

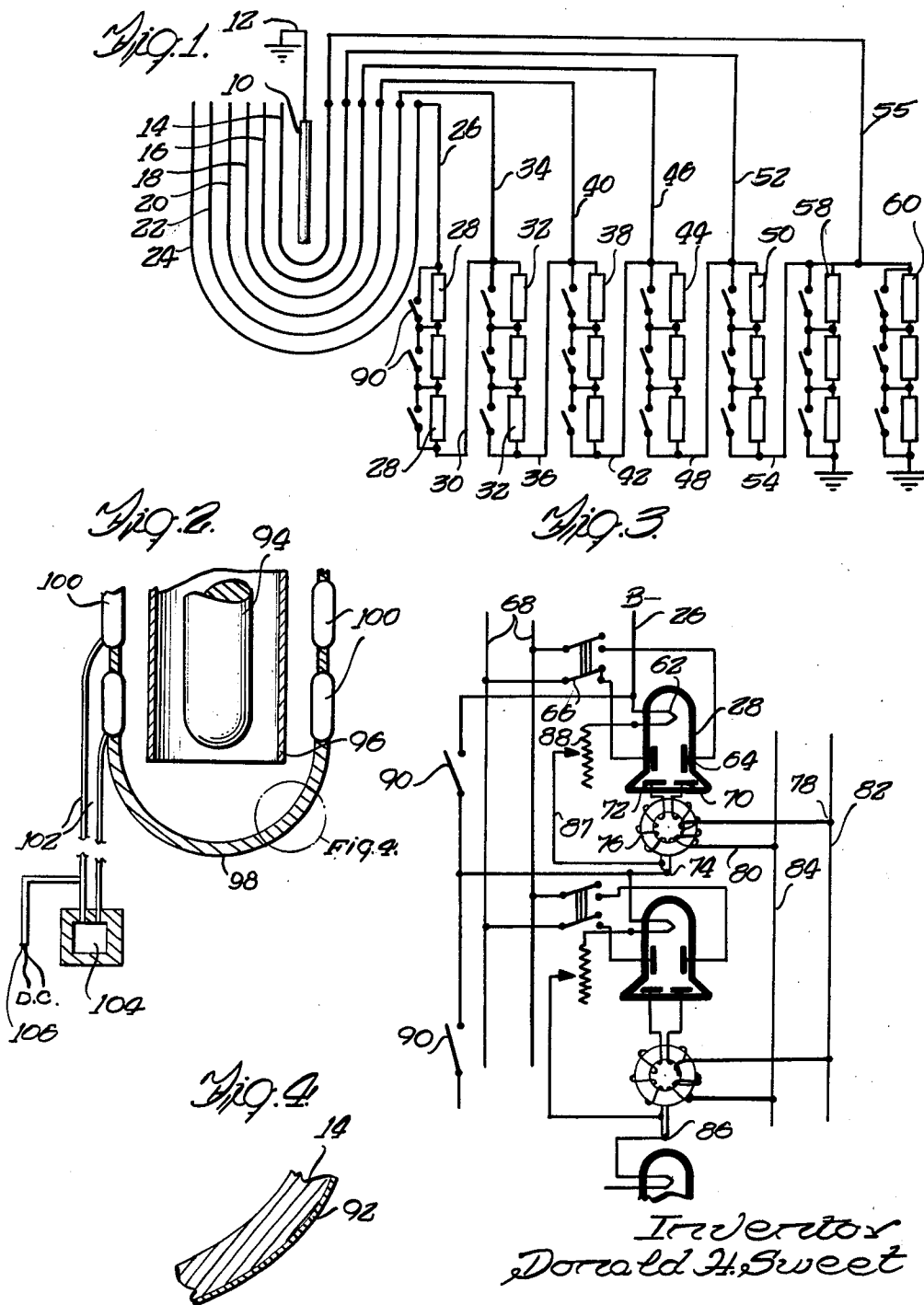
April 13, 1965

D. H. SWEET

3,178,631

ATOMIC POWER PLANT

Filed Oct. 23, 1959



1

3,178,631

ATOMIC POWER PLANT

Donald H. Sweet, 1033 Hinman Ave., Evanston, Ill.

Filed Oct. 23, 1959, Ser. No. 848,443

9 Claims. (Cl. 322-2)

My invention relates to the generation of power, and includes among its objects and advantages the derivation of power in the convenient form of an electric current, directly from a suitable electron source, substantially without major thermal effects.

