

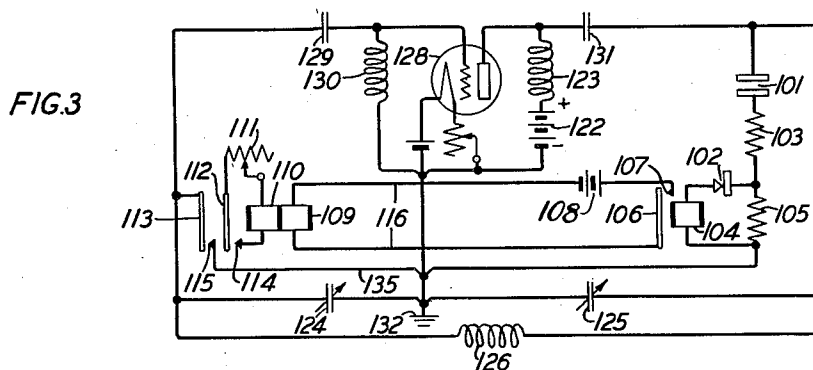
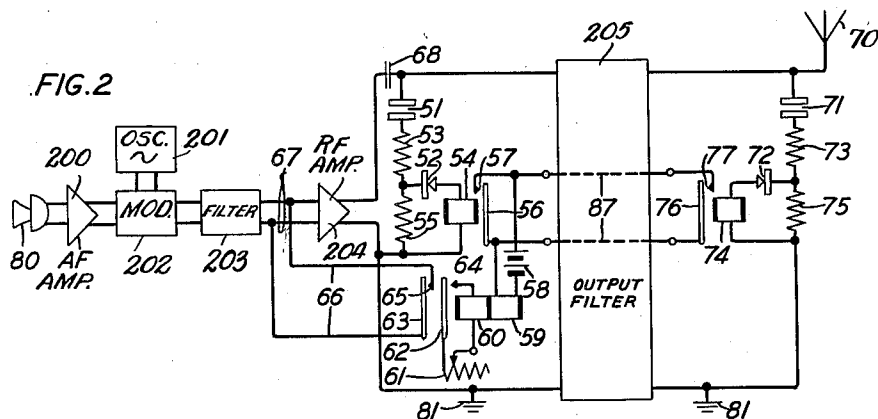
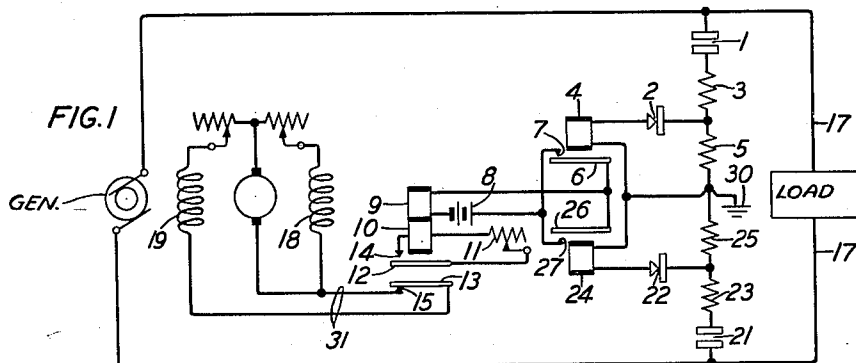
Aug. 4, 1936.

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2,049,948

PROTECTIVE MEANS FOR ELECTRIC CIRCUITS

Filed May 24, 1933



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2,049,948

PROTECTIVE MEANS FOR ELECTRIC CIRCUITS

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Application May 24, 1933, Serial No. 672,614

21 Claims. (Cl. 250—36)

This invention relates to protective means for electrical circuits and more particularly to protective means for radio frequency transmission apparatus.

5 An object of this invention is to protect electrical apparatus from overloads of voltage.

Another object of this invention is the provision of means for the prevention of breakdown and damage to extremely expensive apparatus.

10 A more particular object is the provision of protective means, the operation of which causes no appreciable loss in the continuity of radio transmissions.

15 In accordance with a feature of this invention, means relieve the overload of potential in an electrical circuit for a predetermined period and subsequently restore the circuit to its operative condition.

