Arguments by A.C. Sturt submitted by him as the inventor through Reddie and Grose in response to the Final Office action of United States Patent Application No. 11/921 544 Thermonuclear Power Generation of Alan Sturt

Further literature cited by the examiner:

a. Survey of collective instabilities and beam-plasma interactions in intense heavy ion beams. Ronald C. Davidson et al. Nuclear Instruments and Methods in Physics Research A 606 (2009(11-21.
b. Patent application US 2001/0043663. System and method for the production of 18F-fluoride. Ruth et al. Pub date Nov 22 2001.

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United States Patent Application No. 11/921 544
Thermonuclear Power Generation of Alan Sturt

I refer to your letter of 6 March 2012 with the enclosure of a Final Office action which has been issued on my above application.

I begin with my review of the two new documents which the examiner has produced, and compare them with my invention. I then address the rest of the document point by point, covering the physics and the collision process in some detail. This is necessary because the arguments of the examiner contain some elementary but serious errors. Mehlich and Ruth teach nothing in relation to this application. After that conclusion there is not much left apart from his opinion that it just will not work.

A. US Patent Application Publication US 2001/0043663A1 published 22 November 2001 (Ruth et al.). System and Method for the production of 18F-Fluoride.

This is claimed to be a process for synthesising the isotope ^{18}F which has a short half-life, making it suitable for use in medical applications.

1. The invention is a batch process for making fluoride compounds of the atom ^{18}F from molecules of oxygen gas composed of the ^{18}O isotope.
2. The oxygen gas is loaded into a reaction chamber with a volume of about 15 millilitres to a pressure of about 20 atmospheres.
3. The oxygen gas is then irradiated with a proton beam passing through a foil window which transmits the beam while containing the ^{18}O oxygen gas and the formed ^{18}F fluoride. Irradiation for a time which can be calculated raises the temperature of the ^{18}O oxygen gas to " well over 100ºC ".
4. The oxygen nuclei are claimed to undergo a nuclear reaction and are converted to ^{18}F fluoride with emission of a neutron.
5. The fluoride sticks to the walls of the vessel, " but not too much ", so that it can be dissolved off using a solvent which is water, steam, acids or alkalis.
6. The chamber is emptied, so that the process can start again.

This is not so much nuclear reaction as alchemy of the medieval kind. Bombarding chemical compounds with charged particles cannot cause transmutation of the nucleus to form elements of higher atomic number, not least because their electron shells, which are the source of their chemical interaction, make the nucleus totally inaccessible. There is also the question of the repulsion of the positive charges on the particle and the nucleus. This is how Rutherford discovered the existence of the nucleus in the first place. He fired alpha particles, now known to be helium nuclei i.e. positively charged, at a foil and found that almost all passed straight through or were deflected. However, very occasionally a particle would bounce back as if it had hit a brick wall, as he put it. So he concluded that there must be a hard nugget at the centre of the atom, which he called a nucleus. Nothing was transmuted. No transmutation has ever been performed by this technique. No transmutation is possible by this process.

The same certainly applies to protons which have been slowed down by passage through a foil window. In addition, oxygen exists as a stable diatomic molecule i.e. two atoms per molecule. The claim that this molecule is transmuted into a compound of fluorine of higher atomic number is incredible. The claim that a neutron is emitted during the process is beyond belief. Whatever this process achieves, it is not transmutation of elements or it would be possible to do nuclear chemistry in test tubes, like the alchemists of old trying to turn lead into gold. This is the sort of element-building that requires the pressures and temperatures of stars, not 100ºC and 20 atmospheres.

The conclusion is that the Ruth application teaches nothing. All the arguments in which Ruth is cited, either alone or in combination with the other processes, should be struck out. When Ruth is cited later as teaching elution by carrier gas, it is no more relevant than teaching by a chemical laboratory dishwasher.

The differences between the above and my process could scarcely be more stark. Mine uses heavy ions, which are atoms of heavy elements stripped of their orbital electrons, so that they can be accelerated to relativistic speeds. They are then caused to collide head-on. Thus they are not atoms, let alone molecules. The heavy ions are highly positively charged, and so repel each other. This repulsion requires considerable momentum to overcome it, hence the necessity for the particles to reach relativistic velocities to achieve collision. The result of head-on collisions is that the pairs of heavy ions disintegrate into fundamental particles and form a kind of evanescent plasma, which I have called a collision mass in which fusion of light ions is performed.

