an electron. The result is the production of hydrogen and there is still an electron surplus to carry the current to the anode. The energy released by neutron decay will revert to the zero-point field to keep things in balance, but the driving force has been that 50,000 volts.

The neutron can travel quite a distance in that 898 seconds and can find its way into living cells. However, if produced in the open air close to the overhead power line it might decay by combination with nitrogen-14 to produce carbon-14 plus the proton. Carbon-14 has a half life of about 5600 years. It is known to be produced naturally in the atmosphere and has a general equilibrium. Besides this it has found its way into the carbon dioxide of all living plants. Hence the basis for radioactive carbon dating. That equilibrium arises presumably from the neutrons produced by cosmic radiation bombardment that spreads the effects in a weak concentration worldwide.

So, is it unrealistic to suggest that there is a much more intense local creation of carbon-14 owing to the sustained excitation of an overhead power line? Is it unrealistic to suggest then that an excess of radioactive carbon-14 can build up in the bodies of people living close to those overhead power lines? Radioactivity can be harmful to one's health. Maybe if these people are carbon-dated they will be found to have aged prematurely? Maybe too much carbon-14 can distort the DNA cell composition in our bodies via an isotope effect as considered by Berezin [2].

This then is the scenario that we should be examining, especially if our scientists are confident that magnetic fields are not the culprits causing the anomalous health problems of those living in the near proximity to corona-discharging power lines.

The author acknowledges the stimulus for what is reported in this paper provided by information supplied by Dr. Paul E. Rowe of 7l West Way, Mashpee, MA. 02649, USA. Dr. Rowe's opinions on the aether as the source of protons are based on his experiments, as yet unreported in published work, and in reaching this conclusion he is fully cognizant of the prior work of Winchester and Skinner.

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> [1997 update concerning the above references: I have no information concerning eventual publication of Rowe's paper [1]. Reference [6] was published at pp. 167-172 of volume 10 of the 1987 Hadronic Journal. Reference [14] appeared at pp. 72-76 of volume 1 of Physics Essays in 1988. Reference [15] appeared at pp. 169-176 of volume 11 in the 1988 Hadronic Journal. All of the 14 author's papers that have appeared in Hadronic Journal and Physics Essays are reproduced in full in the author's book 'Aether Science Papers', ISBN 0 85056 0152, published in July 1996 by the publisher of these Energy Science Reports.]
>
> [Concerning the anomalous effects observed in plasma tube discharges and typically those implicit in reference [11] above, it is noted that Energy Science Report No. 8 in this series concerns a Canadian invention which generates electricity using a plasma discharge tube. There is substantial excess energy produced and one can only infer that its source has to be the aether. Hopefully this technology of the Correa invention which is the subject of U.S. Patents Nos. 5,416,391. 5,449,989 and 5,502,354, granted in 1995/1996 to Dr. Paulo N. Correa and Alexandra N. Correa will now be developed commercially. This author (H. Aspden), in deciding to write these 10 Energy Science Reports, realized that only a major breakthrough by which the existence of a real aether medium can be proved by tapping its energy commercially, can arouse the physics community from their slumbers in their relativistic dream world. This Report No. 10 is the last such report, because events on the New Energy front must run their own course at their own pace and there is little more that this author can do to encourage interest in these matters. Our future health and well being depends upon a sustained source of non-polluting energy and an understanding of how the aether contributes as a creative force. Harold Aspden, March 29th, 1997].

US005151577A

United States Patent [19]

Aspden

[11] Patent Number: 5,151,577

[45] Date of Patent: Sep. 29, 1992

[54] ELECTRIC SURFACE HEATING AND APPARATUS THEREFOR

[76] Inventor: Harold Aspden, Acres High, Hadrian Way, Chilworth, Southampton, SO1 7HZ, England

