Sept. 20, 1960 A. C. DUCATI 2,953,718

APPARATUS AND METHOD FOR GENERATING HIGH TEMPERATURES

Filed May 1, 1958 2 Sheets-Sheet 1

Fig. 1.

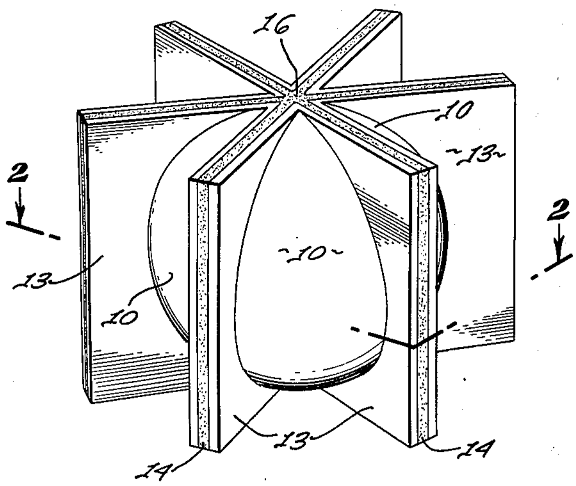


Fig. 3.

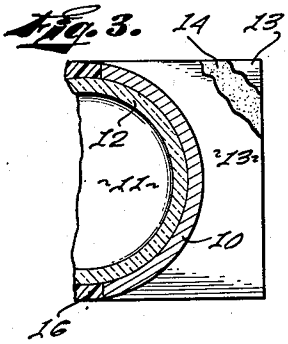
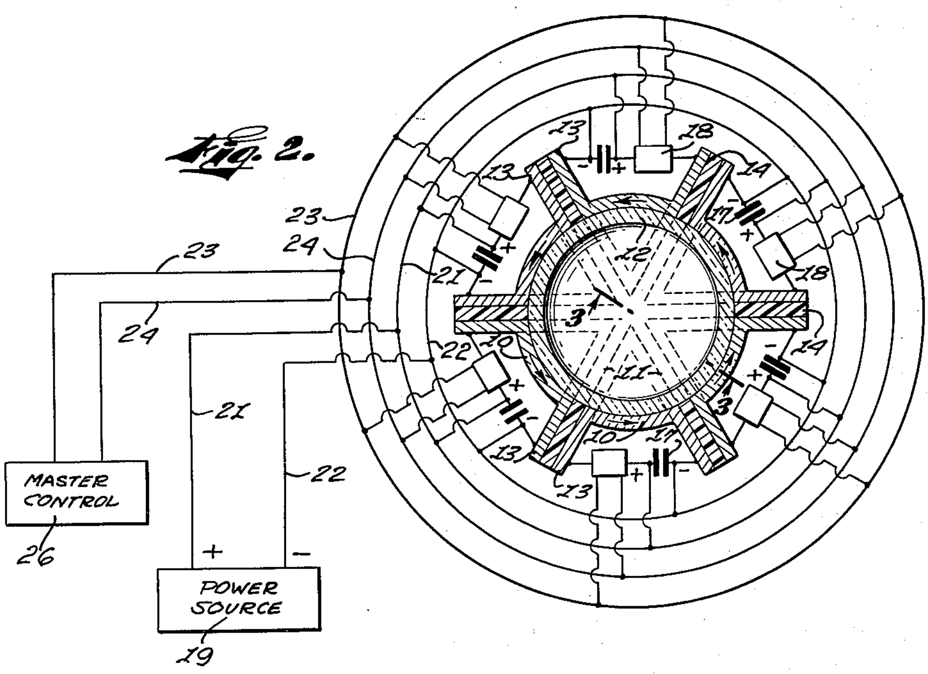


Fig. 2.



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Filed May 1, 1958 2 Sheets-Sheet 2

Fig. 5.

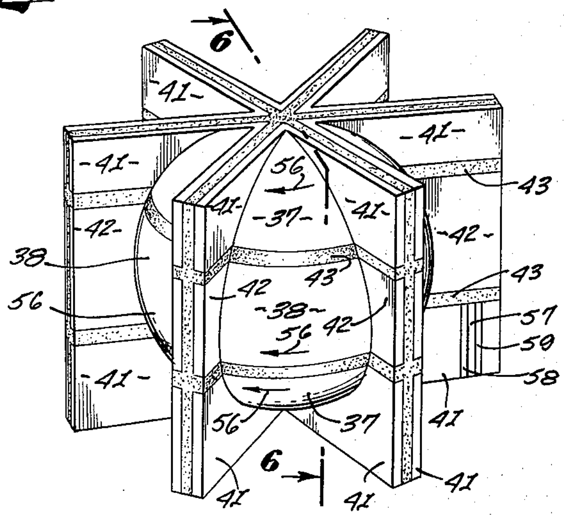


Fig. 8.