This is not what is conventionally meant by 'plasma' because it has fewer electrons than ordinarily electrically ionised atoms would have; the origin of its electrons is intranuclear, which is only a proportion of the total number of electrons contained in an atom. The explanation of these terms is that my model of the nucleus is a dynamic entity, rather than a nugget. A nucleus is said to contain protons with a total charge which equals the number of electrons that orbit it, and so it remains neutral overall. The mass of the nucleus shows that it must also contain other particles with a mass which is very nearly the same as that of a proton, but with no charge. Hence the term neutron. This led Rutherford et al. to postulate the model of the atom as a positively charged nucleus orbited by electrons. However, this did not say why such electrons stay in orbit instead of spiralling into the nucleus because of the attraction of opposite charges.

Neutrons are not fundamental particles. In fact when liberated from a nucleus, they decompose at room temperatures into a proton and an electron by a process which has a half-life of about 10 minutes. This led me to propose that neutrons do not exist as entities in nuclei at all. In fact the entire nucleus is composed of protons held together by electrons in close orbit around and between them, much closer than the orbiting electrons. These I call intranuclear electrons, and it is these which are liberated when heavy ions collide. Liberating these electrons removes the glue which binds the protons together in the nucleus and prevents them from flying apart. As soon as collision occurs, this is what happens: the nucleus unzips.

It is the intranuclear electrons that repel the electrons orbiting outside, which solves Rutherford's unanswered problem. What we see as a neutron in the laboratory when it has been ejected from a nucleus is in fact a proton which took an intranuclear electron with it when it was ejected. It would take a few minutes for the close association to unwind, the half-life. The close orbiting of such electrons occurs only at the pressures and temperatures of stars. Neutrons cannot be synthesised in the laboratory.

So a collision mass is composed of the protons and intranuclear electrons of two heavy nuclei unzipped by collision. It is an unconventional 'plasma', but it provides a short-lived environment of highly energetic fundamental particles in which light nuclei are caused to fuse with each other to produce new energetic nuclei. When the new nuclei are neutralised, they eventually give the atoms from which heat is extracted. The light nuclei do not require acceleration into the apparatus. They just have to be present in that environment, which is normally described as " introduced ". The particles in the collision product interact with them i.e. bump into them to provide them with the energy and velocities that cause them to fuse. The whole process is carried out cold under conditions of high vacuum, not under pressure.

Stripping away orbital electrons by the use of Van der Graaff generators is well known to those skilled in the art. These are electrostatic generators in which charge is carried on an insulated belt from an external source to an isolated metal sphere. They are even used in spectacular demonstrations . They are not an inventive step, but an instrument in the innovative process, like fractionation columns in chemical processes. The inventor died in 1967.

B. Nuclear Instruments and Methods in Physics Research A 606 (2009) 11-21. Ronald C. Davidson et al. Survey of collective instabilities and beam-plasma interactions in intense heavy ion beams.

This is a review of research papers on theories of instability of heavy ion beams. It is not clear why this is thought to be relevant to my application, since the difficulties as they relate to the process of my invention have been successfully overcome. This is shown by the fact that beams of heavy ions have been accelerated both at the Large Hadron Collider at CERN and at Tevatron at Fermilab to relativistic velocities high enough to cause the disintegration of the heavy ions on collision. This is the first stage of my invention which prepares the collision products at a point at which fusion of light nuclei can be carried out. After collision has occurred, instability of the heavy ion beams is no longer a factor. They have done their job. Particles which do not collide continue on their way for recycling, which gives time to correct any instabilities of flow to which they have been subjected, before they are accelerated back into the collision zone, if this is required.

The processes of the research papers are aimed ultimately at discovery of new particles and particularly the Higgs boson, which would complete the Standard Model of particle physics. To this end they need to produce unambiguous results which would define each new particle. The gist of the papers is as follows. Strongly anisotropic beam distributions i.e. wide distributions of particle velocities develop naturally during the acceleration of a large bunch of particles, but advanced analytical and numerical simulation studies have shown that this can be eliminated or greatly reduced by introducing a very modest axial spread in the beams i.e the greater the lateral distance between the ions on their journey, the less likely they are to interfere with each other, which is reasonable. High focal spot intensities are achieved by compressing the beam longitudinally and transversely i.e. concentrating the ions on one spot for detection facilitates interpretation of the results. But, of necessity, the assumptions on which theoretical research papers are based have to be idealised: “ equilibrium charge and current neutralisation”, “ absence of an applied focusing field ” and a “ perfectly conducting cylindrical wall of a particular radius ”.

