April 9, 1963 H. FISCHER 3,085,176

ULTRA-RAPID, HIGH INTENSITY SWITCH PULSE GENERATION IN COAXIAL CIRCUITRY

Filed May 26, 1960 2 Sheets-Sheet 1

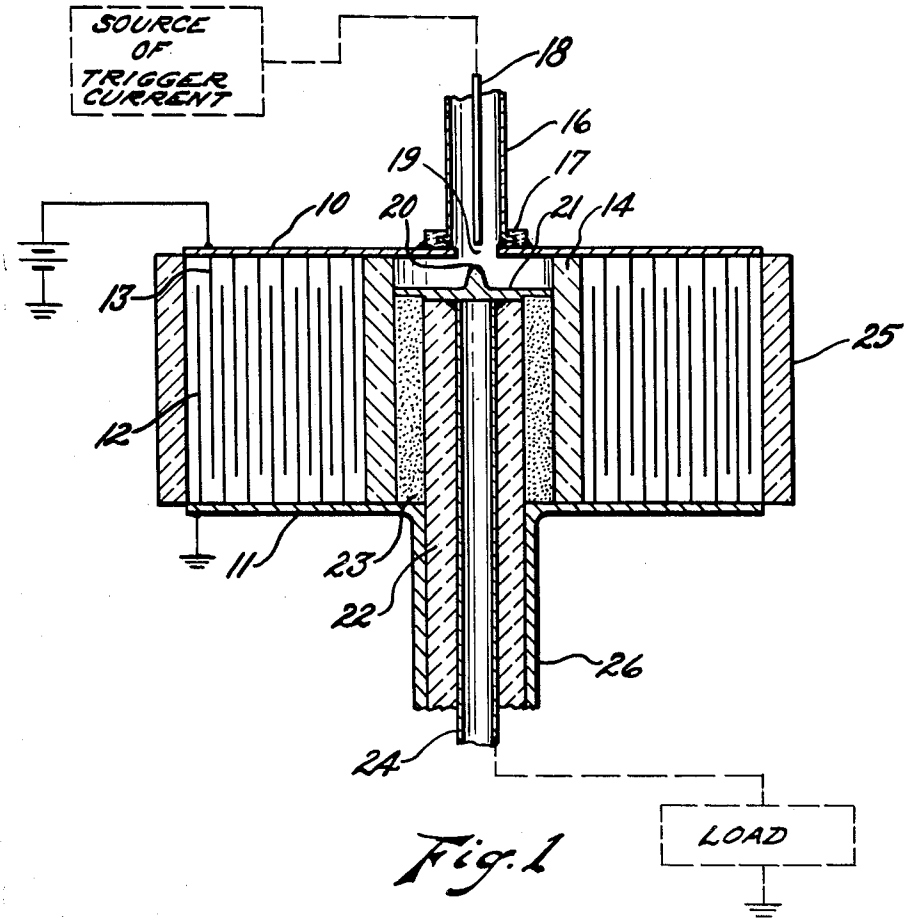


Fig. 1

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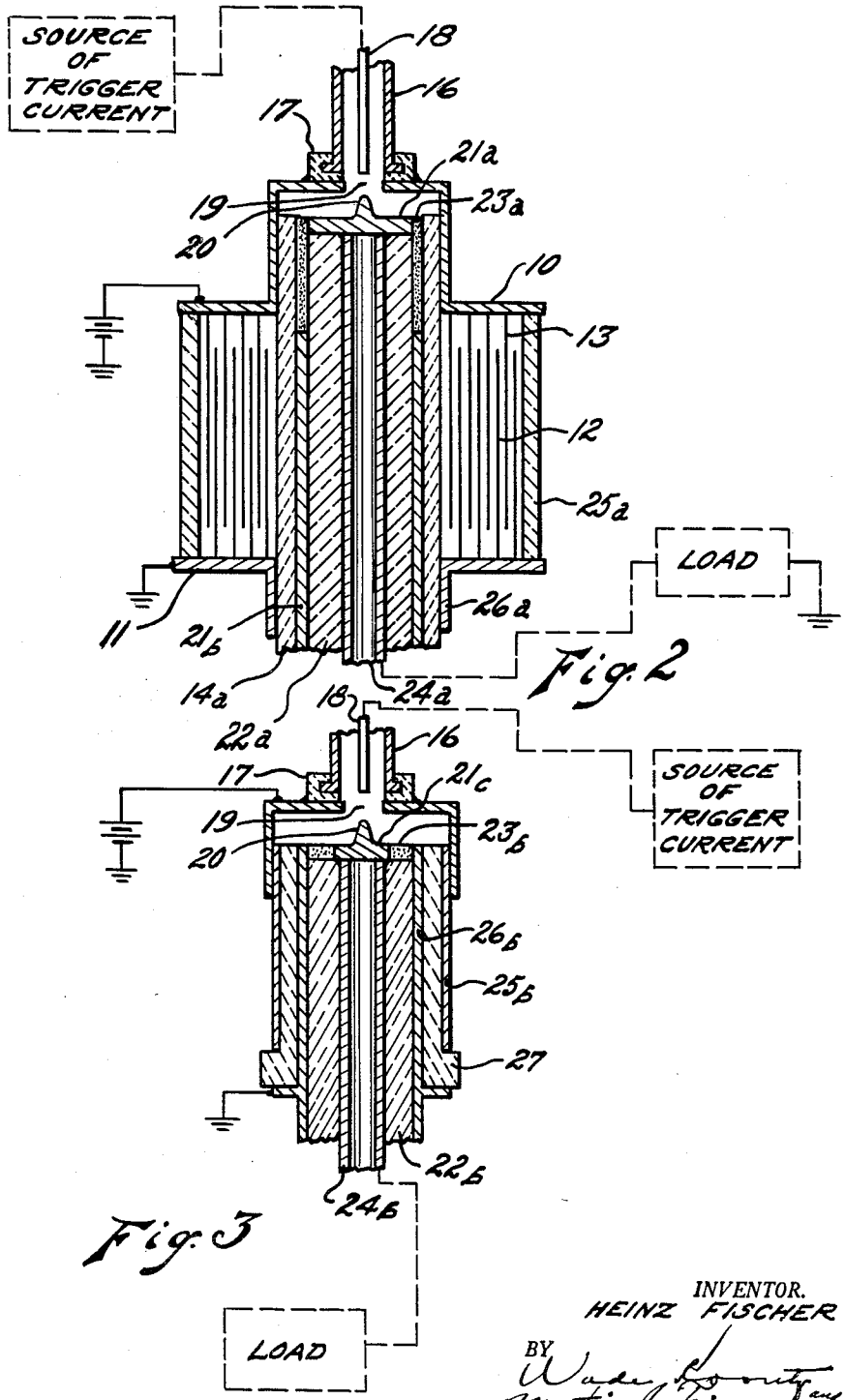