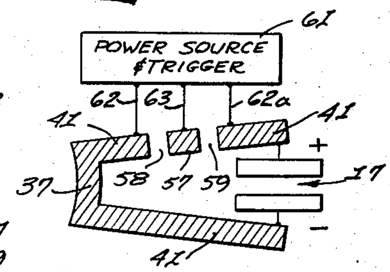


Fig. 4.

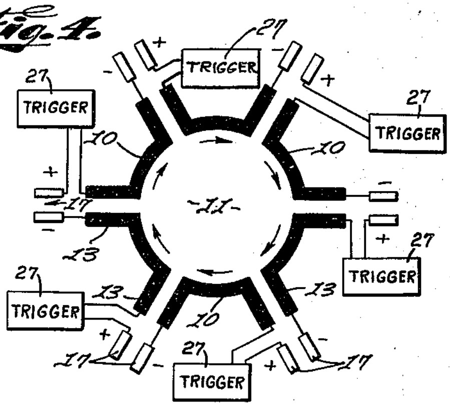
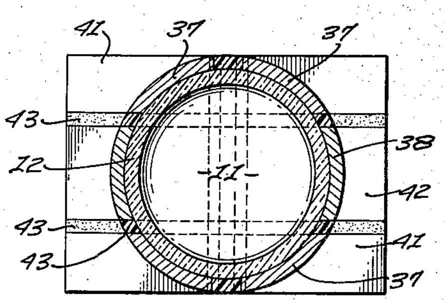


Fig. 6.



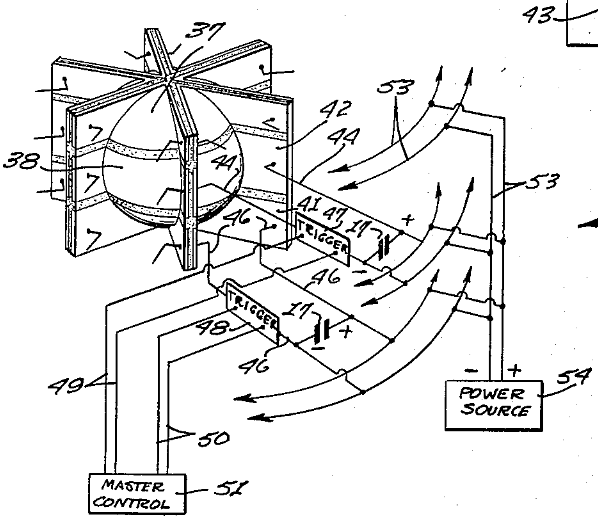


Fig. 7.

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United States Patent Office

2,953,718

Patented Sept. 20, 1960

1

2,953,718

APPARATUS AND METHOD FOR GENERATING HIGH TEMPERATURES

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Filed May 1, 1958, Ser. No. 732,304

11 Claims. (Cl. 315—163)

This invention relates to an apparatus and method for generating high temperatures, and high-intensity light. The invention pertains to the general field of discharge-type devices for generating momentarily temperatures measured in millions of degrees.

Discharge-type devices of the class indicated may be divided into those employing electrodes, and those effecting a discharge in space. Devices employing electrodes present substantial problems of contamination due to the vaporization of electrode material. This produces, particularly in the case of repetitive operation, detrimental effects because of the high radiation capabilities of vapors of impurities. It follows that a large amount of the energy stored in the discharge is dissipated in the form of radiation, thereby reducing the effective temperature of the gas.

With relation to devices which effect discharges in space, that is to say without electrodes, these conventionally consist of a toroidal chamber which produces, in conjunction with magnet means and by virtue of a pinch effect, a toroidal plasma concentration of filament-like dimensions. The energy stored in this pinch of plasma is readily radiated because of the geometry of the apparatus. For this and other important reasons, such apparatus has been characterized by limitations as to the maximum temperature which may be achieved, it being difficult to supply energy at a rate sufficiently fast to permit the attaining of ultra high temperatures. Other limitations and defects of such toroidal-type plasma devices have included a relative instability of the plasma.

In view of the above factors characteristic of discharge-type devices for obtaining extremely high temperatures, and intense sources of light, it is an object of the present invention to provide a method and apparatus for generating, in the absence of electrodes, a volume of plasma sufficiently small that its ability to accept energy may be matched to the rate of addition of energy required for reaching the desired temperature.