In the accompanying drawings:

FIGURE 1 is a circuit diagram of a power plant according to the invention;

FIGURE 2 is a fragmentary section of a modification on a plane containing the axis of the source;

FIGURE 3 is a circuit diagram of cascaded cathode ray tubes and transformers; and

FIGURE 4 is a greatly enlarged section of the area indicated in the dotted lines in FIGURE 2.

In the embodiment selected to illustrate the invention, the source 10 is a source of negative electrons, which may emanate from the source with varying energy contents, including extremely high velocities. Specifically, such material is at present being produced by atomic fission and is accumulating in large quantities and constituting a serious problem of waste disposal. Such fission residues commonly include highly radio-active isotopes including many elements that are transition elements in the periodic system and extremely rare in nature. They might become useful resources if they could be eventually salvaged in commercial concentrations in the form of the stable isotopes to which they will eventually decay.

Physically, these residues are of a predominantly metallic nature, but it is not necessary that the rod 10 composed of them be of any significant structural strength. It is sufficient if the material is compacted enough to hold its shape under its own weight, and where that is inconvenient, the source 10 can be a tube or canister filled with pulverulent radioactive material. I have indicated the source 10 connected to ground through a conductor 12.

Surrounding the source 10, I provide a multiplicity of enclosing envelopes of conductive material, of which I have illustrated six, 14, 16, 18, 20, 22 and 24. From the outermost envelope 24, a conductor 26 delivers current to a cascade of three directifying units 28.

It will be apparent that if each of the successive envelopes is kept at a strong negative potential with respect to the envelope next inside it, the outer envelope 24 will be at the maximum negative potential. This negative potential will be available to induce a flow of current through the directifiers 28. From the positive terminal of the first cascade of directifiers 28, a conductor 30 extends to the negative terminal of a second cascade of directifiers 32.

The second cascade of directifiers 32 duplicates the cascade 28 except that it operates at a different electric potential higher than the negative potential of envelope 24 by reason of the potential rise through the cascade 28. The next envelope, 22, is also connected to the negative terminal of the second cascade 32 by a conductor 34. Similarly, conductor 36 continues the circuit to the negative terminal of the cascade 38, and envelope 20 is connected in by the conductor 40. To complete the series conductor 42 goes to cascade 44, which also receives additional current from envelope 18 through conductor 46. Conductor 48 continues the circuit to cascade 50 and receives additional current from envelope 16 through conductor 52. Conductor 54 continues the circuit and re-

2

ceives additional current from envelope 14, through conductor 55.

Conductor 55 delivers to two cascades 58 and 60 arranged in parallel, and both these cascades are connected to ground.

It will be apparent that electrons collected by envelope 24 at maximum negative potential will deliver a first increment of energy in passing through cascade 28. Then they will be joined by the electrons collected by envelope 22 and the increased current will deliver another increment of energy in passing through cascade 32. Thus the current in each cascade is greater than the current in the previous cascade, but the voltage increments need not necessarily be uniform. Rather, they will conform to the velocity emission spectrum of the source 10.

It will be obvious that if three directifiers are inadequate to take up the potential drop between one envelope and the next, the number of directifiers can be increased indefinitely, depending on the optimum voltage load for the type of directifier employed and the total voltage drop between successive envelopes. I have illustrated the cascades all of the same length, but it will be obvious that the spectrum of the source may be such that some of the cascades should be materially longer than others.

The successive increments in amperage may cumulate until directifiers of convenient size can only carry part of the load, and I have illustrated the load over the final cascade to ground potential, subdivided between two cascades 58 and 60 in parallel.

Directifiers as such are well-known in the art, as typified by the patents in Class 321, Electricity, Conversion Systems; Subclass 34, Current Conversion, Directifying.

787,228, Steinmetz, Apr. 11, 1905

1,390,727, Schenkel, Sept. 13, 1921

2,611,090, Wolff, Sept. 16, 1952

2,619,622, Johnson, Nov. 25, 1952

2,730,669, Webster, Jr., Jan. 10, 1956

are mentioned as illustrative.