Fig. 2

Fig. 3

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ULTRA-RAPID, HIGH INTENSITY SWITCH PULSE GENERATION IN COAXIAL CIRCUITRY

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8 Claims. (Cl. 315—39)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the United States Government for governmental purposes without payment to me of any royalty thereon.

This invention relates to the generation of electrical energy in the form of a pulse of high amplitude, with ultra-rapid rise to such high amplitude, and suitable for switching, signaling, and cycle-triggering purposes in high-intensity coaxial transmission lines or other coaxial circuitry. This application is a continuation-in-part of my application No. 724,775 filed March 28, 1958.

In my Patents 2,728,887; 2,900,566; and 2,911,567 I have disclosed methods and apparatus for generating electrical pulses of extremely high temperature, extremely intense brilliance, and extremely rapid rise to peak amplitude, following discharge of energy previously stored in a capacitor assembly having coaxial relationship to pulse-forming elements of the apparatus. My copending application No. 724,775 illustrates pulse-forming elements establishing a spark gap at the central axis of a coaxial transmission line, and featuring intimacy and directness in the method of transferring current from the capacitor parts to the spark gap-defining electrode elements. The present application proposes the insertion into this coaxial-gap structure of a resistance factor of selected value, to provide a desired degree of high-voltage build-up prior to formation of the electrical pulse across the gap, the effect being to tend to match the impedance characteristics of the coaxial conductors receiving the discharge energy of the capacitor, thus tending to stabilize the pulse operation by eliminating unwanted transient current oscillations and insuring development of a pulse of predetermined amplitude and shape, in accordance with the selected impedance-resistance-capacitance relationships.

The accompanying drawings will further aid in understanding the invention principles wherein:

FIG. 1 is a schematic cross-sectional view of a toroidal resistor type embodiment of the invention;

FIG. 2 is a schematic cross-sectional view of a resistor type extended line and multi-layer capacitor as a second embodiment of the invention; and

FIG. 3 is a schematic cross-sectional view of a resistor type single layer capacitor as a further embodiment of the invention.

Referring first to FIG. 1, the capacitor portion of the assembly includes a pair of flat metallic discs **10** and **11**, to which are secured the upper and lower edges, respectively, of alternate strips **12**, **13** of metal foil that are spirally wound—along with an inter-leaving strip of insulating material such as paper—about a spool **14** of dielectric material. A similar dielectric spool **25** surrounds the assembly. The coaxial conductive portion of the assembly includes an outer tubular conductor **16** having a terminal collar **17** of insulatory material bonded to the disc **10**, and an inner conductor in multiple parts including, first, a trigger current-receiving rod or wire **18** terminating just short of the central tip **20** of a metallic disc **21** constituting the conductive cap of the main portion **24** of the inner conductor, which is sheathed in insulator **22**, and also in a jacket **23** of carbon or other conductive material whose resistance value is so chosen as to establish a matching relationship with the impedance characteristic of the coaxial line, including the electrode

gap **19** immediately above tip **20**. The jacket **23** also serves to support the conductor on disc **11** of the capacitor portion of the assembly, and thus completes the inner conductive part of the coaxial line, which extends from disc **11** to wire **18** by way of resistor **23**, cap **21**, tip **20** and the gap **19** between tip **20** and the wire **18**. The outer conductive part **26** of the line is integral with disc **11**, as indicated.