A further object is to provide a method and apparatus for achieving a discharge in a very small volume, approaching a point.

Another object is to provide apparatus and method for achieving very high temperatures through the use of three-dimensional implosions created by three-dimensional magnetic fields of predetermined shapes.

A further object of the invention is to provide novel shaped cavities for the production of three-dimensional magnetic fields.

Another object of the invention is to provide novel apparatus for producing pulsed magnetic fields, such apparatus having extremely low inductance in order that the rate of change of magnetic field strength will be very great.

Another object of the invention is to provide an apparatus and method for achieving a very dense concentration of ionized particles in a space which approaches a point, through the use of a generally spherically imploding shock wave.

2

These and other objects and advantages of the invention are more fully set forth in the following specification and claims, considered in connection with the attached drawings to which they relate.

In the drawings:

Figure 1 is a perspective view of one form of apparatus constructed in accordance with the present invention, characterized by a plurality of lune-like elements each of which is electrically connected to a plurality of generally radial plates;

Figure 2 is a horizontal section taken on line 2—2 of Figure 1 and showing, in schematic form, one electrical circuit adapted to be associated with the apparatus of Figure 1;

Figure 3 is a fragmentary section on line 3—3 of Figure 2;

Figure 4 is a schematic view corresponding generally to Figure 2 and showing a second type of electrical circuit associated with the apparatus;

Figure 5 is a schematic view corresponding roughly to Figure 1, but showing a modified form of apparatus in which the lune-like elements are cut into sections such as spherical triangles and spherical rectangles;

Figure 6 is a vertical section taken on line 6—6 of Figure 5;

Figure 7 is a view illustrating, in fragmentary schematic form, one type of electrical circuit for association with the structure shown in Figures 5 and 6; and

Figure 8 is a fragmentary schematic view illustrating one form of trigger or switching device for initiating the flow of current through the apparatus.

Stated generally, the present invention achieves ultra high temperatures, and provides an intense light source, by creating a relatively dense concentration of ions (and electrons) at a point, or a small volume approaching a point, instead of a somewhat uniform concentration along a line as in the case of toroidal structures. This is accomplished by creating a three-dimensional implosion in a specially shaped cavity, through the use of pulsed magnetic fields of great strength. An important aspect of the invention is in the provision of apparatus having a very low inductance, and high current-carrying capacity, in order that the rate of change of magnetic field strength may be very great. The resulting point-like electrodeless discharge is highly stable and is capable of accepting energy at a rate greater than the rate at which it radiates energy, so that extremely high temperatures are achieved.

The apparatus of the invention comprises, in general, electrical conductor means shaped and disposed in such manner as to define a generally spheroidal cavity. The cavity may be oblate, prolate, or other variations from true spherical, in order to achieve the most advantageous distribution of the three-dimensional magnetic field which is generated when current is passed through the conductor means. The cavity should be evacuated to a relatively high vacuum. The conductor means are such that inductance is reduced to a minimum, thereby increasing the rate of change of magnetic field strength, with consequent rapid inward acceleration of ionized particles to create an imploding shock and a very high temperature at the center. The temperature is obtained because of the high speed of the ions (and electrons), and the collision thereof, and because the discharge is achieved in such a small volume that it is incapable of radiating energy as fast as it receives it.

As employed in the present specification and claims, the term "spheroidal" is intended to mean not only geometrical shapes which approach spheres, such as oblate or prolate spheroids, but also to include true or perfect spheres. The term "lune," and other expressions employed in spherical geometry, are intended, in the present specification and claims, to include not only the perfect geometrical shape but also approximations thereof. It is to be understood that variations from true spherical, etc., may be desirable in order to achieve optimum magnetic field distribution and strength. Furthermore, in embodiments in which the electrical conductors which form the cavity are separated into a number of components, it may be desirable to effect current flow through various components at different times, within a very short time interval, and to vary the shapes of the components in accordance with the times at which currents are passed therethrough.

The entire apparatus for generating very high temperatures includes a load, electrical connections to the load, and power supply means to supply a pulse of current to such electrical connections. Reference will first be made to the load which is shown in Figures 1-3, and comprises a plurality of corresponding lune-like elements **10** having a common axis. The number of elements **10** may be very large, but only six have been shown in the present illustration. Each element **10** is formed of a good electrical conductor capable of carrying a high current, for example relatively thick copper. The elements **10** are assembled together in order to form a complete sphere or spheroid, and are rigidly and strongly mounted in any suitable manner. For example, mounting may be achieved by supporting the lune elements **10** in a thick mass of insulating material having a high strength. Such insulating material may be jacketed and encased with steel, or other strong material, at a location remote from the sphere.