However, all this is relevant to my application only in the sense that the problems of acceleration of heavy ions to relativistic velocities have been studied and overcome. The aim of their research has been to discover new particles, notably the Higgs boson. By contrast, in my application the nature and characterisation of particles formed is irrelevant. What matters is the bulk property of heat, which subsumes everything that has occurred during the process.

Finally, on the question of acceleration processes, I quote the examiner’s own words on page 2 of the Detailed Action: The issue is not whether the invention can be operated like the Tevatron accelerator at Fermilab and the LHC at CERN. The issue is rather “ whether or not the description in the specification provides any evidence that the claimed invention can be made and practiced for its asserted utility of fusion energy production ”. I take this to mean that he agrees that the process can be operated, but doubts whether it would produce heat. This question is answered below.

What follows is a page by page rebuttal of the points made in the Detailed Action.

Page 2

The wording suggests what has been stated above: the examiner thinks the apparatus can be operated, but doubts whether heat will be produced. Indeed it would be “ world news ” if the physics had been tested.

Page 3 the physics

In fact the physics has been tested, and it is world news. The Joint European Torus (JET) at the Culham Centre for Fusion Energy near Oxford achieved the world’s first controlled release of deuterium-tritium fusion power in 1991, and the world record for fusion power at 16 megawatts in 1997. See their website. According to cited paper W section 3.10 *Significant fusion power >10MW) produced in the 1990s*, in 1991 JET carried out experiments with 10% tritium added to a deuterium plasma for two pulses, each producing a peak fusion power of about 1.7 MW and a fusion energy of 2 MJ per pulse. Further advances were made in 1993.

The apparatus they use is a torus or tokamak. Beginning with a high vacuum, deuterium and tritium are introduced into the tokamak. The velocity at which they enter the torus is not a factor in their subsequent reaction. A very large pulse of electricity is applied for 30 seconds and the resulting plasma is stored in a magnetic confinement system. External heating is also used. It is stated that there are no electrons in the core region i.e. the extreme conditions have stripped them off the nuclei. Nuclear fusion occurs, and the temperature can rise to as high as 100 million degrees. JET began operating in 1983. The claim is that “with adequate funding, the first fusion power plants should be operating by 2040 ”. JET has carried out much important work to assist the design and construction of ITER which is the next step in scaling up.

There is a parallel with the process of the present application, except that this decomposes the nuclear chemistry into more manageable stages. A Van der Graaff generator is used to strip electrons off heavy atoms to give heavy ions. These are then fed into the collider under high vacuum and accelerated to relativistic speeds in two opposing beams, each containing billions of heavy ions. Pairs of the heavy ions collide head-on, causing them to disintegrate completely to form a collision mass, which is a short-lived, localised plasma. The zone in which the beams collide therefore contains many such collision masses.

Light nuclei, which are reactant light atoms from which electrons have been removed, are introduced into the collision zone, and when they coincide with a collision mass, nuclear fusion is facilitated. The velocity at which they are introduced is not instrumental in causing fusion. They just have to be present in the location. The light nuclei need to collide with each other to fuse, but the energy to achieve that is transferred to them by the particles in the collision masses, in exactly the same way as they collide with each other in the tokamak plasma. This is a parallel of the sort of energetic Brownian motion which occurs with atoms and molecules when they react chemically, rather than translational velocities of the bulk.

Page 3 alternative channels

Provided the “ channel ” which we claim occurs, and the Culham experiment teaches that it does, the process of the application succeeds. Alternatives would require the only other free particles, which are protons, to take part in transmutation, which we have precluded at the start. If a proton deactivated a light ion, the ion would still be available for subsequent activation, or it would remain inactive and be recycled.

Page 3 cross sectional data

The question of cross-sectional data is answered as follows. Scattering cross-section is the number of particles scattered per unit time divided by the incident number per unit flux density. In other words it describes the probability of collision. The advantage of the invention is that it decouples the formation of the plasma from the process of fusion. The ‘plasma’ or collision mass is made by the head-on collision of pairs of heavy ions both travelling at relativistic velocities to their mutual destruction. The probabilities of collision of these heavy ions or the ‘cross-sections’ are exactly the same as those which applied in the same processes in the Tevatron accelerator or Large Hadron collider, which were successful. In fact the probabilities might be even higher, because the number of particles accelerated could be much greater, since there is no need for simplicity of analysis of the results. Heavy ions which do not collide or are deflected continue on their way and are recycled. The parameter which matters in this application is the heat eventually generated.

