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GENERATOR FOR CURRENTS IN THE ORDER OF MEGA-AMPERES
THROUGH THE USE OF EXPLOSIVES

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FIG. 1

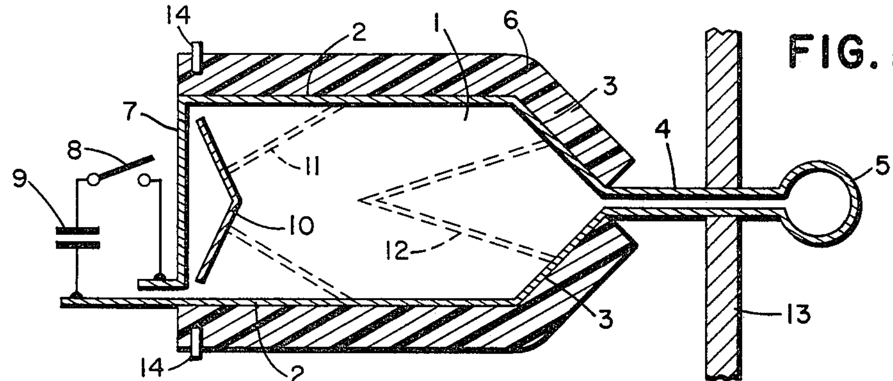


FIG. 2

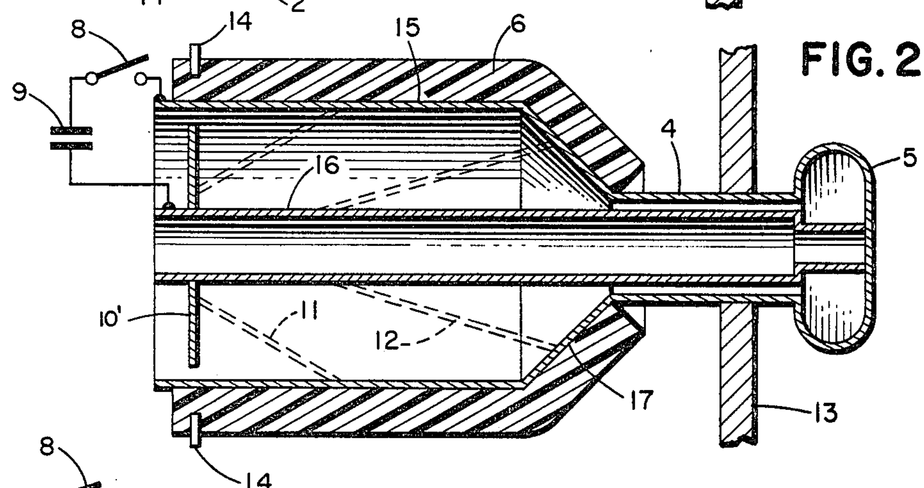
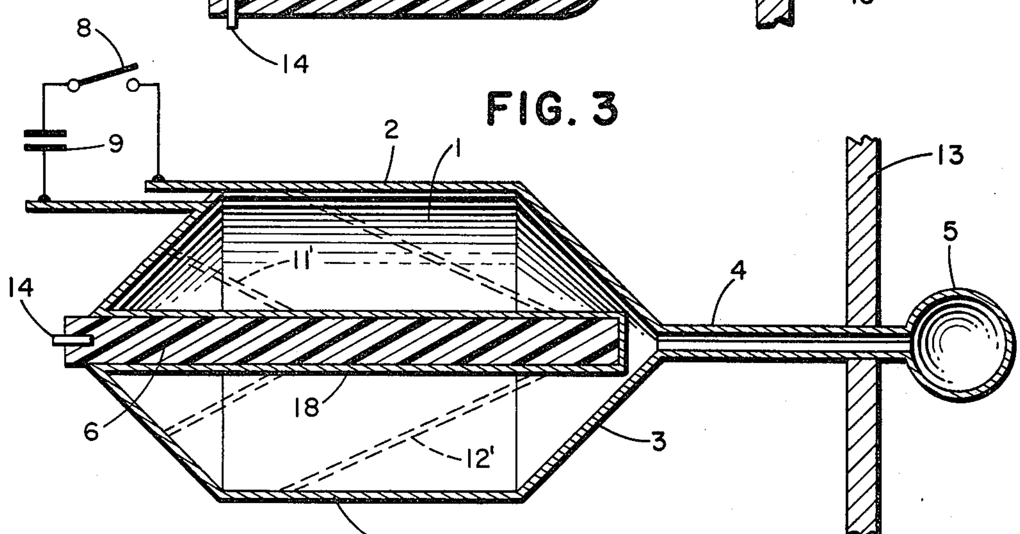