Lune elements **10**, when assembled as indicated, define a cavity **11** which, in the illustration, is a perfect sphere but which may be spheroidal as previously stated. Thus, in the illustrated embodiment both the external and internal surfaces of each element **10** are lunes of spheres having a common center and different radii. The lunes **10** are shown as being shaped correspondingly to each other, but it is within the scope of the invention to make lunes of different angles when such is desirable in order to achieve optimum magnetic field conditions.

The cavity **11** may be small, such as a few inches in diameter, and should be evacuated to a substantial vacuum. Small amounts of gases may be introduced into the cavity **11**.

In the illustrated embodiment, an envelope **12**, shaped as a hollow sphere, is mounted in the cavity in order to facilitate evacuation thereof. The outer surface of the envelope **12** is preferably in engagement with the interior surfaces of the lunes, so that maximum efficiency is achieved. It is within the scope of the invention to eliminate the evacuated envelope **12** and substitute a sealing means for permitting evacuation of the cavity **11**.

Proceeding next to a description of the connector means for delivering current to the lunes **10**, these comprise plate-elements **13** which lie generally in planes each of which contains the axis of lune elements **10**. A plate-element **13** is connected, for example integrally, at each edge of each lune element **10**, and extends generally radially therefrom in the plane indicated. Plate-elements **13** are also formed of good electrical conductors, and may have thicknesses corresponding to that of the lune elements. Elements **13** terminate, at their upper and lower edges, relatively adjacent the poles of the lune elements.

Sheets of insulating material, indicated at **14**, are provided between the plate-elements **13** for adjacent lunes, and also between the edges of the lunes, in order to maintain the lunes **10** and the plates therefor electrically separate. The insulating material **14** may be of any suitable construction, and should be relatively thin in order that the adjacent plates **13** may be disposed generally parallel to each other and close together. At the poles of the apparatus, the insulating material comes together at insulating caps **16**.

It is pointed out that the plate-elements **13**, instead of lying exactly in radial planes from the common axis of the lunes **10**, should extend parallel and adjacent each other. This is because, as will be described subsequently, the current in adjacent plates **13** flows in opposite directions and provides an inductance-cancelling or minimizing effect when the plates are relatively close together. Such minimization of inductance is, as previously stated, extremely important since it is necessary to pass very large currents through the plates **13** and lunes **10** in a very short period of time in order that the requisite rate of change of magnetic field strength may be achieved. Thus, the current flowing through the plates and the lunes should be on the order of millions of amperes, and the current flow should only continue for a very short time interval.

Circuit of Figure 2

Referring particularly to Figure 2, the power supply means previously referred to, including the switching means therefor, is shown in highly schematic form. The illustrated circuit is one in which the lune elements are connected in what may be termed parallel or independent relationship, the flow of current therethrough being entirely separate. The power supply comprises a plurality of capacitors **17** which are connected, respectively, to the outer ends of the plate-elements **13** for each lune **10**. The discharge of each capacitor **17** through the assocoated plate element **13**, and thus through the associated lune **10**, is controlled by suitable switch or trigger means **18** which are, in each instance, connected in series with a capacitor **17**. It is emphasized that the showing of Figure 2 is highly schematic as to the capacitors **17** and trigger means **18**, since each capacitor **17** may be very large and may comprise, for example, a large number of plates separated by dielectric. Capacitors **17** are of the low-inductance type, and are so connected to the outer ends of plates **13** that inductance is maintained at a minimum.

Capacitors **17** are connected to a power source **19** by means of leads **21** and **22**. The power source may be of any suitable type adapted to supply a direct voltage to the capacitors. Trigger means **18** are associated, through leads **23** and **24**, with a master control **26** adapted to effect discharge of the capacitors at the desired times. It is to be understood that the capacitors may be charged in a number of ways, for example independently from a number of power sources.

The polarity of capacitors **17** is so selected that the current flow through each separate lune circuit will be in the same direction. Thus, assuming that leads **21** are charged positively and the leads **22** negatively, as indicated, the capacitors **17** will each discharge in such manner as to produce a clockwise flow of current through the individual lunes **10**, as viewed in Figure 2. Such clockwise flow of current is, in each instance, through a circuit comprising the capacitor **17**, trigger means **18**, one plate **13**, the lune **10**, the other plate **13** and back to the capacitor.

