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

1. Literature cited by examiner:

   A. US 4,172,008 Nuclear fusion reactor. Inventor Fleet. Oct 23 1979.
   B. US 4,229,704 Method and means for measurement and control of pulsed charged beams. Inventor Lewis. Oct 21 1980.
   C. US 4,347,621 Trochoidal nuclear fusion reactor. Inventor William Dow. Aug 31 1982.
   D. US 5,729,580 Hydrogen ion array acceleration generator and method. Mar 17 1998.
   N. DE 4400851 (Espacenet) Nuclear fusion in proximity of heavy nucleus for rapid energy removal and increased probability if light nuclei collision. Mehlich Frank (DE)1 June 1994.
   O. DE 3322606 (Espacenet) Quantum energy 11. Blum Juergen. 10 Jan 1985.
   U. Controlled Thermonuclear Reactions. L.A. Artsimovich. Gordon and Breach Science Publishers, New York. Scientific Library US Patent Office July 22 1965.
   V. Plasmas and Controlled Fusion. Rose and Clark. M.I.T. Press. Scientific Library US Patent Office Oct 9 1961.
   W. 50 years of fusion research. Dale Meade. IOP Publishing and International Energy Agency, Nucl. Fusion 50 (2010) 1-14.
   X. Generic Issues for direct conversion of fusion energy from alternative fuels. Rosenbluth and Hinton Plasma Phys. Control. Fusion.36 (19940 1255-1268.

Letter from A.C.Sturt to Reddie and Grose:

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

I have read the letters and literature which you sent me, and make the following comments. First a general comment. In analysing a process it is necessary to consider not only its parts but also their sequence and interactions, because it is in these that the novelty lies. This is relevant in discussion of the innovative use of carrier gas. Secondly, I have had a further good look at the Mehlich document. The translation you sent me does not change the picture much, but I have identified a few additional points of difference.

I. Your letter of 15 September 2011.

I agree with page 1.

Page 2.

It is correct to say that the heavier rather than the lighter nuclei are accelerated in my invention. It is necessary to use heavy nuclei because their considerable combined momentum means that the head-on collision of two of them produces a collision mass with enough energy of impact to overcome their mutual repulsion, and to cause the fusion of lighter nuclei which are inside the collision mass at the time. The collision mass is composed of the electrons and protons which made up the structure of the heavy nuclei. These have very high velocities immediately after the collision, and form a sort of short-lived plasma of the sort that is known to cause the fusion of light nuclei. They collide with the light nuclei with enough energy to force them to fuse.

The use of acceleration is not necessary for the lighter nuclei; they just have to be in proximity in the right place at the right time to react with each other when the heavy nuclei collide and form their collision mass.

I use the term “nucleus” instead of ion because there are various degrees of ionisation depending on how many electrons the atom or molecule loses. In my invention I envisage that substantially all of the orbital electrons are stripped off the atom, because residual electrons orbiting around nuclei repel each other, and so prevent the nuclei from even getting close enough to each other to react with each other.

Page 2. The Mehlich document (paper N).

I agree with your suggested clarification that we should state that the “further” particles have a lower atomic number than the accelerated first and second particles, in order to differentiate my process from the Mehlich document.

However, the justification which Mehlich gives for introducing a heavy nucleus into the neighbourhood of two light nuclei is that it actually enables the light nuclei to come together by removing energy from the locus of collision, quite the opposite of my invention. He claims that this is achieved by the addition of a single heavy nucleus for two light nuclei.

In his description the reactants in the form of light atomic nuclei are scattered onto a third, heavy nucleus before the reaction. How do you scatter anything onto an atomic nucleus? It must surely mean a mixture of atoms. The reactants are then accelerated together as a “molecular ion” towards a target, and the reactants are bombarded in

“molecular” form. A “molecular ion” appears to be made by removing one of the electrons from molecular hydrogen, deuterium or tritium, each of which contains two atoms. The feasibility of accelerating such a molecule at anything like the rate required for fusion reactions is extremely doubtful. In any case, the residual electron on the “molecular ion” will prevent the nuclei from ever getting anywhere near each other, let alone fusing, by the preceding argument.

Nowhere does the Mehlich document specify the velocity to be achieved by “acceleration” or “bombardment”. The concern seems to be the spacing of particles in a target. Clearly particle velocity, and hence momentum and energy of collision, are not fundamental to the process. By contrast my process requires not only heavy nuclei but also acceleration to a velocity of a tenth or more of the speed of light. This provides the momentum which is destroyed by head-on collision, and smashes the nuclei into component particles which form the collision mass.

The description seems to switch effortlessly from nucleus to molecular ion as a convenient way of ensuring that two light nuclei are in the same location at the same time, which must be true. Unfortunately the electron which binds the nuclei into a single molecular species also prevents them from making contact with each other, which is required for fusion.