[21] Appl. No.: 640,833

[22] Filed: Jan. 14, 1991

[30] Foreign Application Priority Data

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[51] Int. Cl.[5] H05B 3/34

[52] U.S. Cl. 219/528; 219/212

[58] Field of Search 219/211, 212, 528, 529, 219/549; 363/146

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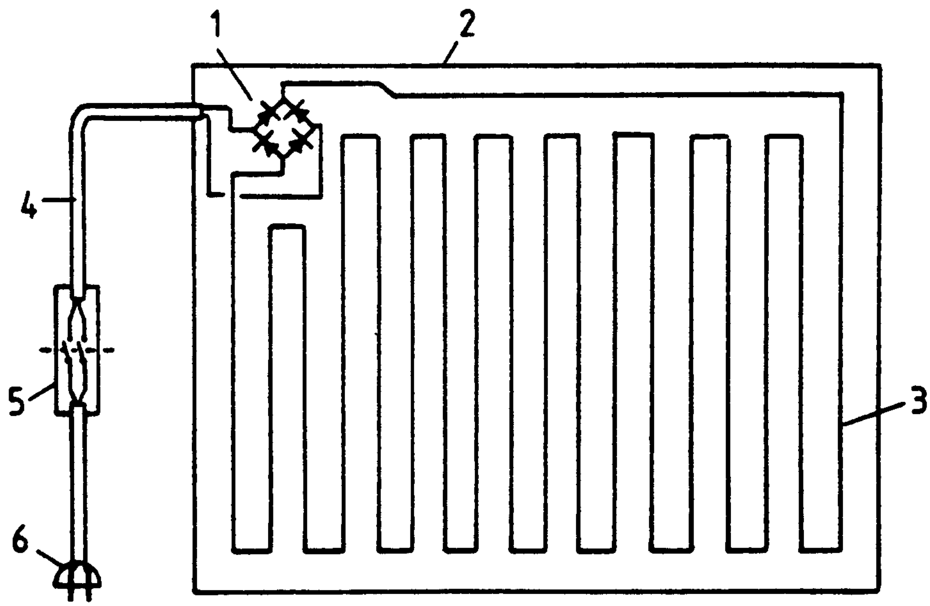
Primary Examiner—Teresa J. Walberg

[57] ABSTRACT

The harmful effects which build up in the bloodstream and in body fluids owing to cyclotron resonance caused by mains-powered heating appliances such as electric blankets are reduced by powering the appliance through a single-phase full-wave rectifier which converts 60 Hz ac into heating power that is 81% dc and 18% ac at 120 Hz. The rectifier can be incorporated in the blanket or within the housing of a switch, plug or power socket.

4 Claims, 2 Drawing Sheets



APPENDIX VI

LIVING CELLS AND SUPERCONDUCTIVITY

Although unrelated to cyclotron resonance as such, there is another kind of resonance that may intrude upon the workings of cells in the human body. It is best described as 'Supergraviton Resonance', there being a physical mechanism by which molecules or small groups of molecules can, owing to a dynamic interaction with the aether, develop a resonant condition which converts heat into electricity. This is at the very heart of the action which accounts for what is known as 'warm superconductivity'.

In summary, all matter has a quantum jitter motion connected with the Planck's constant of action and this needs to be balanced dynamically. The balance comes from the transient existence of gravitons and a heavy molecule needs to induce the supergraviton form so as to optimize the action. Gravitons and supergravitons are states where a kind of pseudoparticle is created by borrowing energy from the aether. It is the electromagnetic interaction of these graviton forms that accounts for the force of gravitational attraction between particles of matter.

Now, the key point of relevance here is that the supergraviton has a high mass effect, equivalent to 102 atomic mass units and, in performing the dynamic balancing act with a heavy molecule, the spread of the action of several supergravitons can reduce the effective mass value to 101 amu. There is supergraviton resonance when the mass of the molecule is an integer times this 101-102 value. In this state of resonance any collisions between the molecules or between molecules and free electrons, as in electrical conduction though a metal, will result in energy (the random motion we see as heat) being deployed regeneratively into setting up electric fields which can sustain electric current flow without loss. That is the state of superconductivity but the generation of a flow of electricity in organic matter that is non-metallic is also possible and, if heat can convert into electricity in the human body, that should be of interest to those who read this Report.

I do not intend here to present what has not already been published and so the following items may seem disconnected, especially where they are partial exerpts quoted from a longer text. They will, however, serve as a guide to my other work on this subject and be helpful to those wishing to study these ideas further.

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New Energy News is a monthly newsletter published by the Institute for New Energy, P.O. Box 58639, Salt Lake City, UT 84158-8639, USA. On page 2 of the October 1995 issue there is a note entitled 'Cold Fusion is a Live Issue' (author: H. Aspden) which explains how, in April 1989, I had developed a paper, published later that year, about the technological applications of the supergraviton and had extended it to have bearing upon the 'cold fusion' theme. The latter phenomenon is the anomalous generation of heat in the cathodes of electrolytic cells containing heavy water. The l02 factor was the basic feature of that paper. My note on 'Cold Fusion is a Live Issue' followed a item I had entitled 'Eureka-An Energy Echo from a Cathode' in which I referenced Professor Alec Broers discovery in IBM in 1965 of using lanthanum hexaboride as a cathode which, for example, could make electron microscopes durable. Tungsten cathodes as used in earlier work burned out after a few hours. The point of my note was that the composition of one lanthanum atom and six boron atoms had a molecular mass of 203.78 amu. This is twice 101.89. Heat was being regenerated as electricity and so the burning process was eliminated.

Now, in my note on the live issue, after extending the same argument to show why superconductivity at room temperature accounts for the very powerful permanent magnet properties of samarium cobalt, I reported searching through a commercial listing of chemical compounds based on sodium (for reasons detailed in the note) to find a compound which was recorded as having a molecular mass close to 102 amu. The best one I could find was sodium polyphosphate, recorded as 101.96 amu. Ideally I was hoping to find a compound of which all atoms were of single isotope form. Oxygen was 99.8 per cent pure in this respect and sodium and phophorus both fitted that requirement.

