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IMPULSE VOLTAGE TESTING EQUIPMENT

Filed Aug. 13, 1938

2 Sheets-Sheet 1

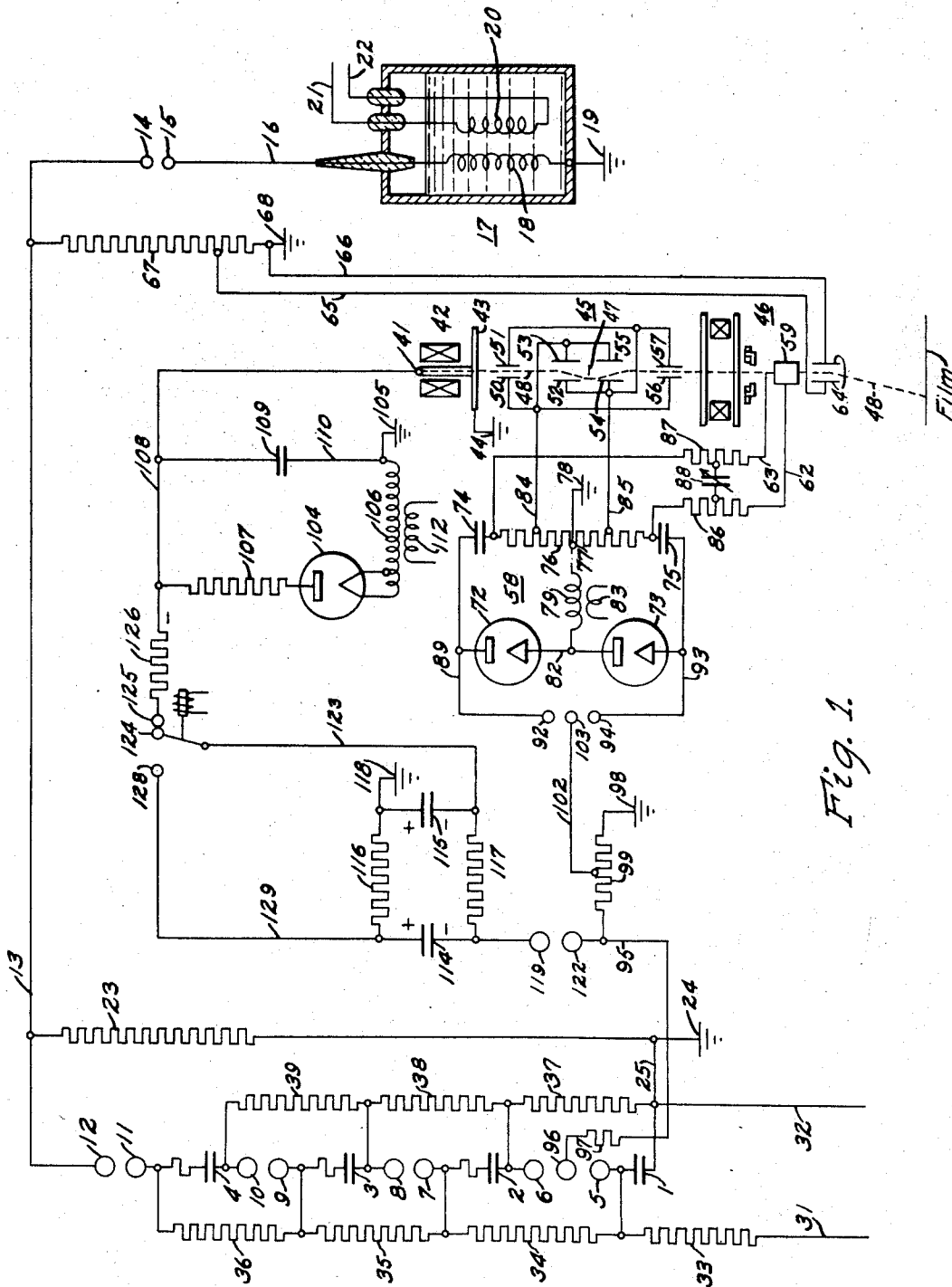


Fig. 1.