In FIGURE 3, I have indicated a specific arrangement of cathode ray tubes especially adapted for the directification required. The B-minus terminal 26 is connected direct to the cathode 62 of the first tube 28, and the current inside the tube may be deflected in conventional ways, as by the potential plates 64 connected, through the two-pole switch 66, with power lines 68 from a suitable source of timing current of relatively insignificant power. The oscillating potential of the plates 64 will deflect the ray from side to side to impinge first on the right hand target 70 and then on the left hand target 72. From each of these targets a winding extends to a delivery point 74, being wound on a closed circuit magnetic core 76, but one of the windings is wound to generate a magnetic field in one direction and the other generates a magnetic field in the opposite direction. Power delivery terminals 78 and 80 are at opposite ends of a take off winding on the same core 76 and deliver power to the power mains 82 and 84.

The next cathode ray tube 28 merely duplicates the one previously described and receives the same current from the point 74 and delivers at a lower potential at the point 86, and so on to the end of the cascade.

A suitable design for the cathode ray tubes will involve a very small charge of gas in each tube, and with the values properly selected the cathode may be sustained in temperature by the main current. However, for starting and controlling purposes I provide an exciting circuit. The conductor 87 and the adjustable resistor 88 connect the cathode 62 direct to the delivery point 74. At the time of starting, this circuit may be completely open by moving the slide contact beyond the end of resistor 88, and the operation of the tube may be initiated by heat-

ing the tube until the tube fires, after which the separate excitation may be reduced or discontinued.

I have indicated short-circuiting switches 90 for all the rectifiers, and when the power plant is not in use all the switches 90 will be closed and such electrons as the envelopes may happen to collect will find their way back through ground. However, collection will be at a minimum because all the envelopes remain at ground potential.

The opening of any switch 90 in any cascade except 58 and 60 will immediately interrupt this flow and the electrostatic capacity of the envelopes and the parts between the envelopes up to the break in the return circuit is very small, so that the potential drop across the break in the circuit will build up until the associated rectifier fires. Thus the condition for maximum load will be with all the switches 90 open.

It will be obvious that the potential drop between successive envelopes must be resisted by adequate insulation. The best insulation is a hard vacuum, obtained by inclosing all the envelopes in a sealed housing and evacuating the housing.

Each envelope constitutes a wall of conductive material adapted to maintain the negative potential imparted to it by the operation of the plant, and it is this negative potential against which the high velocity electron travels until it has been slowed down enough to be intercepted and come to rest in the metal of one of the envelopes. The metal of the envelope 14 may be of tungsten or steel if operation must be at high temperatures. But where the temperature permits, lead is the material of choice, and, whatever the material used for the main body of the intercepting wall, it is desirable to coat the side remote from the source with a backing layer including appreciable amounts of germanium, or some other electron acceptor. In FIGURE 4, I have indicated such a backing at 92.

The emanations from the source may also generate a good deal of heat. This is likely to be especially true when the source is a mixture of miscellaneous fission products, some of which decay by emitting particles other than electrons. In FIGURE 2, I have indicated a rod 94, which may be about 4" in diameter and of plutonium. Stockpiled plutonium decays slowly to thorium, but its beta radiation is concentrated at about 0.78 mev. For such radiation, the single, first envelope 96 should be very thin and held at about 0.70 mev., while the outer envelope 98 can be much thicker, and held at the maximum potential the source can impart to it.

Because these potentials are a function of the rate at which the source puts electrons into the shield, and the rate at which the path back through the cathode ray tubes lets them leave the shield, the working voltage is automatically self-regulating, and complete control involves only adjustment of return path resistances and counter E.M.F.'s. A short circuit to ground by closure of all the switches 90 will reduce the voltage to substantially zero without any corresponding increase in current, because the current cannot exceed the total electron emission of the source.

Each increment of resistance added to the return path will raise the shield potential without a corresponding reduction in current, until the top shield potential is high enough to stop all the emitted electrons. After that, further increase in resistance will reduce current, and power, with top voltage still present.

The outer envelope 98 includes, over a major portion of its area, packets 100 of multiple thermo-couples connected through cables 102 with cold junction units 104, and arranged to deliver direct current energy at terminals 106. The amount of power derived may be material although it will be an insignificant fraction of the power developed in the cascades of cathode ray tubes. Delivery of power from the packets 100 will lower the temperature of the packets and in this way the heat energy unavoidably

developed can be taken out so as to prevent extreme temperature rise, and make it possible to use materials that cannot function at high temperature.