20 In accordance with another feature of this invention a discharge path and automatic means associated with the output circuit of a radio frequency transmission system disables the input circuit for a fixed predetermined interval after which the apparatus again becomes operative.

25 In accordance with another feature of this invention means are provided whereby the high potential direct current for supplying the output circuits of a radio frequency amplifier is not discontinued during the operation of the protective mechanism.

30 Other features and advantages which are inherent in the invention will become apparent upon a consideration of the description given hereinafter and from a consideration of the appended claims.

35 In circuits of high power radio frequency transmitting systems especially high potentials are used. For transatlantic radio telephony, for example, a potential of over 18,000 volts is employed. It has been found that the potential in these circuits sometimes builds up to a point of which serious damage to the associated networks and apparatus results if it is not either removed or reduced. Heretofore, in order to protect the
40 elaborate networks, a discharge path was provided in the output circuit. Whenever the dangerous radio frequency surges were produced, the currents would pass over the discharge path. However, when the surge was once produced, the
45 normal radio frequency potential, although below that which caused serious damage to the apparatus, was sufficiently high to maintain the discharge. This condition resulted in the necessity of terminating the operation of the trans-
50 mission equipment completely. Since time was

an important factor in radio telephony or broadcasting, the situation not only severely hampered the continuity of the program or conversation, but in addition resulted in a serious economic loss.

5 In accordance with this invention means are provided whereby the expensive networks of radio frequency circuits are rendered immune from damage and the conversation or program is not appreciably interrupted by this protection. 10 A discharge path is provided in the circuit of a radio frequency transmitter at a point at which the excessively high potential radio frequency surges pass over the discharge path instead of through the networks to be protected. Means 15 associated with the discharge path disable the circuit for a fixed predetermined period in response to the discharge in the path and then restore the apparatus to its former operative condition. If the circuit is reenergized immediately after the discharge has been dispersed, the discharge path, due to the presence of ionized gas or vapor, usually breaks down again at a potential below that which causes damage to the 20 apparatus. The short delay before reenergization permits the gas to dissipate. 25

A better understanding of this invention may be obtained by reference to the accompanying drawing in which:

30 Fig. 1 is a schematic of a generic form of the invention;

Fig. 2 is a schematic of the application of the invention to radio transmitting systems; and

35 Fig. 3 is a schematic of this invention applied to an oscillator.

Referring to Fig. 1, GEN represents a generator or source of power connected by means of a line 17 to the apparatus or instrumentalities for which protection against excessive surges is desired. The generator comprises a field 19 and an exciting means 18 connected in series therewith by means of the line 31. The exciting means 18 comprises another source of power such as a battery or another generator. A discharge path comprising the gap 1 is connected between the ground 30 and one side of the line 17 at a point between the source of power GEN and the apparatus or load represented in the drawing by the rectangle labeled Load. Connected 40 by the other side of the line 17 and ground 30 is another discharge path comprising the gap 21. The gap 21 is connected to the line between the generator GEN and the apparatus or load. In series with each of the discharge paths 1 and 21 55

are means for providing a relatively small potential difference which is sufficient to operate an actuating means without any appreciable damage thereto upon the occurrence of a discharge in the respective paths. This means comprises two resistances 3 and 5 for the gap 1 and 23 and 25 for the gap 21, resistance elements 3 and 23 having a considerably higher value than that of resistances 5 and 25, respectively. The lengths of the gaps 1 and 21 determine the potential at which a surge passes over the path. Connected in parallel to the resistance element 5 is an actuating means comprising an electromagnetic device 4. When a discharge passes over the path 1, the potential across the low resistance element 5 is considerably less than that which exists across the high resistance 3 or the line 17. As a result, while the electromagnetic device is actuated, it is not damaged by the passage of current across the discharge path. A like actuating means comprising the electromagnetic device 24 and connected in parallel with the resistance element 25 is provided for the discharge path 21. If the source of power is alternating current, means for converting that current into pulsating current may be inserted in series with the actuating means 4 and 24. The elements 2 and 22 comprising copper oxide rectifiers are media for serving this function. Other means, such as space discharge devices, may be employed. Means operated by the actuating means are provided which disables the circuit for a short interval after which the circuit is again restored to its normal condition. This means comprising an instrumentality responsive to the actuating means, circuit contacts, the instrumentality disabling the circuit by means of the circuit contacts, and a delay acting device for sustaining the disability for a fixed predetermined period. The instrumentalities responsive to the actuating means comprises an electromagnetic device 9, the circuit for the energization of which is completed through make contact 7, battery 8 through the device 9 to armature 6 or make contact 27, battery 8, through the device 9 to the armature 26. The circuit contacts for disabling the circuit comprises the break contact 15 and the armature 13. The opening of these contacts disables the field of the source GEN by opening the line 31 connecting the field 19 to the exciting means 12. The delay acting device comprises an auxiliary winding 10 of the electromagnetic device 9. This device serves to sustain the energization of that device for a predetermined interval depending upon the value of the variable resistance 11. The circuit for the auxiliary winding 10 is completed through the engagement of make contact 14 and armature 12. Other delay acting devices such as those employing space discharge devices may be employed for this purpose.