As indicated by the arrows in Figure 2, the current flowing upon discharge of capacitors **17**, in the indicated example, is such as to simulate a counterclockwise flow of current (Figure 2) around the axis of a continuous sphere as distinguished from a sphere which is actually divided up into a number of lunes. If each capacitor **17** is initially charged to the same voltage, and assuming that the capacitors **17** correspond to each other, it will be understood that upon simultaneous operation of all trigger means **18** the current flow through the lunes **10** will simulate a continuous current flow around the axis of a continuous sphere or a spheroid. When the currents are very high, the strong magnetic field produced by the current flow causes a breakdown of the gas at the center portion of the evacuated cavity **11**, so that a small area at the center of the cavity **11**, approaching a point, becomes extremely hot and provides an intense source of light.

Stated more definitely, the breakdown at the center of the cavity **11** is caused by an implosion, that is to say by a radially inwardly directed shock wave resulting from the very dense magnetic field. There is, in other words, an inwardly directed, concentric spherical blast of ionized particles. Since the rate of change of magnetic field strength is extremely high, because of the low inductance and the large amounts of current employed, the ionized particles accelerate rapidly toward the center. The rapid acceleration of the particles, and the collision thereof, produce the high temperature in a relatively small zone near the center.

Dividing the sphere into a number of lunes **10** has the effect of reducing inductance, and permitting the use of a large number of power supplies for the single sphere. The permissible current range is thus greatly increased as compared to apparatus in which there is a single electrical circuit around a substantially continuous sphere. The described apparatus has the further important advantage that there is little or no inductance in the plate-like elements **13**. With the described polarities, current flow in adjacent plates **13** is in opposite directions, so that an inductance-cancellation effect is achieved. This is particularly true when the plates **13** are relatively close to each other, as indicated.

Circuit of Figure 4

Proceeding next to a description of Figure 4, the apparatus is the same as that shown in Figures 1–3 except that the capacitors **17** and lunes **10** are connected in series instead of parallel. Thus, one side of each capacitor means **17** is connected to one plate **13**, and the other side of such capacitor means is connected to the adjacent plate **13** for the next lune **10**. A trigger **27** is employed for each capacitor. The triggers may be interposed respectively between the capacitors and the associated plates **13**. Alternatively, each trigger may be incorporated in a plate **13** itself, as will be described in connection with Figure 8. The capacitors **17** are all charged from a suitable D.C. power source, or power sources, and the polarity is made such that the capacitors **17** have corresponding charge. Thus, in the illustration, the advance sides of the respective capacitors **17**, in clockwise direction, are charged positively whereas the trailing sides are charged negatively. The use of many series-arranged triggers **27** produces the advantage of reducing the voltage impressed across each.

To generate the extremely high temperature in the cavity **11**, the triggers **27** are operated simultaneously to close the series circuit. The capacitors **17** then discharge simultaneously in series, to produce in the lunes **10** currents which flow clockwise about the periphery of the evacuated chamber **11**, as indicated by the arrows. The effect is substantially the same as was stated in connection with the previous embodiment. It is pointed out that the current flow through the plates **13** is, as in the previous embodiment, in opposite directions through adjacent plates. The inductance-cancellation effect is thereby achieved with the circuit of Figure 4, as well as with that of Figures 1–3.

Embodiment of Figures 5–7

Proceeding next to a description of the embodiment of Figures 5–7, inclusive, the construction is the same as that shown in Figures 1–3 except that the lunes and associated plate elements are separated, by insulation means, into a number of parts. For example, the lunes **10** of the embodiment of Figures 1–3 may be separated into a plurality of spherical triangles **37** and quadrangles **38**, as illustrated. The plate-like elements associated with the lunes of the embodiment of Figures 1–3 are divided, correspondingly, into sections **41** and **42**.

The above-indicated division is accomplished by insulator means **43** lying in spaced parallel planes which are perpendicular to the common axis of the lunes of the embodiment of Figures 1–3. As in the case of all embodiments of the invention, the individual components are rigidly mounted in position by suitable means, not shown. Such means may include a large block of very strong, insulating material, which may be suitably jacketed or otherwise reinforced.

By dividing the hollow spheroid into a large number of components **37**, **38**, etc., it is possible to achieve current distributions, magnetic field shapes and strengths, etc., different from those attained with the other embodiments. Each section **37**, **38**, etc., may have a separate capacitor element discharged therethrough, either simultaneously or at times which differ by only a very small fraction of a second.