That led me to write the following: "Now, what has this to do with cold fusion? The answer, very simply, is that sodium is known to transmute into magnesium in living cells and the action is known to involve as a catalyst ATP and ADP, adenosine triphosphate and adenosine diphosphate, which play a major role in energy conversion in living matter! See the mention of ATP by Gerald Lindley at p.17 in the September 1995 issue of New Energy News. It is apparent that the 102 mass resonance seems to hold the key to this mystery in plant life and within our bodies".

Lindley, in that September 1995 issue of New Energy News, drew attention to the biological molecule ATP as having a molecular mass equal to that of 5 supergravitons. He went on to explain how earlier work by Solomon Goldfein in the 1970s had brought the magnesium atom into play as a nucleus about which four ATP molecules were stacked. Lindley argued that the whole complex had a mass that was an integer multiple of 101.846 amu which he said "further supports Aspden's proposal of a supergraviton mass of 101-102."

Responding to that I went in search of more facts about the ATP topic or related research and, from a lead in something written by Solomon Goldfein, I came to read a 1976 paper by Alfred A. Wolf and Ernest H. Halpern (Proc. IEEE, pp. 357-359). In referring to it Goldfein had said that, in theory, cholesterol molecules might form locating channels in which they might combine with a sodium ion to form a structure superconductive at 350 Kelvin. That was speculation, and I was getting out of my depth in trying to understand these curious molecular forms that are outside my technical discipline. I was, however, really surprised when I saw in that IEEE paper that six different bile salts were superconductive, sodium doxycholate having the highest transition temperature of 277 Kelvin.

As I remarked in my note in New Energy News (November 1995, pp. 5-6) "Here was room temperature superconductivity of record in 1976, ten years before the discovery of the 77 Kelvin warm superconductivity was announced! Moreover, the action was in substances in living matter in which sodium is believed to experience cold fusion by transformation into magnesium, the subject discussed by Goldfein!"

My research during the years 1994 through to date has been on efforts to build an electric motor that can extract energy from the thermal background, including the heat condition latent in the aether. However, my interest in the motor theme, the supergraviton and its role in unifying electromagnetism and gravitation, as well superconductivity, caused me to be alert when I read an article in The Times just two days before writing these words. It caused me to send the following communication to the Editor of New Energy News and I present it as the final item in this Report.

THE MOTORS THAT KEEP US ALIVE

On the day (March 24th 1997) I was concluding the final pages of my latest Energy Science Report No. 10, 'Cyclotron Resonance in Human Body Cells', the London newspaper, THE TIMES, published an item on page 15 headed `Wheel power: The circle of life'.

It was reported, by reference to "the current Nature journal" that each of our body cells houses a tiny motor - "the smallest motor in creation - an enzyme that rotates to do its work and is only five millionths of a millimetre across". "The enzyme consists of seven components - a central axle, and six sub-units wrapped around it to form a collar". "The inner component is free to spin inside the collar". "What is stunning is that it is the very first time rotation has been demonstrated in an enzyme". As the motor turns "the molecules of ATP are produced like sausages from a machine". "Biochemists know how quickly this reaction goes, so it is possible to work out how fast the motors should spin - 20 revolutions per second".

Although this is hardly New Energy Technology it touches upon something reported earlier in the pages of New Energy News and seems worthy of further comment. Energy from the food we eat is converted by the enzyme ATP synthase into chemical energy in the form of ATP. Well, we must now wonder how chemical energy manages to set something rotating. In contributing to our internal body heat it would keep any 'loose' ions in the ATP molecules active in their random thermal motion. It then needs no more that the ever-present geomagnetic field to perform, as it should, according to the Larmor formula, as used in cyclotron theory. The ions are deflected into a reacting orbit and the beauty of all this is that the rotation around those orbits occurs at an angular speed which is the same whatever the speed of those ions. To get 20 revolutions per second in the Earth's field, which approximates 0.5 gauss, those ions need a mass of 39 amu, which identifies potassium.

The motor speed observed by the Japanese researchers who discovered this phenomenon was lower than this 20 rev/s owing to a drag effect imposed by the technique of measurement. We know, however, that the actual speed of a basic d.c. motor is lower under load than it is under no load conditions, so my guess is that these motors in our bodies are trying to run faster than 20 rev/s. 32 rev/s in a 0.5 gauss field would identify magnesium (mass 24 amu).

I then note that on pp. 17-18 of New Energy News, September 1995, Lindley refers to the "stacking" of molecules of ATP around an Mg ion as suggested in the 1970s by Solomon Goldfein who said of biological ATP that it "met the criteria for a microscopic cyclotron".

AUTHOR'S CONCLUDING NOTE

I hope that what I have written will prove of interest to those concerned about the physics which govern our lives and, as this Energy Science Report No. 10 is the last such report I shall be writing, I further note that I will now concentrate for a while on publishing my research findings on Internet, where I plan to provide full references and abstract information concerning all my prior published work. My Internet Web page access address is:

http://www.energyscience.co.uk

Information about my books and other Energy Science Reports in this series is provided on those Web pages.

This report was first issued on 31st March 1997.

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