The lengths of the discharge paths are regulated so that a surge passes over either path whenever a potential exists on the line 17 which might damage the apparatus desired to be protected. When the surge occurs in gap 1, a portion of the current passes through the device 4, armature 6 engages contact 7, relay 9 becomes energized, armature 12 engages with make contact 14 and armature 13 disengages from break contact 15. This latter action opens the line 31. The field 19 of the generator becomes deenergized and the surge ceases. A discharge over the gap 21 energizes the device 24, armature 26 engages with contact 27, relay 9 becomes energized, armature 13 disengages from contact 15, arma-

ture 12 engages contact 14, the field of the generator becomes deenergized and the surge ceases. Although armature 6 disengages with make contact 7 upon the cessation of a surge over the discharge path 1 and armature 26 disengages from contact 27 in a like manner when the surge over the discharge path 21 ceases, relay 9 remains energized for a predetermined period thereafter due to the induced electromotive force stored in auxiliary winding 10. This delay affords a sufficient time for the high potential to be dispersed from the system and the ionized gas to be dissipated from the gap. After the interval, electromagnetic device 9 becomes deenergized, armature 12 disengages from the contact 14, break contact again engages with armature 13, the circuit from the exciting source to the field is completed and the system returns to normal condition.

Fig. 2 shows the invention applied to a radio transmitting system, a line from the transmitter 80 passes through successively an audio frequency amplifier 200 and a modulator 202 supplied with radio frequency currents by the oscillator 201. The modulated currents then pass through an input filter 203, and through a radio frequency amplifier 204. Since the anodes of the space discharge devices of the amplifier are supplied with a high potential direct current, a block condenser 68 is interposed between one side of the line and the output filter 205. The other side of the line from the radio frequency amplifier is connected to ground 81. From the output filter the ungrounded side of the line passes to the antenna. The above described radio transmitting system is of the conventional type well known to those skilled in the art.

For the protection of the apparatus from excessive surges, a discharge path 51 is inserted across the line in the output circuit between the block condenser 68 and the output filter 205. In series with the discharge path are two resistance elements 53 and 55. Element 53 has a relatively high resistance and element 55 is low. A value of 2500 ohms has been found satisfactory for element 53, while that of 2 ohms is desirable for element 55. In parallel to the resistance 55 an electromagnetic device 54 is inserted. Means for the passage of pulsating current through the device 54 when a surge occurs in the path 51 is provided. This means comprises the copper oxide rectifier 52 in series with the device 54. A make contact 57 and an armature 58 are associated with the device 54, the energization of device 54 causing the engagement of the armature and make contact. For the protection of the apparatus from the high potentials resulting from atmosphere charges attracted by the antenna 70 a similar discharge path 71 is inserted between the antenna and ground. In series with this discharge path are two resistance elements 73 and 75. An electromagnetic device 74 is connected across resistance 75. A copper oxide rectifier 72 connected in series with device 74 serves to convert the radio frequency current to pulsating current. Associated with electromagnetic device 74 are make contacts 77 and armature 76. An electromagnetic device 59 is energized by the engagement of the armature 56 with make contact 57 or the armature 76 with make contact 77 whenever their respectively associated electromagnetic devices 54 or 74 are energized. The circuits by which device 59 is energized are as follows: make contact 57, one side of line 87, battery 58, electromagnetic device 59, 75