However, another essential difference is that he uses targets. In my invention there is no “target” or for that matter “missile” above the level of the independent, individual nucleus of a heavy atom. When the head-on impact occurs, there is nowhere else for the resulting energy to go, and so all is concentrated on smashing up the two nuclei involved in the collision. Hence the term “collision mass”. The light nuclei are not targets, because they collide with each other on a stochastic basis inside the collision mass, as a result of the energy of the “plasma”. This is rather like any two atomic species reacting together chemically when the temperature is high enough for them to react, though of course the collisions would have much higher energy. Thus the two heavy ions have to be destroyed and cease to exist before the light nuclei can undergo fusion. This is the opposite of the inventive step that Mehlich claims.

In addition the solid target to which the Mehlich document refers means that there must by definition be atoms adjacent to the site of impact on the target. These will immediately conduct away the heat which was intended to cause fusion, so that the target would have a warm patch where impact occurred, but no fusion would take place. This would be analogous to the effect of plasma touching the walls of a reactor in the paper V p24 cited by the examiner; the plasma would cool below that required for fusion to take place. This is the reason for using the mechanism of my invention; a collision mass is not in contact with any surface which could remove its energy while it is doing its job.

The same would be true if the target were a liquid, because the molecules are in contact with each other and make effective conductors. However, if the target was a gas i.e. literally composed of molecules like oxygen or nitrogen, the missile would not get anywhere near a nucleus, because it would be fended off by their orbital electrons, and the gas molecule would move aside. Hence my use of nuclei i.e. from which the orbital electrons have been removed.

As far as I can determine the claims of the Mehlich document are:

a. The presence of a heavy nucleus to enable fusion of two light nuclei, though the process by which all three come together is not stated.
b. A process as claimed above in which the light nuclei are bound and accelerated together in the form of a "molecular ion"' towards a target that provides "'the scattering nucleus", which is presumably the heavy ion.
c. A process in which heavy ions are used to bombard molecules containing the light reactants. It is not clear how this is done.
d. A process in which one of the light nuclei is accelerated towards a target containing the other reactant.

These points are all addressed above, but there is just one further point that may need consideration on page 3 line 11. This states that reactants i.e. light nuclei may be included in the target to increase the probability of reaction etc, which has been dealt with above. But it then goes on to say: "or vice versa" i.e. the two light nuclei may be bombarded with heavy ions. This implies that the individual light nuclei are targets, and heavy ions are accelerated at them. In this case the light nuclei are suspended by some means and the heavy ions are fired at them, but if so, there is no reason why they should have the slightest effect. The electrostatic repulsion of the nuclei will just push the light nuclei aside. By this technique there are no head-on collisions to generate additional energy from momentum, and no means of concentrating it on any locus of fusion, if there were. The result will just be a mixture. The alternative seems to be that the light nuclei are held still by some method, such as embedding them in a material while the heavier ions hit them. This is in effect a target, and that has been dealt with above.

The conclusion is that his invention is completely different from mine. I hope the change in the claim to "further particles" having lower atomic number than the first and second particles is sufficient to cover such comprehensive differences, but in any case the additional arguments may prove useful in any dispute.

Page 2. The Fleet document (paper A).

The process described in this document is basically laser-induced nuclear fusion. This is quite different from my invention which is nuclear fusion in what may be seen as a free-standing, molecular-size plasma.

Opposing beams of ionised gas e.g. deuteron/tritium are fired into a "firing chamber" to form a fuel gas ball. Electrons appear to be stripped off in the process, and so the fuel ball is composed of nuclei; they cannot be said to be a "gas" in the normal sense of the term. The quoted velocities are less than a tenth of those in my invention, and since they are light ions the momentum and energy of collision will be far less than that of the heavy ions in my invention. This will not be enough to cause fusion, which is admitted in the text. So the stated function of the process so far is to strip off orbital electrons and prepare fuel for the next step, which is fusion by lasers.

Lasers operate by stimulating the interaction between nuclei and their orbital electrons; this is implicit in the "wavelength" of the laser. However, the orbital

electrons have all been stripped off in the preceding process. I cannot see how lasers would raise the temperature at all, let alone cause fusion. In fact the most likely outcome is destruction of the fabric of the firing chamber, because that is where the orbital electrons are located. Neither would the other method of causing fusion work: the injection of high energy electron beams. The most likely result of that would be the association of such electrons with nuclei to form atoms i.e. back to square one. The assertion that either of these processes would cause nuclear fusion has to be justified, but in any case it is quite different from my invention.

On the other hand, fusion by plasma in bulk has already been demonstrated to work, and it would make a viable process, if only you could prevent it from consuming the reactor too. Much effort is being expended to this end. The process of my invention overcomes this problem by avoiding the use of bulk materials and concentrating the reaction in transient, isolated "collision masses" which have masses comparable to those of a couple of heavy nuclei.

There is the question of the use of a carrier gas which I claim in claims 1, 15 and 16, and subsequent claims 19 and 23. The function of the carrier gas in my invention is to carry away the heat produced by fusion i.e. it is a sequential step that succeeds the fusion reaction, as shown in the diagrams. The carrier gas is mixed with the products of fusion i.e. after fusion has taken place. If it were present before nuclear fusion had taken place, it would inhibit the reaction. I envisage that the carrier gas mixture would probably be sucked out of the reactor in streamlines, rather like a jet engine. I know of no other process which comprises the use of a carrier gas in molecular form to remove heat immediately and continuously from a process of nuclear fusion in an accelerator-fed reactor.