Others may readily adapt the invention for use under various conditions of service by employing one or more of the novel features disclosed, or equivalents thereof. For instance, an evacuated chamber for the shields of FIGURE 1 will normally need to include arms, radiating away from each other far enough to enable conventional insulating materials to prevent arcing where the leads leave the chamber. In some instances, mechanical problems in getting the intermediate shields thin enough to minimize interception of electrons passing through, may be alleviated by making them of aluminum foil, or preferably beryllium, and by perforating the foil with a multiplicity of holes of diameter up to about half the linear distance out to the next shield.

As at present advised, with respect to the apparent scope of my invention, I desire to claim the following subject matter:

1. Power generating equipment comprising, in combination: a primary electron source of electrons of high potential; means for transforming the flow of electrons from said source into a uni-directional current in a conducting medium; said means comprising a conductive shield substantially enclosing said source; means for keeping said shield at a negative potential sufficient to arrest and collect significant numbers of the electrons emanating from said primary source; return means for returning collected electrons from said shield to said source; and power receiving means adapted to derive power from the current flowing in said return conductor means; said conductive shield including a series of shield elements; the first element being adjacent to and substantially enclosing said primary electron source; each succeeding shield element enclosing all the previous ones; said return conductor means being adapted to maintain predetermined potentials in all said shields; each shield being kept at a predetermined negative potential with respect to the adjacent shield inside it; said power receiving means being adapted to generate counter electromotive forces in said return conductor means; said counter electro-motive forces being the chief agent maintaining said predetermined controlled negative potential.

2. Equipment according to claim 1, in which said power receiving means is a D.C. to A.C. converter activated by the direct current received, and delivering the received energy in the form of alternating current.

3. Equipment according to claim 2, in which power receiving means is connected in circuit between each shield and the next element inside it.

4. Equipment according to claim 2, in which said converter is a plurality of converter units connected in a cascade; each unit adapted to maintain its pro-rata share of the predetermined pressure drop for the cascade.

5. Equipment according to claim 4 in which a manually operable short-circuiting switch is connected in shunt around each converter unit; whereby closure of all said short-circuiting switches brings the potential of said shield to ground potential, and no power is developed.

6. Power generating equipment comprising, in combination: a primary electron source of electrons of high potential; means for transforming the flow of electrons from said source into a uni-directional current in a conducting medium; said means comprising a conductive shield substantially enclosing said source; means for keeping said shield at a negative potential sufficient to arrest and collect significant numbers of the electrons emanating from said primary source; return conductor means for returning collected electrons from said shield to said source; and power receiving means adapted to derive power from the current flowing in said return conductor means; at least a material portion of the area of said shield being made up of thermocouple elements; and means for withdrawing electrical power by current gen-

5

erated by said thermocouple elements; whereby the temperature of the shield is reduced.

7. Power generating equipment comprising, in combination: a concentrated source of electronic radiation; a first shell enclosing said source; a second shell enclosing said first shell; a first potential control means for setting up in said first shell a potential differing from that of said source to arrest radiation up to the potential of said shell; a second potential control means for setting up in said second shell a potential differing from that of first shell to arrest radiation passing through said first shell, up to the potential of said second shell; said potential control means consisting of transformer means adapted to receive direct current passing from said second shell to said first shell and generate alternating current, and delivering the remaining potential energy received from said second shell to said first shell in the form of direct current at the potential of said first shell; said first potential control means being connected to said first shell and receiving from said first shell the amperage collected by said second shell plus the amperage collected by said first shell; said first transformer means being adapted to deliver alternating current and to deliver its received amperage substantially at source potential.

6

8. Equipment according to claim 7 in combination with one or more additional similar shells, each shell similarly associated with the shell next inside itself, and each adapted to arrest an additional increment of radiation; up to a maximum potential near the end of the radiation spectrum of said source.

9. A combination according to claim 8 in which said transformer means are adjustable to vary the increments arrested, to distribute the collection load between said different shells, to fit the radiation spectrum of said source, and to alter said increments as said source decays and its spectrum changes.

References Cited by the Examiner

UNITED STATES PATENTS

1,390,727	9/21	Schenkel	321—35
2,651,730	9/53	Linder	310—30
2,730,669	1/56	Webster	321—35
2,847,585	8/58	Christian	310—3

LLOYD McCOLLUM, *Primary Examiner.*

ORIS L. RADER, MILTON O. HIRSHFIELD,
Examiners.