FIG. 3



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GENERATOR FOR CURRENTS IN THE ORDER OF MEGA-AMPERES THROUGH THE USE OF EXPLOSIVES

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ABSTRACT OF THE DISCLOSURE

A device for generating intense electrical currents through explosive compression of magnetic flux, comprising a conductor shaped to form a compression chamber, load transmission lines, a wall separating the load from the compression chamber, whereby an explosion of said chamber reduces the inductance of the system.

The present invention concerns a device which utilizes explosives as a source of energy for the creation of magnetic fields and of high intensity currents. Various methods are known for the conversion of chemical energy of an explosion into electromagnetic energy. The basic principle of these methods resides in compression through explosion of an electric conductor enclosing a magnetic field initially generated by conventional electric methods. In this process, the current of the system as well as the magnetic field which is tied in with it are notably amplified. In general, all these methods are destructive in the sense that each system ceases to exist after the creation of said magnetic field.

A system is known which utilizes the implosion of a metallic cylinder in order to compress the flux initially enclosed therein, said implosion occurring as a result of a cylindrical explosive charge placed upon the external surface of said metallic cylinder.

Such a system presents, however, the disadvantage that the explosive charge is necessarily very complex in order to avoid irregularities in the compression process. In the process of use, furthermore, the entire system and, therefore, also the pertinent apparatus which is connected thereto is completely destroyed.

The present invention is based upon an electrical system in which a current I_0 (generated by a bank of condensers) produces a flux ϕ according to the formula:

(1) $$\phi = L_0 I_0$$

wherein L_0 is the initial inductance of the circuit. Said system is compressed by the action of a chemical explosive in such a manner as to diminish the inductance of said circuit. Supposing that in this transformation, the magnetic flux which is enclosed remains constant, a supposition which is rigorously valid only for perfect conductors, the reduction of the inductance in the system must be followed by an increase of the current since it follows that:

(1') $$\phi = LI$$

during the entire compression process. There is therefore an increased current according to the formula:

(2) $$\frac{I}{I_0} = \frac{L_0}{L} = \gamma$$

where γ is called the compression co-efficient and in practice may achieve values from 100 to 200.

The total energy of the system increases by the same factor, in fact:

(3) $$\frac{E}{E} = \frac{LI^2}{L_0 I_0} = \frac{L_0}{L} = \gamma$$

This in practice, signifies that the work performed by the explosive is transformed into electromagnetic energy, that is the electromagnetic energy which finally results is given or obtained from the product of the compression factor and the initial electromagnetic energy.

The device according to the invention is constituted by a conductor body disposed in a manner to form successively: a compression chamber (in contact with which there is placed the explosive), a transmission line and a load, said load being separated from said compression chamber by means of the transmission line extending through a protective wall which is between said load and said chamber, said compression chamber assuring the closing of the electrical circuit during the occurrence of the explosion in such a manner as to permit the reduction of the inductance in said circuit.

According to one embodiment of realization, the conductor body is constituted by two flat parallel metallic conductor walls which converge at one end into one end of the transmission line nearest the load and are connected at the other end by a flat metallic end conductor wall and by the source of initial current, appropriate means being provided for the initial closing of the circuit through said source, and wall and parallel walls.

According to another embodiment, the conductor body is constituted by two coaxial metallic cylinders electrically connected at one end through the source of initial current, the external cylinder converging at its other end towards the internal cylinder so as to form therewith the coaxial transmission line and toroidal load.