Figure 7 shows, in schematic and fragmentary form, a circuit by which each section **37**, **38**, etc., is associated with a separate capacitor means **17**. Thus, for example, one capacitor **17** is shown as connected through leads **44** to the plate sections **42** at opposite edges of one spherical quadrangle **38**. A second capacitor **17** is shown as connected through leads **46** to the plate sections **41** at opposite edges of a spherical triangle **37**. A trigger or switch means **47** is interposed in leads **44**, and a trigger or switch **48** is interposed in leads **46**. These trigger circuits are connected through separate leads **49** and **50** to a master control circuit **51**.

When the master control **51** is so operated that triggers **47** and **48** effect simultaneous closing of the discharge circuits through leads **44** and **46**, the indicated capacitors **17** discharge simultaneously through the connected elements **38** and **37**. As previously indicated, however, the master control **51** may be so operated that the triggers **47** and **48** are made to close the discharge circuits at slightly different times which normally overlap.

The capacitors **17** may be suitably charged by means of leads **53** extending to a source **54** of direct voltage. It is within the scope of the invention, however, in this and the other circuits, to charge each capacitor independently from a separate source. The polarity of the electrical connections is so selected that the current flow through quadrangles **38**, triangles **37**, etc., is such as to simulate undirectional flow around a continuous sphere. Thus, with the polarity indicated in Figure 7, the current flow would be in the direction shown by the arrows **56** in Figure 5.

It is to be understood that the electrical connections to the remaining sphere sections in Figure 7 are the same as those shown and described. Thus, in the illustrated form, there would be eighteen capacitors **17** connected to the plate sections **41** and **42** for the respective sphere portions **37** and **38**.

Although Figure 7 shows the parallel-type arrangement, similar to Figure 2, it is to be understood that some or all of the sections may be series-connected, as in Figure 4.

Trigger means—Figure 8

Referring next to Figure 8, there is illustrated in schematic form a trigger means which may comprise the triggers **18** in Figure 2, **27** in Figure 4, or **47** and **48** in Figure 7. For purposes of illustration, this trigger means is shown as incorporated in one of the plate sections **41** of the embodiment of Figures 5–7, namely the one at the lower-right portion of Figure 5. The trigger means is formed by providing an electrically-conductive bar **57** in a gap formed in one of the plates **411**, the bar having a length corresponding to the height of the plate **41**. The air gap is made sufficiently wide that gaps **58** and **59** are provided on opposite sides of bar **57**, and that no arcing will occur thereacross due to the presence of the voltage impressed upon the associated capacitor **17**.

A source **61** of high-frequency and/or high-voltage power, associated with suitable trigger mechanism, is connected across each gap **58** and **59**, such as by leads **62** and **63**. Source **61** is adapted to impress a high voltage, or a high-frequency voltage, or both, simultaneously across each gap **58** and **59** in response to a signal from a master control, not shown.

Assuming that the capacitor **17** of Figure 8 has been charged to the desired voltage, the source **61** is operated to impress across each gap **58** and **59** sufficient voltage or frequency to effect arcing. This voltage need only be impressed momentarily, since upon occurrence of arcing the capacitor **17** immediately discharges by effecting extensive arcing across the gaps **58** and **59**. Stated otherwise, the initial high voltage creates pilot arcs across gaps **58** and **59** which effect instantaneous discharge of capacitor **17** through a circuit comprising plate sections **41**, bar **57**, the gaps **58** and **59**, and sphere portion 37. The circuit described in Figure 8 thus effects a triggering or switching operation for extremely high currents, and without destroying the switch or trigger means.

Summary of the method of the invention

Stated generally, the method comprises momentarily creating a magnetic field having a shape and strength which is such as to effect the three-dimensional implosion previously described. Stated more specifically, the method comprises providing a substantially evacuated cavity surrounded by electrical conductor means having a generally spherical or spheroidal shape. An extremely high current is passed through such electrical conductor means for a very short period of time, to create a rapidly changing magnetic field in the cavity with consequent acceleration of ionized particles toward the center. An extremely high temperature is thus achieved in the center as the result of the speed and collision of the ionized particles.

An important feature of the method resides in the arrangement of the electrical conductor means comprising the sphere, and the connections thereto, to achieve a sufficiently low inductance that the very high instantaneous current flow is possible. With reference to the apparatus shown in Figures 1–3, a very low inductance, and a very high power input, are achieved by dividing the hollow spheroid into a plurality of lunes **10** and then discharging capacitor means **17** separately through each lune. The electrical polarities are so arranged, as previously stated, that the current flow through the various lunes **10** is in the same direction to simulate a continuous current flow about the axis of a complete sphere. The division of the sphere into lunes not only permits application of much greater power, from a plurality of current sources, but lowers inductance through the provision of plates **13** disposed adjacent each other and containing currents flowing in opposite directions.