Gas such as carbon dioxide has been used to cool conventional nuclear fission reactors by simply circulating it through piles. The over-riding property of such a gas on safety grounds is that it must not support combustion. However, gaseous heat extraction from a nuclear fusion reaction is quite different. The only use of gas in previous nuclear fusion reactions of which I am aware is as the fuel i.e. in the hydrogen bomb, hardly an economic process of heat production. The innovative feature of my invention lies in the entirety of the process which produces useful heat from the nuclear fusion; what is new is the interaction of the method of heat removal working with the method of achieving nuclear fusion. It is the combination of the two processes which increases the economic utility of the whole beyond what either contributes separately. Moreover, with my process it is safe and desirable to use a carrier gas which is combustible, because not only can energy be extracted from its heat, but it can also give additional heat when it is burnt in air. The final advantage is that the product of combustion is simply water, which has its own economic value and which is easily disposed of. This is why extraction as in claim 16 is a necessary part of the invention, rather than simple recycling which is done with carbon dioxide. Hydrogen is part of the unique output of the process.

So compare the Fleet method using conventional heat extraction! The stated claim of the Fleet document is "a method of providing a nuclear fusion reaction". As far as I can see, if the process works, the result is a reactor with very hot casing. Column 7 at the top of the page says: " With these temperatures, the square law distribution will reduce the surface to the order of magnitudes that can be tolerated by the firing

chamber." Heat is recovered from the apparatus through conventional heat exchange using liquid sodium etc. Such processes can never be 100% efficient, because there are always thermodynamic losses between the successive stages of this sort of heat transfer.

By contrast, the stated title of my invention is "a method and apparatus for heat production". The reaction is comparatively cold, at least until the fusion products reach the carrier gas and transfer much of their vibrational energy. The carrier gas consists of molecules, particularly molecular hydrogen. This can be successively diluted with more molecular hydrogen gas without loss of thermal energy until it reaches a temperature useful for processing. Such dilution increases the volume of useful gas, which is an economic advantage. Nothing is lost by the dilution; the result is just a more plentiful output of hot gas.

Thus the output of the process as a whole is hot gas, composed mainly of hydrogen. The heat can be harnessed in its own right in turbines, heat engines etc, and when that has been completed, the hydrogen can be piped around without loss and then burnt as a fuel where it is needed using the oxygen of the atmosphere, which is free.

Under the circumstances, I do not think the Fleet document is relevant to my invention.

Page 2. The other patents cited.

I have checked through the other patents cited, and as far as I can see they have no bearing on my application.

Page 2. Modified claims.

I have looked through the modified claims, and they seem all right to me. I assume the squiggle in claim 23 refers to claim 21.

II. Draft letter to the US attorney.

I have looked through your draft letter to the US attorney, and have the following suggestions to make.

On page 3 paragraph 2 we need to clarify the wording of the second paragraph which states that the carrier gas cools the fusion. This may imply that it takes part in the fusion process, but as described above it would in fact inhibit the fusion process. I suggest replacing the words "The reaction is controlled by … this way of performing fusion." by the following:

"A carrier gas is introduced to provide an economically useful method of extracting heat from a nuclear fusion reaction."

On page 4 paragraph 4 after "nothing like as damaging as plasma" you might add at the end:

"… and can itself be diluted successively with more molecular hydrogen or other gas without reducing the quantity of useful heat produced".

The point of this is that some heat energy is always lost in heat transfer apparatus, but not in my process. Nothing is lost by dilution, which is the advantage of having an output in the form of a gas, especially a combustible gas such as hydrogen. And so at the end of the paragraph, you might add the comment that:

"Oxygen is as free as air".

Why not? It is quite an advantage, which other methods do not have!

On page 5 paragraph 3 last sentence "As there are no neutrons, no radioactivity is produced", add the qualification "in the product". So change to:

"As there are no neutrons in the product, it contains no radioactivity."

On page 5 paragraph 6 add a comma after "expensive", or it may give the impression that the specialised detectors measure the quantity of gas produced, and so are not needed. So just to clarify:

"… without the need for the specialised detectors which are very expensive, and simply measure the quantity …"

On page 5 paragraph 7 at the end it might be worth stating that this temperature reduction has the same effect as described in the paper V cited by the examiner p 24, in which plasma is rendered ineffective by contact with the walls of the vessel.

On page 5 last paragraph, too many "finallys"! There is another one on page 6. You could probably ditch this one.

Finally (!) on claims 15 and 16, it might be worth making the point that according to the above analysis they are essential and innovative in my nuclear fusion process, and the claims need to be retained. The examiner may have had fission reactors and carbon dioxide in mind when he ignored claim 16. We should also make the point that velocities are not specified in the Mehlich document, and the momentum and energy produced by velocities comparable to the speed of light do not feature in at all.

I trust this analysis covers everything raised.

Yours sincerely

A.C.Sturt