the other side of line 87 to armature 56; or make contact 77, one side of line 87, battery 58, electromagnetic device 59, the other side of line 87 to armature 76. Connected across the line 67 between the input filter 203 and the radio frequency amplifier 204 is a line 66. Circuit contacts for closing that line comprise the armature 63 and the make contact 65 associated with the electromagnetic device 59. The energization of the device 59 produces the disability of the transmitting circuit at a point between the input filter 203 and the radio frequency amplifier 204 by means of the closure of line 66 by the engagement of armature 63 with the make contact 65. A means for sustaining the disability of this circuit for a predetermined interval comprises an auxiliary winding 60 associated with the electromagnetic device 59, a variable resistance 61 connected in series with the auxiliary winding and a circuit completing means comprising the armature 62 and the make contact 64 associated with the device 59. By adjusting the variable resistance 61, the time that the circuit remains disabled may be varied. When the relay 59 is energized, the engagement of armature 62 with the make contact 64 completes a circuit for the auxiliary winding 60 so that the device 59 remains energized for a short interval from the induced electromotive force produced in this winding. The block condenser 68 prevents the surge across the gap from being sustained by the direct current source of the radio frequency amplifier 204.

The lengths of the discharge paths 51 and 71 are adjusted for insuring protection to the apparatus at the minimum potential at which damage to the associated networks or apparatus of the system occurs. For the system employing 18,000 volts a length of .375 inch has been found satisfactory. When an excessive potential occurs, a surge passes over either paths 51 or 71. The difference of potential across resistance elements 55 or 75 causes the passage of radio frequency currents through the respectively associated parallel circuits. The copper oxide rectifiers 52 and 72 convert this current into pulsating current. As a result either device 54 or 74 is actuated. Electromagnetic device 59 then becomes energized by the engagement of either armature 56 with the make contact 57 or armature 76 with make contact 77 depending upon whether device 54 or 74 is energized. As a result of the energization of electromagnetic device 59, armatures 62 and 63 engage respectively with make contacts 64 and 65. The closure of line 66 disables the input circuit of the radio transmitter system with the consequential relieving of the high potential in the output circuit. The engagement of the make contact 64 with the armature 62 completes the circuit for the energization of the relay 59 from the induced electromotive force produced in the auxiliary winding. Since a lesser potential is required to maintain the surge after the initial discharge, this short interval of continued disability of the input circuit insures the removal of the potential sufficient to maintain the surge. In addition the ionized gases resulting from the surge are dissipated. It has been found that three-tenths of a second is usually satisfactory for this purpose. While the potential of the output circuit of the radio frequency amplifier of certain transatlantic radio systems is approximately 18,000 volts, that of the input of these same systems is less than 10 volts. After the interval

of delay device 59 becomes deenergized, contact 65 is disengaged from armature 63 and the circuit again becomes operative.

In Fig. 3 the application of the invention to an oscillator is illustrated. The numerical designation 128 represents a space discharge device comprising a grid, cathode and anode. The elements 124 and 125 are variable condensers connected in series with each other and respectively in the input and output circuits of the oscillator. Connected across the condensers is an inductance 126. By adjusting the condensers 124 and 125 the oscillator may be tuned to the desired frequency. In shunt with the output circuit is a choke coil 123 in series with a source of current 122 for the anode of the space discharge device. The function of the choke coil 122 is the prevention of an excessive amount of current from being shunted around the condenser 125. A condenser 129 is in series in the input circuit. Between the condenser 129 and the grid of the space discharge device, a choke coil 130 is shunted across the input circuit. The oscillator, the elements of which are outlined above is well known and is a modification of the oscillation generator fully described in U. S. Patent 1,624,537 granted to E. H. Colpitts on April 12, 1927.