According to a still further embodiment, the explosive is placed in an internal cavity in the compression chamber.

Denoting by I_{max} the maximum current which can be generated in a given system and by L_c, L_t, and L_e the respective inductances of the compression circuit, of the transmission line and of the load there will be obtained:

(4) $$I_{max.} = \frac{L_c + L_e + L_t}{L_e + L_t} I$$

It follows that, in order that the compression co-efficient be sufficiently high, the following must apply:

$$L_e + L_t \ll L_c$$

In practice this condition is the same as saying that the proposed generator is useful if tied in with a small inductance load (L_e).

Upon the conductor part which forms the compression chamber, there is disposed the chemical explosive in a manner that, being detonated, firstly closes the circuit and thereafter compresses the conductor without electrically interrupting the circuit in order to obtain the desired reduction of the circuit inductance L.

With an appropriate selection of the type and of the dimensions of the transmission line, it is possible to safeguard the load circuit and the various measuring apparatus connected thereto. The matter of safeguarding the load not only represents an optimum desideratum from the economic point of view but also permits a utilization of magnetic fields and of the generated currents also after having reached the maximum compression, which thereby renders the subject of the present invention useful not only from the scientific point of view but also from that of pratcical application.

By way of illustration and without limiting the scope of the invention there are described various practical embodiments referred to the annexed drawings in which:

In FIGURE 1 is presented an embodiment of the device according to the invention, wherein the conductor is constituted by a flat lamina of copper shaped in a manner so as to form in continuous manner the system circuit;

In FIGURE 2 is illustrated a variation of the invention wherein the conductor body is constituted by a series of coaxial cylinders;

In FIGURE 3 there is illustrated another embodiment of the invention wherein the explosive is placed internally of the compression chamber.

The subject device, shown in FIGURE 1 in lateral view, is constituted by a cavity **1**, wherein occurs the implosion, delimited by two parallel metallic walls **2**, for example, in flat copper having a thickness of 1 mm. which act as conductors for the initial current as well as containers and compressors of the magnetic flux; at one end said walls converge at **3** into one end of transmission line **4** which is remote from load **5** and continue parallel and nearer to each other along the transmission line which extends between the compression chamber **1** and the load **5**. The two metallic walls **2** are an integral part of the electrical circuit, schematically represented in the figure, into which there is discharged the condenser bank **9**, by means of the switch **8**. An end or bottom **7**, also metallic, connects, by means of the condenser bank **9** and the switch **8**, the metallic walls **2**. In proximity to the bottom **7** of the compression chamber **1** there is placed a metallic lamina **10** appropriately shaped so as to assure the closing of the electrical circuit at the initial instant of implosion.

The explosive **6**, of the plastic type, is placed externally along the walls **2** and **3** and possess a variable thickness between 0.4 and 1.6 cm. The detonation is primed simultaneously, for example by two detonators **14** in such a manner as to have the initial current I_0 at the maximum when, following the detonation, the system closes upon itself by means of the shaped lamina conductor **10**. The dash lines **11** and **12** represent the walls **2** deformed by the shock wave in two successive instances of the implosion. The protective wall **13**, properly disposed out of contact with and spaced from the explosive, provides safeguarding of the load **5** and the various measuring apparatus connected thereto from the effects of the implosion. The detonators **14** are located at the end of the compression chamber which is remote from load **5** in order to effect primarily a closing of the circuit and thereafter a progressive compressing of the flux chamber without interrupting the electrical circuit. This applies to all embodiments.

In FIGURE 2 is represented in section a variation of the invention in which the device is constituted by an assembly of coaxial cylinders **15** and **16** extending along the transmission line **4**, cylindrically symmetrical and terminating at the load **5** which is of toroidal shape.

The explosive **6** externally surrounds the cylindrical surface **15** as well as the truncated conical surface **17** and is primed by detonators **14** located at the base of cylinder **15**. A circular ring bottom **10′** assures the closing of electrical circuit at the initial instant of implosion.