The light nuclei which are the reactants for fusion are comparatively stationary when fed into the reaction area. The relevant probabilities are those of the light ions’ being in the volume of a collision mass, which is much greater than that of a single heavy ion. An approximate calculation of the relative sizes of nuclei and atoms show the advantage of using collision masses for synthesis. Atomic diameters lie in the range 1 to 3 x 10^{-10} m. Nuclear diameters lie in the range 1 to 7 x 10^{-15} m. The ratio of their volumes is therefore of the order of 10^{15} i.e. the volume of an atom is about a million billion times larger than that of a nucleus. The chances of hitting an atom are about a million billion times greater than that of hitting a nucleus, which is why chemical reactions work.

When the heavy nuclei collide, they unzip as described above to form a collection of protons and the intranuclear electrons. The electrons flee the scene because of their mutual repulsion, and they travel much faster than the protons, since they have one eighteen hundred and fortieth of the mass of a proton but the same force of electrostatic repulsion. For an instant, while the protons are still grouped close enough i.e. before their mutual repulsion forces them too apart, their combined positive charges hold the electrons at about the same distance as orbital electrons in a heavy atom. Hence the ‘collision mass’. Hence the size estimated to be of the order of that of an atom. Of course the structure is not definite like that of an atom, and it will last only an instant, because the protons also repel one another with the same force of electrostatic repulsion. This is what I meant by “ collective electromagnetic interaction” as in cited paper U “ Controlled Thermonuclear Reactions ” by Artsimovich.

Short life in this instance is an advantage. Even plasmas which last a few seconds can be a problem as far as containment is concerned. In any case, in this process there is always another one coming along. If the light ions miss one collision mass, they can be caught by the next one forming in the vicinity. They may even be partly activated in one, and finished off in another, because there is no mechanism for losing energy by a vibrating ion under these conditions other than collision with another nucleus, propelled by the other particles of the collision mass, since they have no electrons to radiate it away. Decoupling of these processes means that it does not require the collision of three input particles. Two light ions will do as in the tokamak, the same energy i.e. enough to destroy nuclear binding forces, but achieved at a much lower temperature than in a bulk reactor, because it is localised.

Page 3 economics

I am not sure why a patent application on a process requires a cost/benefit analysis or an energy balance. What is claimed is thermonuclear power generation. The input energy is largely electricity, very small quantities of deuterium, of which the seas are full, and very small quantities tritium, which is in effect a by-product of conventional nuclear reactors. The output is very hot, combustible gas, probably hydrogen which can be transported without loss. The input for nuclear fission reactors is oil and gas, materials mining and transport, the cost of long term storage of waste, of which there is none in this application, and reliance on overseas sourcing. The output from nuclear fission reactors is hot water or steam, which must be used locally. The economies of production depend on a host of imponderables such as the price of oil, the value of currencies, the geopolitical situation etc. None of these can be forecast for the purposes of patent applications. All that can be said with certainty is that more alternatives are needed.

Page 4 staffing

The examiner quotes the need for PhDs to support his thesis that the application is just a lengthy basic research project. I know that two of the people who run programmes at CERN are professors of physics, who are regular broadcasters, and one is professor of theoretical physics at Surrey University. Their research programmes require many PhDs and engineers who are engaged in winding the LHC up to its maximum performance, because 99.9% of the speed of light has not been enough to isolate the Higgs boson. By comparison, relativistic speeds of a tenth up to, say, two thirds of the speed of light, which is what this application requires, are easier to achieve. Moreover, much of the work lies in the detector systems, which are extremely complex and comprise about half the total investment in the LHC. Nothing remotely so elaborate is required in the process of this application. Therefore it should be possible for it to be operated by those skilled in the art.

The fact that “a veritable army of skilled research scientists and engineers have labored for over half a century without success to date ” suggests that any potential alternative should be welcomed. The basic research has been done and the principles have been established, but there is obviously scope for continuing research and development, particularly engineering. This is true of any innovative process; conventional nuclear reactors have been the subject of continuing development over the last 50 years, and they have still not solved all their problems. Waste storage may never be solved in the terms which are being strictly applied because of long half-lives. Waste storage is not a problem in the process of this application.