With relation to the apparatus shown in Figure 4, the method comprises connecting the lunes **10** and associated plates **13** in series with capacitor means **17**, charging the capacitor means **17** to corresponding polarity in a series circuit, and discharging the series circuit to effect current flow through the lunes **10** in corresponding directions which simulate a continuous unidirectional flow about the axis of a complete sphere.

With reference to the circuit shown in Figures 5–7, the method comprises dividing a hollow spheroid into a plurality of sections by means of insulating elements disposed at angles to each other, for example in perpendicular planes, and discharging a capacitor through each such section and at substantially the same instant of time. As in the previous forms, the polarities are so selected that the current flow throughout the sphere is in the same direction. The method may include charging the capacitor means to various values, discharging the capacitor means at times which are not exactly simultaneous, and shaping the sphere-forming elements in such manner as to achieve optimum magnetic field conditions.

Additional theory and disclosure relating to all embodiments

To amplify upon the previously-stated theory relative to the present invention, it is pointed out that the flow of current is in a given direction through the conductor means and circumferentially about the axis of the spheroidal cavity. This results in the formation of an induced current sheet flowing in the opposite direction and through the gas. The induced current sheet is located within the evacuated cavity and is initially relatively close to the cavity wall formed by the conductor means. Thus, in the situation in which there is an envelope (such as number **12**) within the cavity, the induced current initially flows through the gas adjacent the inner wall of the envelope, it being understood that the envelope is formed of non-conductive material.

The sheet of induced current, composed of ions and electrons, acts as a barricade through which the lines of magnetic force may not pass in quantity. This is particularly true when the rate of change of magnetic field strength is great. This being the case, at least the majority of lines of magnetic force initially pass (in a spheroidal configuration) between the conductor metal and the current sheet—or largely through the envelope **12** in cases where there is an envelope.

The generally spheroidal magnetic field acts as a piston to drive (implode) the current sheet, that is to say the ions and electrons, radially inwardly toward the center of the cavity. As the current sheet collapses toward the center, in a shock wave, the lines of magnetic force collapse toward the center (in the above-indicated piston action) to compress the gas, and greatly elevate its temperature because of the speed and collision of the particles. The inward movement continues until the external magnetic pressure is counterbalanced by the internal pressure resulting from compression and temperature increase.

Since the lines of magnetic force may not pass through the electrical conductor metal, the conductor is provided with non-conductive openings (such as plugs **16** of insulation) at the poles of the cavity. The lines of force thus flow through the poles and externally of the spheroid to form continuous loops. As previously indicated, the reinforcing material in which the apparatus is embedded is non-conductive (except possibly in a casing remote from the sphere) and thus does not interfere with the external portions of the lines of force.

To aid in the above-described action, the gas within the cavity should be ionized before the capacitors commence to discharge. This may be done in any suitable manner, such as by passing radio-frequency waves through the cavity. For example, electrodes may be located near (but outside) the opening at each pole, and energized by a radio-frequency oscillator.

It is emphasized that the present invention produces a relatively stable concentration of high-temperature plasma near the center of the cavity. The plasma is stable because the magnetic field is generated by the flow of current through the metal conductor. This is to be contrasted with pinch-type devices, in which the constricting magnetic field results from flow of current through the gas. In such pinch devices, instability resulting from variation in current flow is compounded by simultaneous variation in the magnetic field.

The present apparatus may be pulsed, for example at a relatively high frequency, instead of being employed as a single-operation apparatus. This may be accomplished by rapidly charging and discharging the capacitors.

It is to be understood that the terms "point," "approximating a point," etc., do not mean that the high-temperature occurs only at a geometrical point. What is meant is that the highest concentration of plasma is in a small volume, as close to a point as possible. There may, however, be plasma concentrations of lesser density at regions other than the center of the cavity.

Various embodiments of the present invention, in addition to what has been illustrated and described in detail, may be employed without departing from the scope of the accompanying claims.

I claim:

1. In an apparatus for obtaining very high temperatures, electrical conductor means encompassing a cavity, a substantial number of electrical conductors extending outwardly from said electrical conductor means and electrically connected therewith, said electrical conductors being arranged in pairs the conductors in which are insulated from and adjacent each other, and means to pass current through said electrical conductors to said electrical conductor means and in opposite directions through adjacent portions of said electrical conductors to minimize the inductance of the latter, said last-named means being adapted to effect simultaneous flow of current in opposite directions through the electrical conductors in each pair.