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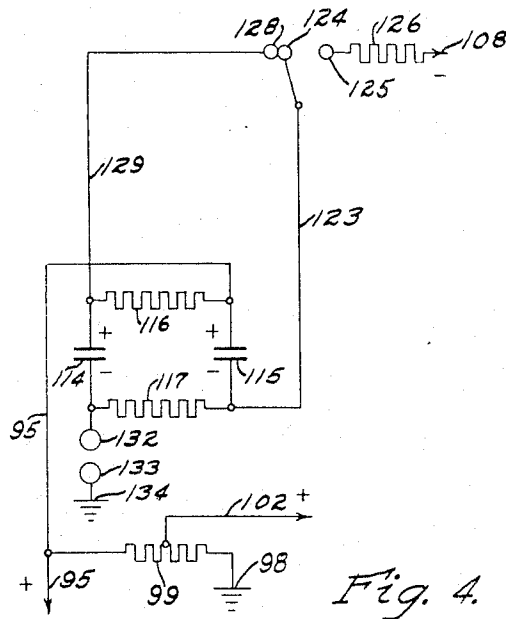
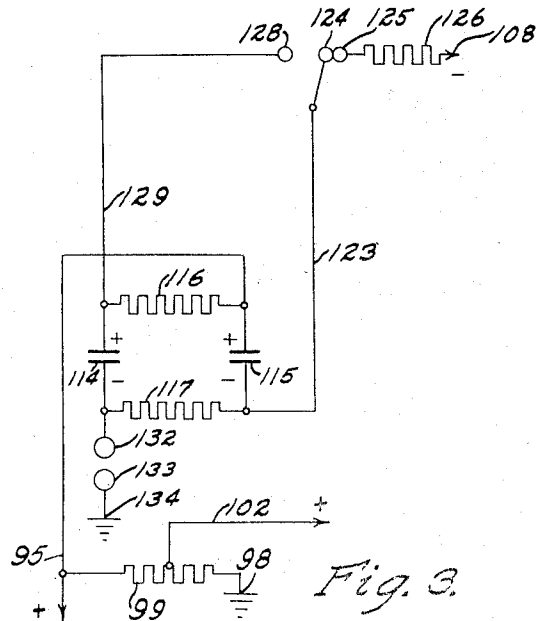
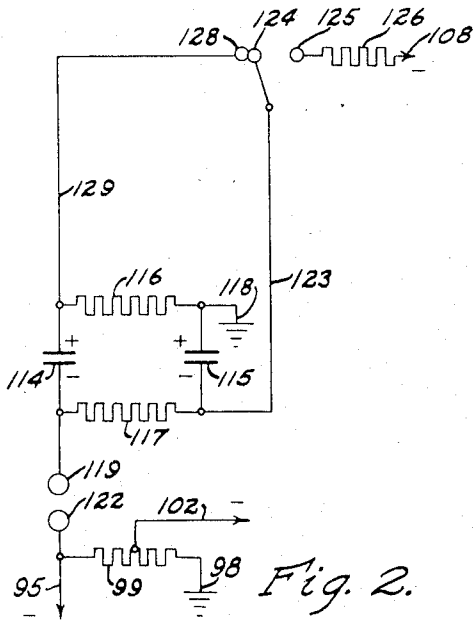
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2 Sheets-Sheet 2



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IMPULSE VOLTAGE TESTING EQUIPMENT

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7 Claims. (Cl. 175—183)

Our invention relates to impulse voltage testing of electrical apparatus in which a surge generator is employed in connection with a cathode ray oscillograph for recording surge characteristics, such as voltage.

In testing the impulse voltage strength of insulating material employed in electrical apparatus and recording the surge wave, it is necessary to initiate the discharge of the surge generator at a very definite time with respect to the operation of the timing circuit of the oscillograph. In order to accomplish the correct timing of the surge generator throughout its operating range, it has been found that the initiating voltage applied to the surge generator tripping circuit should be relatively high—for example, 60 kilovolts or more.