Page 5 excess novelty

The examiner writes “his innovative solution attempts to set his process apart from those in the fusion community at large more than can be justified”. Whether it can be justified is a matter of opinion. However, he then goes on to misrepresent the process of the application as “applicant’s art is comprised in heavy ion beam fusion, adding an additional light-ion beam to merge with the heavy ions once they have come close enough to form what applicant call a collision mass”. But as described above, in this application the heavy ions do not fuse. They collide and destroy each other, so that they are reduced to electrons and protons. There is no light ion beam, and it does not merge with the heavy ions once they have come close enough. As made clear above, the heavy ions no longer exist as such at that point. The acceleration stage has passed, and so the survey by Davidson et. al is no longer relevant.

Page 6 collisions and neutrons

The analysis of the size of a collision mass is given above. The interaction of the heavy ions is not just intense: it is a head-on collision enough at velocities great enough to destroy them. As for the question of what happened to the neutrons, that is described at length above: in my model there are no neutrons in nuclei, just electrons in close orbit around the protons. This is a new analysis of the known properties of neutrons which is equally relevant in physics in general and in astrophysics. It is consistent with all the known observations and measurements.

Page 7 mechanics

The examiner is confused about the relative velocities of particles. The mechanics is as follows. Heavy ions are twenty times or more the mass of light ions. For example, the relative atomic mass of gold is 197, and the relative atomic mass of lithium is 7. If the relativistic velocity of heavy ions which is just sufficient to destroy them in head-on collisions is v for each heavy ion in a pair, each has an energy of $½mv^2$. The total energy of the collision is twice that i.e. mv^2. This is the energy required to make a collision mass from heavy ions travelling at relativistic velocities in head-on collision. It both overcomes the mutual repulsion of the positively charged heavy ions, and proceeds to destroy them. Relativistic velocities have been shown at the LHC and the Tevatron accelerator to be necessary to provide sufficient momentum for the destruction of such nuclei.

If two light ions were colliding at the same relativistic velocity, each would have an energy of one twentieth of the energy of the heavy ions. The total energy of collision would then be on twentieth i.e. 5% of the energy of collision of the heavy ions. This would not be anything like enough to cause destruction of the nuclei, witness the observations of Rutherford that alpha particles did not affect the nuclei of the atoms in a foil.

If a heavy ion and a light ion travelling at the same relativistic velocity were to collide head-on, the energy of the heavy ion would be $\frac{1}{2}mv^2$ as before, but the energy of the light ion would be only a twentieth of that. This would make a total energy of collision of only 52.5% of the energy needed to cause disintegration in a head-on collision which destroyed the heavy ions. Disintegration simply would not happen.

Thus it matters considerably which ion is travelling at relativistic velocity and which is simply loitering. Which brings me to Mehlich.

Pages 7-8 Mehlich

The examiner writes that there is no substantial difference between “accelerating” and “introducing into”, and that it makes no difference which particle is accelerated. The preceding analyses show that these statements are untrue. He also makes a point about Van der Graaff “accelerators”, though they are in fact generators, not accelerators. He then embarks on some tortuous reasoning about what Mehlich teaches, and is particularly focussed on what Mehlich would achieve with two deuterium nuclei.

Mehlich in fact teaches nothing of relevance to the application, as demonstrated by considering the processes at the level of the particle. Setting aside what may or may not already have been written, the position is as follows. Mehlich’s claim is that the nuclear reaction between two light nuclei is enabled by the presence of a third, heavy nucleus. His process covers a range of possibilities and reactants, but the one which concerns my application is bombardment of the two reactants with heavy ions.

If heavy ions are fired at mixtures of light ions, the actual process begins when a heavy ion hits a light ion. This has all the problems of cross-section which the examiner raised earlier i.e. the probability of a heavy ion actually hitting a lighter ion is very low, because of their extremely small diameters. The light ion which has been ‘activated’ or moved by the impact then has to find another light ion with which to react, a process which itself has an even lower probability of success, because both ions are now small and have lower cross-sections. Thus the reaction of the two light ions depends on two highly improbable events in sequence, which has an infinitesimal chance of success. If it is claimed that the heavy ion merely has to be in the vicinity of the two light ions rather than making contact, the probability of three ions coinciding in this way is also infinitesimal, especially as they are all positively charged, and so repelling each other.