By using "Teflon" barium titanate, mica, or equivalent material of high dielectric strength for insulator **22**, it is possible to form this insulator **22** of extremely thin sheet material thus reducing the inductance-impedance factors to values of smaller magnitudes than have heretofore been available.

FIG. 2 embodies the principles above-described as included in FIG. 1, except that the central elements are extended axially to position gap **19** substantially above the plane of terminal plate **10**; also the over-all diameter of the capacitor is reduced, and a shorter resistor **23***a*, at the upper end of intermediate conductor **21***b*, interposed between inner and outer conductors **24***a* and **26***a* respectively. Resistor **23***a* performs in the same fashion as resistor **23** of FIG. 1.

FIG. 3 also embodies the same principle, utilizing a resistor **23***b* surrounding electrode element **21***c*; also a single layer of Teflon or the like, as at **27**, coacts with conductive elements **26***b* and **25***b* to form the energy storage unit of the capacitor, thus serving the function of the multi-layer storage unit **12** of FIGS. 1 and 2. By substitution of this single-layer arrangement, "streamlining" of the assembly may be accomplished.

The D.C. power supply for charging the capacitor elements preferred has a potential of at least 50 kilovolts, and may be of substantially greater voltage potentiality, dependent upon the degree of heat and light pulse intensity to be achieved at the spark gap **19** (whose dimension may be on the order of 0.25 to 1 cm.), and also, of course, dependent upon the energy storing capacity and storing time cycle of the capacitor elements as well as upon the nature of the work to be accomplished at the "load" point of the transmission line—for example, infrared signalling, the initiation of nuclear or analogous reactions, the melting of refractory substances, vaporization of metals, or related high temperature operations.

What I claim is:

1. The combination of a high-capacity storage unit including conductive elements separated by dielectric material and wound about a coaxial transmission line having a pulse-forming gap in its inner conductor, and impedance-matched resistance means electrically connecting one of the storage unit conductive elements to said transmission line gap, to control the pulse stability.

2. In a capacitance assembly, a hollow spool of dielectric material, a pair of sheets of electrically conductive material and an intervening sheet of dielectric material wound about said spool, a flat metallic disc joined to one edge of one of said conductive sheets, said disc having a centrally disposed area lying within the circumference of said spool, a tubular conductor of known resistivity disposed coaxially of said spool, said tubular conductor having one of end surfaces abutting the centrally disposed area of said disc, and coaxially disposed resistance means abutting the other end surface of said tubular conductor to receive the energy previously stored in said wound sheets on each capacitance-discharging operation.

3. In a capacitance assembly, a hollow spool of dielectric material, a pair of sheets of electrically conductive material and an intervening sheet of dielectric material wound about said spool, a flat metallic disc joined to one edge of one of said conductive sheets, said disc having a centrally disposed area lying within the circumference

of said spool, a tubular conductor of known resistivity disposed coaxially of said spool, said tubular conductor having one of end surfaces abutting the centrally disposed area of said disc, coaxially disposed resistance means abutting the other end surface of said tubular conductor to receive the energy previously stored in said wound sheets on each capacitance-discharging operation, and means electrically connecting with the other of said conductive sheets for triggering each capacitance-discharging operation.

4. In a capacitance assembly, a hollow spool of dielectric material, a pair of sheets of electrically conductive material and an intervening sheet of dielectric material wound about said spool, a flat metallic disc joined to one edge of one of said conductive sheets, said disc having a centrally disposed area lying within the circumference of said spool, a tubular conductor of known resistivity disposed coaxially of said spool, said tubular conductor having one of end surfaces abutting the centrally disposed area of said disc, coaxially disposed resistance means abutting the other end surface of said tubular conductor to receive the energy previously stored in said wound sheets on each capacitance-discharging operation, and means electrically connecting with other of said conductive sheets for triggering each capacitance-discharging operation, said triggering means including a coaxial section of transmission line having its outer conductor terminating in a flat metallic disc joined to said other of said conductive sheets, and having its inner conductor terminating in pulse-forming gap relationship to said first-named transmission means.

5. In a capacitance assembly, a pair of flat metallic discs enclosing a current storing capacitance unit, a tubular conductor of known resistivity, said tubular conductor having one of its end surfaces abutting one of said discs, and transmission means coaxial with said tubular conductor for receiving energy from said capacitance unit on each capacitance-discharging operation.

6. An assembly as defined in claim 5, including means electrically connecting with the other of said discs for triggering each capacitance-discharging operation.

7. An assembly as defined in claim 6, wherein said triggering means includes a conductor having pulse-forming gap relationship to said coaxial transmission means.

8. An assembly as defined in claim 6, wherein said triggering means is disposed in a plane substantially spaced beyond the confining planes of said metallic discs, to escape the effect of the major portion of the magnetic field circulating in the region confined by said discs.

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