The initiating condenser that controls the discharge of the surge generator and initiates the operation of the oscillograph timing circuit may be charged from the same direct current supply source as the cathode of the oscillograph. The voltage of this supply source is, in many cases, fixed by the operating conditions of the oscillograph at a voltage below that required for the surge generator initiating condenser, such, for example, as at a value in the neighborhood of 37 kilovolts.

It is an object of our invention to provide a method and means for coordinating the initiation of the discharge of a surge generator with the operation of an oscillograph.

It is a further object of our invention to provide a common source of supply of direct current energy for supplying the cathode of the oscillograph and for supplying current to the circuits for initiating the operation of the surge generator and the oscillograph.

Other objects and advantages of our invention will be apparent from the following description of certain preferred embodiments thereof, reference being had to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of circuits and apparatus organized in accordance with our invention for employing a negative initiating surge to trip the surge generator and oscillograph;

Fig. 2 is a diagrammatic view illustrating a portion of the circuits and apparatus illustrated in Fig. 1 with the tripping switch in its discharging position;

Fig. 3 is a diagrammatic view of a portion of the circuits and apparatus used in the system of Fig. 1 arranged for delivering a positive initiating surge to trip the surge generator and oscillograph; and

Fig. 4 is a diagrammatic view of the circuits and apparatus illustrated in Fig. 3 with the tripping switch in its discharging position.

Referring to Fig. 1 of the drawings, the condensers 1, 2, 3 and 4 illustrate the capacitor elements of a surge generator arranged to discharge in series through spheres 5, 6, 7, 8, 9, 10, 11 and 12 to deliver a surge voltage to conductor 13 and through the gap represented by spheres 14 and 15 and conductor 16 to the apparatus being tested. Such apparatus is illustrated as a transformer 17, having a primary winding 18 connected between the conductor 16 and ground at 19, and a secondary winding 20 connected between conductors 21 and 22. A load resistor 23 is connected between conductor 13 and ground at 24, to which point one side of the condenser 1 is illustrated as grounded through conductor 25. The several condensers 1, 2, 3 and 4 are arranged to be charged in parallel from a source of direct current energy represented by conductors 31 and 32. Resistors 33, 34, 35 and 36 are connected in series with conductor 31 between the terminals of the various condensers or group of condensers 1, 2, 3 and 4, and similar resistors 37, 38 and 39 are connected in series with conductor 32 between the terminals of the various groups of condensers connected to that conductor.

A cathode ray oscillograph is diagrammatically illustrated including an emission tube 42, having a cathode 41 and an anode 43 connected to ground at 44, a relay part 45 and a recording part 46. The relay part 45 includes a target 47 against which the cathode ray beam, represented by the dotted line 48, strikes and is intercepted when the oscillograph is not recording. The cathode ray beam is bent about the target 47 as illustrated by the dotted line 48 upon the energization of the plates 50, 51, 52, 53, 54, 55, 56 and 57 when energized in accordance with the operation of the oscillograph timing circuit indicated generally at 58.

The recording part of the oscillograph includes a pair of deflecting plates 59 connected by conductors 62 and 63, respectively, to be energized from the timing system circuit 58, and a pair of deflecting plates 64 connected by conductors 65 and 66 to be energized in accordance with some chosen fraction of the voltage drop across a potential dividing resistor 67 connected between conductor 13 and ground at 68.