By contrast, in the process of this application, two beams of heavy ions travelling at relativistic velocities are directly opposed to each other. The aim is to force individual heavy ions to collide head-on with individual heavy ions coming the other way. This destroys them as ions, and liberates the electrons and protons of which they are composed. The energy to overcome the repulsive forces of their positive charges is provided by their momentum, which is produced by their relativistic velocities. The probability of collision is low, because of cross-section effects, but it has been achieved on the LHC and the Tevatron by using billions of heavy ions in each direction. As soon as a pair of heavy ions has collided and disintegrated in this way, their job is done; they are finished and they no longer exist as structures. What remains is a cloud of protons and electrons, which is what I have called a collision mass, and for which I have proposed a loose evanescent structure.

The dimensions of this collision mass are at least a billion times larger than an individual ion, and so the chances that an ion will enter it are at least a billion times greater than in the Mehlich process. Since the particles collided head-on, the collision mass will be relatively stationary while it lasts in the collision zone compared to the relativistic velocities of heavy ions which have not collided. Reactant light ions are present in the collision zone, and will find their way into one of the millions of collision masses in the zone and become activated by the particles of the collision mass, which is to say they will vibrate violently. This is the nucleus as a dynamic entity. They may meet another such light ion in the collision mass and fuse, or more likely, meet one and fuse in another collision mass, as collision masses form and sweep through the collision zone. Such activation is likely to persist long enough for this to happen, because there is no mechanism to stop it, except colliding with another ion. Thus the process has both the energy to drive the process and the greater probability of achieving fusion.

This analysis shows that my process and Mehlich's are different. The probability of success is much greater in mine than in Mehlich's. Mehlich teaches nothing which relates to this application.

Page 8 light nuclei

Deuterium and tritium have long been known for use in fusion reactions. It is quoted in the cited Fleet document of 1977 that "of all the fusion fuels currently under investigation, the deuterium/tritium mixture … has the lowest fusion temperature". It was even successfully used in the JET tokamak experiment at Culham in 1991. These are therefore obvious reactants to start with. The innovation is not the chemicals but the process in which they are used. Finally there seems to be a fixation with what Mehlich would achieve with two D nuclei. The preceding analysis suggests that he would achieve very little. Certainly he teaches nothing relevant to this application. The process of this application is much wider than DD.

Page 8 carrier gas

The carrier gas protects the walls of the reactor with its streamlines, accepts the nuclear vibration of the product and transfers it out of the reactor as hot gas from which heat energy can be extracted. If it is hydrogen, it quenches further reaction, provides a means of energy transport and storage, and finally forms another source of heat when it is burnt in boilers etc. It is not simply a "washout gas".

As shown above, Ruth teaches nothing in relation to this application.

Page 9 reactions and radioactivity

The examiner has concluded that the application is focussed on the production of helium from two deuterium ions after Mehlich, and proceeds to question this. He is simply wrong. The reactants can be any of the light nuclei.

He further concludes that this must lead to radioactivity, which is also wrong. There is no radioactivity because there are no neutrons in the product, for the reasons given above. It is the imbalance caused by the ‘neutrons’ in the nucleus which gives rise to radioactivity.

Page 10 cross sections and electromagnetic radiation

Cross-sections and other reaction channels have been dealt with above.

Electromagnetic radiation is caused by the acceleration of orbital electrons. There are no orbital electrons in the process until the final neutralisation, and then they are all decelerating.

Page 10 fusion energy production

To state that “even for standard reaction channels, such as the most feasible D+T reaction, fusion energy production has thus far not been demonstrated, despite a world-wide effort for over 50 years of intensive research” is simply wrong. JET has done just that, as described above. However, it is true to say that it is not yet a commercial proposition, because the problems of containment prevent it being used at full power.

Page 11 ‘extraordinary claims’

Scrutiny is welcome, but it has to be soundly based. Meade’s 50 years of fusion research refers entirely to reactions in bulk, the instinctive approach of physicists. Mine is much more a systems approach at the particle level, which is why it offers something new. “Not leading to any radioactivity” is inherent in my approach, because there are neutrons in the product.

I am not sure what point he is making about “generation of energy”. The output is certainly thermal energy in the form of the carrier gas. The advantage of my application is that additional energy comes from the use of hydrogen for subsequent combustion: oxygen is free as air.