Across the output circuit between the condenser 131 and the ground 132 is a discharge path comprising the gap 101. In series with the discharge path are means for providing a relatively small potential difference to energize an actuating means. The means for providing the potential difference comprise elements 103 and 105 connected in series with the gap 101, element 103 having a considerably higher resistance than element 105. The actuating means comprising the electromagnetic device 104 is connected across the element 105. Means comprising the copper oxide rectifier 102 for rendering the actuating means responsive to the alternating currents passing through the parallel circuit are inserted in series with the electromagnetic device 104. An electromagnetic device 109 responsive to the actuating means is energized by the completion of the circuit: armature 106, make contact 107, battery 108 to device 109. Means for sustaining the energization of the device 109 for a predetermined interval after its initial energization comprises an auxiliary winding 110, the circuit for which is completed through the variable resistance 111, the armature 112, make contact 114 to the winding 110. By adjusting the resistance 111, the interval may be varied. A circuit for disabling the input circuit of the oscillator comprises a line 135 connected across the input circuit. The circuit is completed by the engagement of armature 113 and make contact 115 of electromagnetic device 109. A block condenser 131 in the output circuit between the source of current 122 and the discharge path prevents the potential from the direct current source 122 from continuing the surge after the disability of the input circuit.

The length of the path 101 is adjusted so that a surge passes over the gap whenever an excessive potential exists in the output circuit. When a surge passes over the gap 101, a small difference of potential is produced across the element 105. Alternating current starts to flow through the parallel circuit comprising the electromagnetic device 104. By means of the rectifier 102, the alternating current is converted for the energization of the electromagnetic device 104. Make

contact 107 engages with the armature 106. Electromagnetic device 109 becomes energized as a result of this action. Armatures 113 and 112 engage respectively with make contacts 115 and 114. The input circuit of the oscillator becomes disabled. As a consequence, the potential of the output circuit is materially reduced. The surge ceases and make contact 107 is disengaged from the armature 106. However, electromagnetic device 109 remains energized for a short period after this disengagement by virtue of the induced electromotive force stored in the auxiliary winding 110. The disability of the input circuit therefore continues for a short period after the excessive potential appears in the output circuit. After this period has passed, armatures 113 and 112 disengage respectively from make contacts 115 and 114 and the oscillator again becomes operative.

While the protective device is described as associated with a particular oscillator, it is equally applicable to all types of oscillators.

What is claimed is:

1. In combination, an electric circuit, a protective system comprising a discharge path in which the discharge is sustained at a potential lower than that required to initiate discharge and means for disabling said circuit for a fixed predetermined period in response to the occurrence of a discharge in said path, said period being sufficient to prevent the occurrence of a discharge in said path at a lower potential than that initially required.

2. In combination, an electric circuit, a protective system comprising a discharge path in which partial ionization of the gases contained therein is produced upon the occurrence of a discharge, means for disabling said circuit in response to the occurrence of a discharge in said path, and means for restoring said circuit to its operative condition after a fixed predetermined period sufficient for the ionized gases produced by said discharge in said path to be dissipated.

3. In combination, an electric circuit, a protective system comprising a discharge path in which partial ionization of the gases contained therein is produced upon the occurrence of a discharge, means for providing a relatively small potential upon the occurrence of a discharge in said path, actuating means responsive to said potential for disabling said circuit, and means for restoring said circuit to its operative condition after a fixed predetermined period sufficient for the ionized gases produced by said discharge in said path to be dissipated.

4. In combination, an electric circuit having a generator comprising an armature and field, a protective system comprising a discharge path in which partial ionization of the gases contained therein is produced upon the occurrence of a discharge, means for disabling the field of said generator on the occurrence of a discharge in said path, and means for restoring said field to its operative condition after a fixed predetermined period sufficient for the ionized gases produced by said discharge in said path to be dissipated.

5. In combination, an electric circuit, a protective system comprising a discharge path in which partial ionization of the gases contained therein is produced upon the occurrence of a discharge, means for providing a relatively small potential upon the occurrence of a discharge in said path, actuating means responsive to said potential, means operated by said actuating means for disabling said circuit, and means for restoring

said circuit to its operative condition after a fixed predetermined period sufficient for the ionized gases produced by said discharge in said path to be dissipated.

6. In combination, an amplifying circuit comprising input and output circuits, a discharge path in said output circuit, and means responsive to any discharge in said path for disabling said input circuit.

7. In an amplifying circuit comprising input and output circuits, a protective device comprising a discharge path in said output circuit, means to disable the input circuit for a fixed predetermined period upon the occurrence of any discharge in said path, and means for restoring said circuit to its operative condition after said period.