In FIGURE 3 there is represented in section another variation of the invention wherein the explosive **6** is placed in a cavity **18** internally of the compression chamber. The dash lines **11′** and **12′** in FIGURE 3 represent two successive deformations of wall **18** at successive stages of the explosion initiated by detonator **14**. Wall **18**, thereby maintains a closed electrical circuit during the occurrence of the explosion. Walls **2** in FIGURE 3 remain substantially unaffected by the explosion.

The herein disclosed embodiments and the details thereof are for illustrative and not limitative purposes, the scope of the invention extending to all obvious modifications and embodiments which fall within the scope of the invention as claimed.

What is claimed is:

1. A device for generating electric currents in the order of mega-amperes, said device being of the type wherein a magnetic flux is compressed through the action of explosives and comprising: an electrical circuit including a conductor body, a source of initial current connected to said body, and a transmission line connected directly to said body for transmitting current from said body to a load, said conductor body defining a flux compression chamber within which magnetic flux is induced by current flow through said circuit, an explosive arranged relative to said conductor body whereby detonation of said explosive deforms said body in a direction whereby there occurs a compression of the magnetic flux within said chamber, a protective wall spaced from and out of contact with said explosive isolating said body on one side of said wall, said transmission line passing through said wall, said conductor body comprising two parallel spaced apart conductor walls converging at one end thereof into one end of said transmission line, said body and said explosive being so arranged that upon detonation of said explosive there occurs a compression of said flux from an end of said body progressively towards said converging walls.

2. A device for generating electric currents in the order of mega-amperes, said device being of the type wherein a magnetic flux is compressed through the action of explosive and comprising: an electrical circuit including a conductor body, a source of initial current connected to said body, and a transmission line connected directly to said body for transmitting current from said body to a load, said conductor body defining a flux compression chamber within which magnetic flux is induced by current flow through said circuit, an explosive arranged relative to said conductor body whereby detonation of said explosive deforms said body in a direction whereby there occurs a compression of the magnetic flux within said chamber, a protective wall spaced from and out of contact with said explosive isolating said body on one side of said wall, said transmission line passing through said wall, wherein said conductor body comprises two parallel spaced apart conductor walls converging at one end thereof into one end of said transmission line, a flat conductor wall at the other end of said parallel walls and extending therebetween and being electrically in series with said parallel walls and said source of initial current, switch means for selectively closing the circuit from said source to said body.

3. A device for generating electric currents in the order of mega-amperes, said device being of the type wherein a magnetic flux is compressed through the action of explosives and comprising: an electrical circuit including a conductor body, a source of initial current connected to said body, and a transmission line connected directly to said body for transmitting current from said body to a load, said conductor body defining a flux compression chamber within which magnetic flux is induced by current flow through said circuit, an explosive arranged relative to said conductor body whereby detonation of said explosive deforms said body in a direction whereby there occurs a compression of the magnetic flux within said chamber, a protective wall spaced from and out of contact with said explosive isolating said body on one side of said wall, said transmission line passing through said wall, wherein said conductor body comprises two concentrically spaced apart conductor cylinders electrically connected together at one end thereof by means of said source of initial current, at the other end the external one of said cylinders converging towards the internal one and thereafter continuing parallel therewith as a coaxial transmission line extending through said protective wall, said coaxial line forming a toroidal shaped load on the ohter side of said wall.

4. The device of claim **1**, wherein said explosive is arranged on the external surface of said conductor body in conformity with the outline of said surface, said conductor body having opposed ends respectively nearest to and remotest from said protective wall, detonators for said explosive located on said body at the end remote from said wall said body being progressively collapsible beginning at said end remote from said protective wall towards the end nearest said protective wall.

5. The device of claim **1**, wherein said explosive is arranged internally of said body whereby it is surrounded by said flux chamber, said explosive being contained in an inner wall portion of said body which is surrounded by an outer wall portion thereof, said flux compression chamber being defined between said inner and outer wall portions, said outer wall portion being substantially undeformable while said inner wall portion is adapted to deform outwardly towards said outer wall portion and progressively from one end of said body towards said converging walls.

6. The device of claim **1**, wherein said conductory body parallel walls and said conductor body converging

walls together with said transmission line constitute an integral body of uniform material.

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