Drawing on his own experience (as a nuclear physicist?), he just does not believe it!

Pages 11-13 rejections

He just does not believe it.

Pages 13-14 Mehlich and Ruth

Mehlich and Ruth have been disposed of above. They do not make my application unpatentable.

The first particles for acceleration have to be heavy nuclei, or they could not develop the momentum needed for the collision process, even if they were accelerated to relativistic velocities. So “one of ordinary skill” might have been tempted to select a first particle from H, D and T, but it could not have worked. Picking two winners from three inevitable losers would have zero percent of success. See above Page 7 mechanics.

The second particles must also be heavy nuclei for the same reasons. Collision of two light particles would have only 5% of the energy required to cause disintegration of the nuclei into electrons and protons of which the collision mass is comprised, as I have defined it. See above Page 7 mechanics.

A word about relativistic velocities, which is the term used in particle physics to describe particle velocities above about a tenth of the speed of light. The reason for using 'relativistic' is that this is the range in which relativity is thought to be important. Particles become increasingly difficult to accelerate as they approach the speed of light, until they reach the limit which is the speed of light *in vacuo*. It is convenient, therefore to describe a velocity in terms of the energy needed to reach it i.e. the input.

However, the kinetic energy is the Newtonian value $\frac{1}{2}mv^2$ or half the mass of the particle times the square of the velocity in ms^{-1}, which is much less. This is the energy released by collision, i.e. the output. When two particles collide head-on so that they are both completely destroyed, the energy released by the collision is twice that i.e. mv^2. This is the kinetic energy required to make a collision mass.

It was to make this distinction between relativistic velocities and Newtonian kinetic energy that the term 'approaching the speed of light' was used.

Page 15-21 Mehlich and Ruth again

The Mehlich and Ruth processes have been discounted above, but the examiner uses them in what seem to be some flights of the imagination to claim that, because of them, everything is obvious, and so his points have to be rebutted one by one as follows.

P15. Paragraph two talks of "introducing one or more further particle(s) such as D particles into the collision mass (in the form of a third, heavy nucleus ("eines dritten, schweren Kernes"…Mehlich's claim 1)…etc. This is completely wrong. The third, nucleus which is introduced into the collision mass is not heavy. The heavy nuclei were destroyed in the making of the collision mass.

The statement that "the second particles and the further particles as defined above are exchanged" according to the application is without foundation.

Mehlich is said to 'teach' in his claims that scattering "at least one nucleus (e.g. H, D, T) onto a significantly heavier nucleus" (streuen mindestens ein leichter Kern (z.B H, D, T) auf eine wesentlich schweres Atom) makes the choice of H, D and T obvious. What does 'scattering' mean, and how does one scatter a light nucleus on an atom? If it means firing it at an atom, the net result is likely to be nothing. If it means firing it at the nucleus of a heavy atom, the net result is still likely to be nothing. Rutherford fired alpha particles, which are light nuclei, at a foil, and the result was that they went straight through, or were deflected, or very, very occasionally were bounced back as if from hitting a brick wall. No increases of atomic number were found. We do not need to go to Mehlich to select T and D as two particles with the best chance of fusing. This was known long before, and put into practice in the tokamak at Culham in 1991.

P16. We have already shown that Mehlich would almost certainly achieve nothing with two DD nuclei.

Carrier gas in the application is not simply an eluent. Ruth uses an eluent for "physically washing" his apparatus between runs, which is a perfectly obvious thing to do. "The Eluent used must have an affinity to the separated ^{18}F-fluoride that is stronger that is stronger than the affinity of the separator' i.e. it must be able to wash it off the walls. "Various chemicals may be used as the Eluent including, but not limited to various kinds of bicarbonates" in solution. It is doubtful whether washing the LHC between runs with bicarbonate of soda solution would do it much good. Helium is used to eject the eluent solution and dry the chamber when "the Eluent is being directed through and out". It does not participate.

In my application the carrier gas protects the walls of the reactor with its streamlines while the fusion is taking place, quenches further reaction, accepts the vibrations of the product ions and turns them into sensible heat, and transfers it as hot gas out of the reactor. If it is hydrogen, it provides a means of energy transport and storage, and finally forms another source of heat when it is burnt in boilers etc. It is not simply a "washout gas", nor is its use obvious.

On claim 4, the question of velocities has been analysed.