8. In an amplifying circuit having an output circuit connected thereto, a protective device comprising a discharge path in said output circuit, said discharge path characterized in this that partial ionization of the gases contained therein is produced upon the occurrence of a discharge, and means to disable said amplifying circuit upon the occurrence of a discharge in said path, and means for restoring said circuit to its operative condition after a fixed predetermined period sufficient to permit the ionized gases produced by said discharge in said path to be dissipated.

9. In an amplifying device comprising input and output circuits, a protective system comprising a discharge path in said output circuit, electromagnetic means responsive to any discharge in said path for disabling said input circuit, and means for sustaining the disability of said input circuit for a fixed predetermined interval.

10. In an amplifying circuit comprising input and output circuits, a protective system comprising a discharge path in said output circuit, means for providing a relatively small electromotive force upon the occurrence of any discharge in said path, means responsive to said electromotive force for disabling said input circuit and means for sustaining the disability for a fixed predetermined interval.

11. In an amplifying circuit comprising input and output circuits, a protective system comprising a gaseous discharge path in said output circuit, means for providing a relatively small electromotive force upon the occurrence of a discharge in said path, an electromagnetic device responsive to said electromotive force, circuit contacts for disabling said input circuit, means actuated by said electromagnetic device for controlling said circuit contacts to disable said input circuit, and means for sustaining the disability of said input circuit for a fixed predetermined period sufficient to permit the ionized gases produced by said discharge in said path to be dissipated.

12. In an oscillating circuit comprising input and output circuits, a discharge path in said output circuit, means responsive to any discharge in said path for disabling said input circuit for a fixed predetermined interval and means for restoring said input circuit to its operative condition after said interval.

13. In an amplifying circuit comprising input and output circuits, a protective system comprising means for short-circuiting said input circuit when an excessive potential exists in said output circuit.

14. In combination, a radio frequency amplifier, input and output circuits connected thereto, a filter connected to said output circuit and a protective system comprising means for short-

circuiting said input circuit of said radio frequency amplifier when an excessive potential is produced in said output circuit between said radio frequency amplifier and said filter.

5 15. In a radio transmitter comprising a radio frequency amplifier having an output circuit connected thereto, a filter connected to said output circuit and an antenna connected to said filter and a protective system comprising means for
10 disabling said radio frequency amplifier when an excessive potential is produced between said filter and said antenna.

16. In a radio transmitting system comprising a radio frequency amplifier having input and output
15 circuits, a filter connected to said output circuit, a protective system comprising a discharge path in said output circuit between said radio frequency amplifier and said filter, and means for disabling the input circuit of said amplifier
20 upon the occurrence of any discharge in said path.

17. In an alternating current circuit a protective system comprising a discharge path, in
25 which partial ionization of the gases contained therein is produced upon the occurrence of a discharge, means for providing a relatively small electromotive force upon the occurrence of a discharge in said path, circuit contacts for disabling said circuit, rectifying means to convert
30 the alternating current provided by said electromotive force to unidirectional current, actuating means responsive to said unidirectional current for controlling said circuit contacts and a delay-

acting device for sustaining the disability of said circuit for a fixed predetermined period sufficient to permit the ionized gases produced by said discharge in said path to be dissipated.

18. An amplifying system comprising a plurality of stages connected in cascade, each stage
5 comprising a space discharge device, and a protective system comprising means for short-circuiting an earlier stage of said system when an excessive potential exists in a later stage.
10

19. An amplifying circuit comprising input and output circuits, a space discharge device connected to said input circuit and a second space
15 discharge device connected in cascade to said first space discharge device and connected to said output circuit and means for short-circuiting said input circuit when an excessive potential exists in said output circuit.

20. In an amplifying system comprising input and output circuits, a protective system comprising
20 ing means responsive to an excessive potential in said output circuit for disabling said input circuit for a fixed predetermined period and for restoring said input circuit to its operative condition after said period.
25

21. In an amplifying circuit having input and output circuits connected thereto, a protective
25 system comprising means, responsive to an excessive potential in said output circuit, for removing the potential from said input circuit.
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