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APPARATUS FOR APPLYING HIGH-INTENSITY ELECTRICAL PULSES TO CRYSTAL RECTIFIERS

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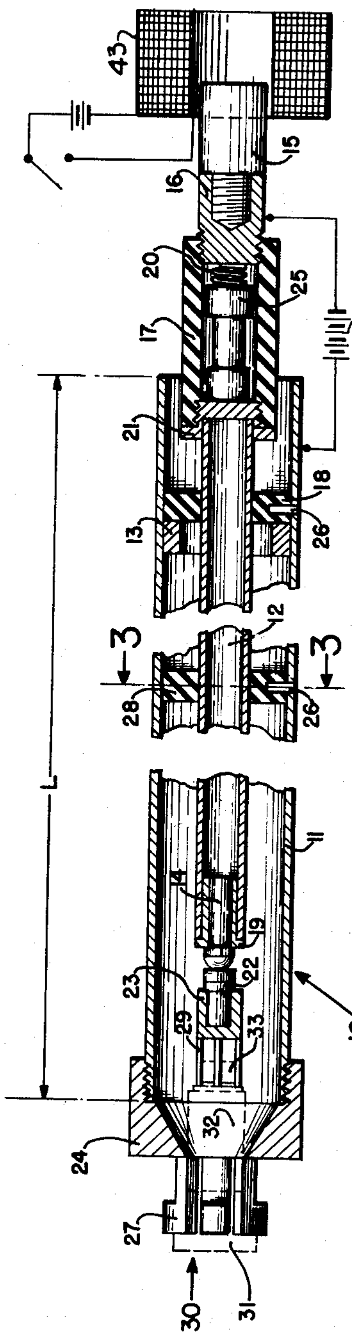

FIG. 1

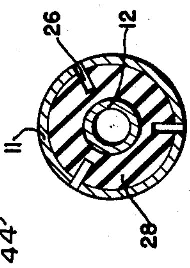

FIG. 3

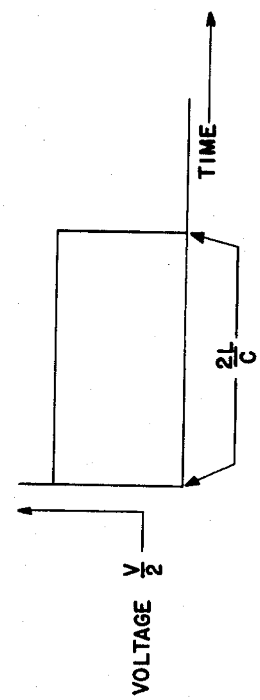

FIG. 2

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APPARATUS FOR APPLYING HIGH-INTENSITY ELECTRICAL PULSES TO CRYSTAL RECTIFIERS

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8 Claims. (Cl. 324—158)

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This invention relates to electrical test equipment and more particularly to apparatus capable of subjecting various types of electrical apparatus to a high intensity electrical pulse of predetermined energy content.

Subjecting electrical equipment to electrical surges involves specialized apparatus, the design of which depends upon the particular equipment to be subjected to the electrical surges. The principles of the present invention are herein disclosed in connection with the laboratory and production testing of cartridge-type crystal rectifiers.

In the manufacture of cartridge-type crystal rectifiers, numerous and extensive tests are made before the unit is marketed, which tests result in a substantial increase in total cost. In pulsed radio frequency systems, impairment and failure of the crystal is usually caused by the application thereto of a voltage pulse or "spike" of very short time duration, often less than 0.01 microsecond. In such a short time, the crystal and the "whisker" contactor are unable to conduct the dissipated heat away from the contact. It has been observed that the resulting temperature is essentially proportional to the total energy in the spike rather than its peak power. For this reason, if a pulse energy test is made before the other required tests, the unit cost of manufacture can be considerably decreased and the crystal reliability increased.

An object of this invention is to provide a device for applying pulse energy to a cartridge-type crystal rectifier or similar electrical equipment.

Another object of this invention is to provide a device for applying pulse energy to a cartridge-type crystal rectifier of simple mechanical construction, efficient operation and which is readily maintained.

These and other objects will be apparent from a careful consideration of the specification and the accompanying drawings in which:

Fig. 1 is a longitudinal cross-sectional view of a preferred embodiment of the present invention;

Fig. 2 is a graph showing certain voltage-time relationships existing in the apparatus of Fig. 1; and

Fig. 3 is a cross-sectional view taken along axis 3—3 of Fig. 1.