The timing system 58 includes two half-wave rectifier tubes 72 and 73 connected for charging condensers 74 and 75, respectively, that are connected to opposite ends of a resistor 76, the mid-

point 77 of which is connected to ground at 78 and through the secondary winding 79 of a transformer to the common conductor 82 between the tubes 72 and 73. A primary winding 83 is inductively related to the transformer winding 79 through which alternating current energy is supplied to the timing circuit. The tubes 72 and 73 maintain the condensers 74 and 75 charged continually to substantially peak alternating current voltage with the flow of a very small current so that during the charging operation substantially no voltage exists across the resistor 76. The plates 50, 53, 55 and 56 of the relay part of the oscillograph are connected by conductor 84 to a selected point on the resistor 76, and the plates 51, 52, 54 and 57 are connected by conductor 85 to another selected point on the resistor 76, so that upon discharge of the condensers 74 and 75 a predetermined voltage will appear across resistor 76 a portion of which will be applied between pairs of relay plates. Likewise, one of the deflecting plates 59 is connected through conductor 62 and resistor 86 to a selected point on the resistor 76, and the other of the pair of plates 59 is connected through conductor 63, resistor 87 to a selected point on the resistor 76. An adjustable condenser 88 is connected between resistors 86 and 87 for adjusting the voltage to be applied across deflector plates 59.

The anode of tube 72 is connected by conductor 89 to a sphere 92, and the cathode of tube 72 is connected by conductor 93 to a sphere 94. A common tripping circuit for tripping the surge generator and the timing system 58 of the oscillograph is provided including a conductor 95 that is connected to a sphere 96 through a resistor 97, the sphere 96 being positioned between spheres 5 and 6 of the surge generator. The conductor 95 is connected to ground at 98 through a high resistor 99 from an intermediate point of which a conductor 102 connects to a sphere 103 positioned between the spheres 92 and 94 of the oscillograph timing system.

In order to provide a source of rectified current for the oscillograph emission tube 42, a rectifier tube 104 is provided connected in a circuit extending from ground at 105 through a secondary transformer winding 106, a resistor 107, conductor 108 that is connected to the oscillograph cathode 41, a condenser 109 and conductor 110 to the grounded side of the winding 106. Alternating current energy is supplied at low voltage to the primary winding 112 for energizing the rectifier circuit which supplies a negative potential of, say, 37 kilovolts to the cathode 41.

In order to provide an initiating condenser assembly of the proper voltage for effecting the desired simultaneous operation of the surge generator and the oscillograph timing circuit to deliver either a positive or a negative initiating surge from a fixed source of negative polarity, condensers 114 and 115 are provided. A resistor 116 is connected between terminals of one polarity, and a resistor 117 is connected between terminals of opposite polarity of the condensers 114 and 115.

In Figs. 1 and 2, the condensers are connected for supplying a negative surge to the tripping circuit, and, as illustrated, the positive terminal of condenser 115 is connected to ground at 118, and the negative terminal of the condenser 114 is connected to a sphere 119 which, together with a sphere 122, forms a gap between the

initiating condenser circuit and the tripping circuit that is set so that it will not break down upon the application of voltage thereacross corresponding to that supplied from the tube 104 to the condensers 114 and 115 in parallel. The negative terminals of the condensers 114 and 115 are connected through conductor 123 and switch contact members 124 and 125 in the position illustrated in Fig. 1, and a charging resistor 126 to conductor 108 constituting a negative potential source through which condensers 114 and 115 are charged in parallel.

The resistors 116 and 117 serve as charging resistors to prevent excessive initial drain of energy from the cathode supply rectifier during charging of condensers 114 and 115. These resistors, which are of high ohmic value, perform a secondary function of preventing short circuiting of the condensers 114 and 115 when discharged in cascade, as will be shortly described.

After the condensers 114 and 115 have been charged by the parallel flow of current from conductor 123 to ground at 118, and it is desired to initiate operation of the surge generator and of the oscillograph, the switch contact member 124 is moved toward the left into engagement with the switch contact member 128 to connect the negative terminal of condenser 115 to the positive terminal of condenser 114 through contact members 124 and 128 and conductor 129, as shown in Fig. 2, thus applying a voltage across the gap between spheres 119 and 122 corresponding to the sum of the voltages of condensers 114 and 115, causing the gap to break down. Upon breakdown of this gap, the tripping circuit including conductor 95, which is normally at ground potential, is raised to a potential corresponding to the voltage drop across resistor 99, thus increasing the potential between sphere gaps 96 and 6 of the surge generator to a value high enough to effect a spark discharge thereacross. Upon the flow of current across this gap, the entire voltage of the condenser 1 that is normally applied between spheres 5 and 6 appears between spheres 5 and 96, causing this gap to break down, thus connecting condensers 1 and 2 in series between spheres 7 and 8 to cause this gap to break down. In a similar manner the successive gaps between spheres 9 and 10, and 11 and 12 break down to apply the full charge of the surge generator between conductor 13 and ground. The gap between spheres 14 and 15 breaks down to apply this voltage across the transformer winding 18 in a well known manner.