2. In an apparatus for obtaining very high temperatures, electrical conductor means encompassing a cavity, a substantial number of electrical conductors extending outwardly from said electrical conductor means and electrically connected therewith, means to pass current through said electrical conductors to said electrical conductor means and in opposite directions through adjacent portions of said electrical conductors to minimize the inductance of the latter, and trigger means provided in at least one of said electrical conductors, said trigger means comprising an arc gap in said electrical conductor and means to impress across said arc gap a voltage adapted to effect arcing.

3. In an apparatus for generating a very high temperature, electrical conductor means shaped to define therein a cavity having a generally spheroidal wall, and means to pass, substantially simultaneously, a substantial number of individual electric currents through said electrical conductor means and to effect flow thereof along said wall in substantially the same direction around an axis thereof.

4. Apparatus for generating extremely high temperatures, comprising a plurality of electrical conductors shaped and arranged to substantially surround a generally spheroidal cavity, means to maintain a substantial vacuum in said cavity, insulator means to maintain said electrical conductors electrically separate, and means to pass electrical currents through said electrical conductors at substantially the same instant of time and thereby effect in said cavity rapid acceleration of ionized particles toward the center portion thereof.

5. Apparatus for generating extremely high temperatures, comprising a plurality of generally lune-shaped electrical conductors having a common axis and shaped and arranged to substantially surround a generally spheroidal cavity, means to maintain a substantial vacuum in said cavity, insulator means to maintain said electrical conductors electrically separate, and means to pass electrical currents through said electrical conductors at substantially the same instant of time and in substantially the same direction around said common axis to thereby effect in said cavity rapid acceleration of ionized particles toward the center portion thereof.

6. Apparatus for generating extremely high temperatures, comprising a plurality of electrical conductors shaped and arranged to substantially surround a generally spheroidal cavity, said conductors being formed as spheroidal sections divided by a substantial number of planes which contain a common axis of said spheroidal cavity and by an additional number of planes perpendicular to said common axis, means to maintain a substantial vacuum in said cavity, insulator means to maintain said electrical conductors electrically separate, and means to pass electrical currents through said electrical conductors at substantially the same instant of time and in substantially the same direction around such common axis to thereby effect in said cavity rapid acceleration of ionized particles toward the center portion thereof.

7. Apparatus for producing very high temperatures, which comprises electrical conductor means surrounding a cavity, a plurality of capacitor means, circuit means to associate said capacitor means with individual portions of said electrical conductor means and in parallel relationship, means to charge said capacitor means, and means to effect substantially simultaneous discharging of said capacitor means through said portions of said electrical conductor means, said capacitor means having polarities such that the current flow through said electrical conductor means is in a substantially uniform direction around an axis of said cavity.

8. Apparatus for generating high temperatures, comprising a substantial number of lune-shaped electrical conductors assembled together as lunes of a hollow spheroid, said lune elements having a common axis of said spheroid, a plate-like electrical conductor electrically connected to each edge of each of said lune elements and extending outwardly therefrom in a generally radial manner from said common axis, whereby the plate-like elements at adjacent edges of said lune elements are relatively close to each other, insulation means to separate from each other said adjacent plate-like elements and also the edges of said lune elements, and means to feed very large currents to the outer portions of said plate-like elements and thus radially inwardly and through said lune elements to other plate-like elements and in directions effecting flow of current through said lune elements in a single direction around said common axis and through adjacent plate-like elements in opposite directions.

9. The invention as claimed in claim 8, in which said last-named means includes capacitor means connected between the two-plate-like elements for each lune element, means to charge said capacitor means, and trigger means for effecting substantially simultaneous discharge of said capacitor means through the associated plate-like elements and lune elements.

10. The invention as claimed in claim 8, in which said last-named means means includes a substantial number of capacitor means, means to electrically connect one terminal of each capacitor means to one of said plate-like elements and the other terminal of said capacitor means to the plate-like element adjacent thereto whereby said plate-like elements, said lune elements and said capacitor means are arranged in series-circuit relationship, and means to effect series discharge of said capacitor means through said plate-like elements and lune elements, thereby effecting flow of current through said lune elements in substantially the same direction around the axis of said lune elements.

11. The invention as claimed in claim 8, in which insulator means are provided generally in planes perpendicular to said common axis to divide said lune elements and plate-like elements into separate sections, and in which means are provided to effect flow of current through said sections at substantially the same time and in such manner that the current flow through said lune sections is in a given direction about said common axis.

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