Referring more specifically to the drawings, Fig. 1 shows a coaxial line 10, of length l, whose characteristic impedance is substantially equal to the impedance of the crystal to be tested, and which consists of a substantially cylindrical outer conductor 11 externally threaded at one end, and

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an inner conductor 12. Two insulating bushings 18 and 28, similarly constructed, are secured within outer conductor 11 by small dielectric pins 26 placed in small holes drilled through outer conductor 11 and into bushings 18 and 28, as shown in Fig. 3. These bushings 18 and 28 slidably support and electrically insulate the inner conductor 12. Bushing 18, located near the unthreaded end of outer conductor 11, also acts as a stop for inner conductor 12 and thus, an adjacent metal flange 13 is silver soldered to outer conductor 11 for further support. An internally threaded metal cap 24, which engages the correspondingly threaded end of outer conductor 11, is drilled at its center and fitted with end fingers 27 to releasably hold a cartridge-type crystal rectifier 30. The crystal cartridge 30 has a metal base 31 and a metal prong 33 separated and insulated by a ceramic case 32 which also houses the crystal and the contacting "whisker." The end fingers 27 hold the ceramic case 32 in such a manner that the metal base 31 and the outer conductor 11 are in electrical contact and the metal prong 33 extends centrally into the outer conductor 11. A metal sleeve 23 is attached to the prong 33 of the crystal cartridge 30 by fingers 29 extending from one end of the sleeve. A flat metal contact 22 is soldered to the end of sleeve 23 opposite the fingers 29. The fingers 29 fit securely over the prong 33 to provide good electrical contact thereat. A contact 14, hemispherically shaped to minimize capacity and high potential gradients, is fitted into the end of inner conductor 12 adjacent to the flat contact 22 and secured by a metal contact plug 19. The contacts 14 and 22 have a metal base and are covered with a very hard shock-resistant material, such as osmium-rhodium, which is ground and polished. A dielectric sleeve 17, internally threaded at both ends, mechanically connects and electrically insulates a core rod or plunger 15 of a solenoid 43 from inner conductor 12. Thus, the core rod 15 threaded at one end thereof engages a metal coupling 16 which is in turn threaded and engages one end of the dielectric sleeve 17. A metal plug 21, externally threaded, which slides over the end of inner conductor 12 and silver soldered thereto, screws into the other end of the dielectric sleeve 17. The inner conductor 12 and the coupling 16 are electrically connected by a resistor 25 and a helical spring 20 located inside the dielectric sleeve 17, the resistor 25 being soft soldered at one end to the plug 21, and in contact at the other end with the helical spring **20** which in turn is soldered to the coupling **16**.

In actual operation the device is usually vertically mounted with core rod **15** at the top. A solenoid **43** is energized causing core rod **15** and inner conductor **12** to rise a predetermined distance. The metal sleeve **23** is fitted over the metal prong **33** of crystal cartridge **30** and this latter assembly inserted into the end fingers **27** of the cap **24** so that flat contact **22** is directly beneath and in line with hemispherical contact **14**. The coaxial line **10** is charged to a voltage V by connecting a voltage source **44** directly to outer conductor **11** and indirectly to inner conductor **12** through resistor **25**. Resistor **25** has a very high resistance value limiting the output current from the voltage source **44** during discharge and making the upper end of coaxial line **10** appear open-circuited. When the solenoid **43** is deenergized, inner conductor **12** drops very rapidly, initially to prevent field emission, engages contact **14** and **22**, forces crystal cartridge **30** from the end fingers **27** of the cap **24** and finally comes to rest when plug **21** meets dielectric bushing **18**. When contacts **14** and **22** are engaged the energy stored in coaxial line **10** is discharged through and absorbed by the crystal in crystal cartridge **30**.

It is generally known that when a uniformly charged transmission line is discharged at one end into a load which has the same impedance as the characteristic impedance of the line, a pulse of electromagnetic energy will flow at a voltage equal to one-half the voltage across the line for a period of time equal to twice the length of the line divided by the velocity of the wave in the line.