Simultaneously, with the breakdown between gaps 119 and 122, a portion of the voltage across resistor 99 appears on the sphere 103, which is so adjusted that the gap between spheres 94 and 103 initially breaks down, thus bringing the combined voltages of condensers 74 and 75 across the remaining gap between spheres 94 and 103, which is so adjusted as to break down and cause the condensers to discharge across this gap between spheres 92 and 94 and impress a high voltage across resistor 76. This voltage is employed for simultaneously operating the oscillograph relay 45 and impressing a voltage between deflecting plates 59 for causing the cathode beam 48 to be moved across the film at a substantially uniform velocity at the same time that voltage is impressed between deflection plates 64 for varying the position of the beam 48 at right angles to its direction of substantially uniform velocity in accordance with the magnitude of the transient being recorded.

It will be seen from the above description that when the switch contact 124 is moved from its charging position, in engagement with contact 125, to its discharging position, in engagement with the contact 128, the voltages of the two condensers are added, the positive terminal of the series connection being grounded at 118, and the negative terminal of the series connection being connected to the sphere 119. This series potential causes the gap between spheres 119 and 122 to spark over and initiate simultaneous discharge of the surge generator and the oscillograph timing circuit. The gap between spheres 119 and 122 prevents the resistor 99 from becoming a load on the cathode supply source during charging of the condensers 114 and 115.

For initiating a positive surge, the condensers 114 and 115 are connected as shown in Figs. 3 and 4, the negative terminals of the condensers being connected to the negative conductor 108 of the cathode supply source in the same manner as in Fig. 1. In this case, however, the spheres 119 and 122 are not employed, nor is the ground connection shown in Figs. 1 and 2 employed. The tripping circuit conductor 95 is connected to the positive terminal of the condenser 115, and the negative terminal of the condenser 114 is connected to a sphere 132 which together with sphere 133, forms a gap connection to ground at 134. The resistor 99 in this case serves as a charging resistor between the positive terminals of the condensers 114 and 115 and ground. Upon movement of the switch contact member 124 to its discharged position, as shown in Fig. 4, a circuit is completed from the positive terminal of condenser 115 that is initially at ground potential due to the connection through resistor 99 through condenser 115, conductor 123, switch contact members 124 and 128, conductor 129 and condenser 114 to impress a voltage between spheres 132 and 133 corresponding to the sum of the voltage of condensers 114 and 115, causing this gap to break down and supply a positive initiating surge to the surge generator through conductor 95 and to the timing system circuit of the oscillograph through conductor 102 to cause simultaneous operation of the surge generator and of the oscillograph, as above described for a negative initiating surge.

Many modifications of the apparatus and circuits illustrated may be made within the spirit of our invention, and we do not wish to be limited otherwise than by the scope of the appended claims.

We claim as our invention:

1. In combination, an impulse generator comprising a parallel charging circuit and a series discharging circuit, a cathode ray oscillograph comprising an emission tube including a cathode, a relay part with a recording part, a timing system for controlling said relay and recording parts, a high voltage direct current supply source connected to said cathode, and means for simultaneously initiating the discharge of said surge generator and the operation of said oscillograph timing system comprising a common tripping circuit, a pair of spaced spheres forming a sphere gap, a plurality of condensers adapted to be connected to said cathode supply source through a parallel charging circuit and to the tripping circuit through a series discharge circuit including said sphere gap.