On claims 10-11. There is no process of which the acceleration of heavy ions is the reverse. I suspect that the examiner is compounding his very first misreading of the application as on page 15.

Page 17. Mehlich teaches the heavy particle to be 'metals'. This is his heavy ion whose presence aids the fusion of light nuclei. He does not teach head-on collisions of heavy or 'metallic' ions at relativistic velocities, and so he does not recognise that the heavy ions are not present at fusion because they have been destroyed to form the collision mass.

When Mehlich talks about the "target", he really does mean a target in the sense of a chunk of metal: "The target may advantageously designed as a rotatable disk or as a cylinder, in order to dissipate the heat created. Predominantly metals will be considered as the target, e.g. copper coated with samarium". This is in aid of dissipating energy quickly enough to prevent two fusing D ions decaying into D ions again. It seems that his third, heavier nucleus is part of the target, and he believes that it would "dissipate any excess energy via electromagnetic interactions, including its electron shell". It is this process for which "in view of these teachings it would have been obvious to select one or more of gold, platinum, silver, iron, lead or uranium", according to the examiner.

This is so far removed from the application that it is difficult to summarise the differences. The application: does not use solid targets, there are no electrons shells left on the heavy ions, there are no unpaired electrons, the heavy ions are collided with each other head-on, both ions in each collision travelling at relativistic velocities, after collision they no longer exist as heavy ions. Dissipation of excess energy is not a consideration.

P17 claim 20. The examiner states that in the application the further particles, which are the light nuclei, “are drawn into the collision mass by gravitational and electroweak forces”. This is wrong. They are gently propelled into the collision zone by force, where the collision masses are forming. Occasionally one will find itself inside a collision mass by chance. No electroweak forces, just mechanics.

Page 18. As shown above, Ruth and Mehlich teach nothing relevant to this application.

The examiner now raises the Fleet patent which was dismissed in a previous letter, presumably on the basis of his misunderstanding of the application which was shown at the beginning of page 15. Fleet is claimed to be a process for achieving nuclear fusion by laser or high energy electron beams. Two rapidly pulsed synchronized opposing beams of ionised gas e.g. deuterium/tritium are fired into a “firing chamber”, and put through a process for stripping off electrons to form a fuel gas ball, which is then ignited by a pair of lasers or high energy electron beams. The examiner claims that “combination is likely to be successful because ion beam guns have long been successfully used in the field of ion beam reactions, including ion beam fusion”. There is no evidence that nuclear fusion has been achieved either by the use of lasers or by beams of electrons.

The examiner claims that for anyone of ordinary skill in the art of beam technology for nuclear reactions, it would be obvious to use two opposing beams of heavy ions accelerated to relativistic velocities and caused to collide to their mutual self-destruction, forming collision masses into which light nuclei are introduced. This is an extremely far fetched assertion.

Page 19 Mehlich and Ruth have been disposed of above. Now Lewis 1979 has been introduced “in a patent on timing ion beams for fusion”, with or without Van der Graaff generators. The aim of this is to control ‘bunching’, bouncing off the walls etc. These are operational techniques which are used at the LHC and on the Tevatron. Their relevance to the argument is not clear.

Page 20. Nobody is claiming Van der Graaff generators as an invention. They are a known piece of apparatus. The same is true of synchrotons. Their relevance to the argument is not clear.

Page 21. Ruth and Mehlich are back again. They teach nothing of relevance to this application as shown at length above.

Finally, the examiner says that: “To one of ordinary skill it would have been entirely obvious to extract the fusion products from the housing, so as to avoid accumulation of secondary nuclear reaction products”. This is not the reason for using extraction. Extracting the carrier gas is important for removing without loss the output which generates power from the nuclear fusion process. The carrier gas protects the walls of the reactor with its streamlines, accepts the vibrations of the product and turns it into sensible heat, and transfers it as hot gas out of the reactor. If it is hydrogen, it quenches further reaction, provides a means of energy transport and storage, and finally forms another source of heat when it is burnt in boilers etc. It is not simply a “washout gas”. Those are the reasons for using extraction. Moreover there is no loss of useful heat as there would be with, say, heat exchangers.

As I wrote at the beginning, I do not think there is much left of the examiner’s objections after my analysis, apart from his opinion that the process is so novel that it will not work. This would be a novel reason for rejecting an innovation, would it not?

I intend to proceed with it.

Yours sincerely

A.C. Sturt