The wave shape shown in Fig. 2 is that which would be obtained from an ideal match between the characteristic impedance of line **10** and the impedance of the crystal in crystal cartridge **30**. The voltage of the pulse is shown as one-half of the voltage V of the voltage source **44**, while the time duration of the pulse is shown equal to twice the length l of the line **10** divided by the velocity of the wave in the line, which is a constant c for any given line. A mismatch would result in an initial pulse whose voltage is slightly more or less than one-half the voltage of the voltage source **44**, depending on the direction of the mismatch, which initial pulse would be followed by additional pulses of diminishing voltages. However, the total energy absorbed by the crystal would remain the same. The energy absorbed by the crystal is found by taking the square of one-half of the voltage of the voltage source **44**, multiplied by the time duration of the pulse and dividing this by the impedance of the crystal. This absorbed energy is usually expressed in ergs.

After the cartridge-type crystal rectifier has been subjected to pulse energy, other and known means are used to determine whether or not the crystal has been impaired.

Thus it may be readily seen that a specified amount of energy may be imparted to a cartridge-type crystal rectifier in a specified time by this invention by merely regulating the length l of the coaxial line and the voltage V of the voltage source **44**. It is further seen that this energy is applied with a minimum of contact chatter and mechanical shock.

This invention is to be limited only by the appended claims.

What is claimed is:

1. Apparatus for applying pulse energy to an electrical device comprising, a transmission line, said transmission line comprising two conductors and having a characteristic impedance substantially equal to the impedance of said electrical device, one of said conductors of said line being movably disposed relative to the other of said conductors, means for conductively connecting an electrical devce to one of said conductors, a voltage source for charging said line, and means for rapidly moving said movable conductor in a direction to connect conductively said electrical device across said transmission line, whereby energy stored in said line is imparted to said electrical device.

2. Apparatus for applying pulse energy to an electrical device comprising, a transmission line, said line comprising two conductors, one of said conductors being movably disposed relative to the other of said conductors, a voltage source for charging said line, means for connecting an electrical device to one of said conductors in such a manner that when movement is imparted to said movable conductor said device is connected across said line and the energy stored in said line is imparted to said device, and means for moving said movable conductor.

3. Apparatus for applying pulse energy comprising a section of coaxial transmission line of predetermined length, the inner conductor being slidably disposed relative to the outer conductor, contact means mounted on said inner conductor, means mounted on said outer conductor adapted to releasably connect a conductive electrical device to said outer conductor, means for electrically charging said coaxial line through a resistor carried by said inner conductor, and means for rapidly moving said inner conductor to advance said contact means toward said connecting means mounted on said outer conductor, whereby an electrical device releasably connected to said outer conductor is conductively connected across said line by said contact means and the energy stored in said line is imparted to said electrical device.

4. Apparatus comprising a section of coaxial line of predetermined length and of predetermined characteristic impedance, the inner conductor being movably disposed relative to the other conductor, means for charging said coaxial line, means for rapidly moving one conductor relative to the other conductor, and means mounted on said conductor adapted to discharge the energy stored in said line across an external load upon movement of said one conductor.

5. Apparatus for applying pulse energy to an electrical device comprising a section of coaxial transmission line of predetermined length, the characteristic impedance of said line being equal to the impedance of the electrical device to which pulse energy is to be applied, means for electrically charging said coaxial line, means for moving one conductor of said line relative to the other conductor of said line, and means mounted on the conductors of said line adapted to impart the electrical charge on said line to an electrical device upon movement of one of said conductors.

6. Apparatus comprising a section of coaxial transmission line of predetermined length and predetermined characteristic impedance, means mounted on one of said conductors adapted to releasably secure an electrical device to said conductor, means for electrically charging said

coaxial line, and means mounted on the other of said conductors adapted to impart the energy stored in said line to said electrical device upon movement of said movable conductor.

7. Apparatus for applying pulse energy to a cartridge type crystal rectifier comprising a section of coaxial transmission line of predetermined length, the characteristic impedance of said line being equal to the impedance of the rectifier to which pulse energy is to be applied, said coaxial line comprising an outer conductor and a slidable inner conductor, means for electrically charging said coaxial line through a resistor carried by said inner conductor, means for rapidly moving said inner conductor relative to said outer conductor, and means secured to said conductors adapted to impart the electrical charge on said line to a cartridge type crystal rectifier upon movement of said inner conductor.

8. Apparatus comprising an electrical device, a transmission line, said transmission line comprising two conductors and having a characteris-

tic impedance substantially equal to the impedance of said electrical device, one of said conductors of said line being movably disposed relative to the other of said conductors, means for conductively connecting said electrical device to one of said conductors, a voltage source for charging said line, and means for rapidly moving said movable conductor in a direction to connect conductively said electrical device across said transmission line, whereby energy stored in said line is imparted to said electrical device.

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