2. In combination, an impulse generator comprising a parallel charging circuit and a series

discharging circuit, a cathode ray oscillograph comprising an emission tube including a cathode, a relay part and a recording part, a timing system for controlling said relay and recording parts, a high voltage direct current supply source connected to said cathode, a common tripping circuit including a sphere for initiating the discharge of said surge generator and a sphere for initiating the operation of said oscillograph timing system, a plurality of condensers, switching means for connecting said condensers to said cathode supply source through a parallel charging circuit and to said common tripping circuit through a series discharge circuit.

3. In combination, an impulse generator comprising a parallel charging circuit and a series discharging circuit, a cathode ray oscillograph comprising an emission tube including a cathode, a relay part and a recording part, a timing system for controlling said relay and recording parts, a high voltage direct current supply source connected to said cathode, a common tripping circuit for said surge generator and said oscillograph timing system, a pair of spaced spheres forming a sphere gap, a plurality of condensers, switching means effective in one operative position to connect said condensers in parallel relation to said cathode supply source and in another operative position to connect said condensers in series relation to said common tripping circuit through said sphere gap.

4. In combination, an impulse generator comprising a parallel charging circuit and a series discharging circuit, a cathode ray oscillograph comprising an emission tube including a cathode, a relay part and a recording part, a timing system for controlling said relay and recording parts, a high voltage direct current supply source connected to said cathode, a common tripping circuit for said surge generator and said oscillograph timing system, a plurality of condensers, high resistance impedance devices connected between corresponding terminals of said condensers, a terminal of one of said condensers being connected to ground, switching means for connecting the opposite terminal to the cathode supply source for charging in parallel, a sphere gap between a terminal of one of said condensers and said tripping circuit, and switching means for connecting said condensers in series circuit relation to discharge across said gap.

5. In combination, an impulse generator comprising a parallel charging circuit and a series discharging circuit, a cathode ray oscillograph comprising an emission tube including a cathode, a relay part and a recording part, a timing system for controlling said relay and recording parts, a high voltage direct current supply source connected to said cathode, a common tripping circuit for said surge generator and said oscillograph timing system, a plurality of condensers, high resistance impedance devices connected between corresponding terminals of said condensers, a terminal of one of said condensers being connected to said tripping circuit, a terminal of one of said condensers having a polarity opposite to the above-named terminal being connected to a sphere gap the opposite side of which is connected to ground, switching means for connecting the terminals of said condensers corresponding in polarity to that connected to said sphere gap to the cathode supply source for charging in parallel, and means for connecting said condensers in series with said sphere gap to effect a discharge thereacross.

6. In combination, an impulse generator com-

prising a parallel charging circuit and a series discharging circuit, a cathode ray oscillograph comprising an emission tube including a cathode, a relay part and a recording part, a timing system for controlling said relay and recording parts, a high voltage direct current supply source connected to said cathode, a common tripping circuit for said surge generator and said oscillograph timing system, a plurality of condensers, corresponding terminals of said condensers being connected to ground, switching means for connecting the opposite terminals of said condensers to the negative terminal of the cathode supply source for charging in parallel, a sphere gap between a terminal of one of said condensers and said tripping circuit the opposite side of which is grounded through a high resistance impedance, and switching means for connecting said condensers in series circuit relation to discharge across said gap.

7. In combination, an impulse generator comprising a parallel charging circuit and a series discharging circuit, a cathode ray oscillograph

comprising an emission tube including a cathode, a relay part and a recording part, a timing system for controlling said relay and recording parts, a high voltage direct current supply source connected to said cathode, a common tripping circuit for said surge generator and said oscillograph timing system, a plurality of condensers, corresponding terminals of said condensers being connected to said tripping circuit and to a ground connection therein, a terminal of one of said condensers having a polarity opposite to the above named terminals being connected to a sphere gap the opposite side of which is connected to ground, switching means for connecting the terminals of said condensers corresponding in polarity to that connected to the sphere gap to the negative terminal of the cathode supply source for charging in parallel, and switching means for connecting said condensers in series between said tripping circuit and said sphere gap to discharge thereacross.

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