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A. CARPE ET AL

PROTECTION CIRCUITS

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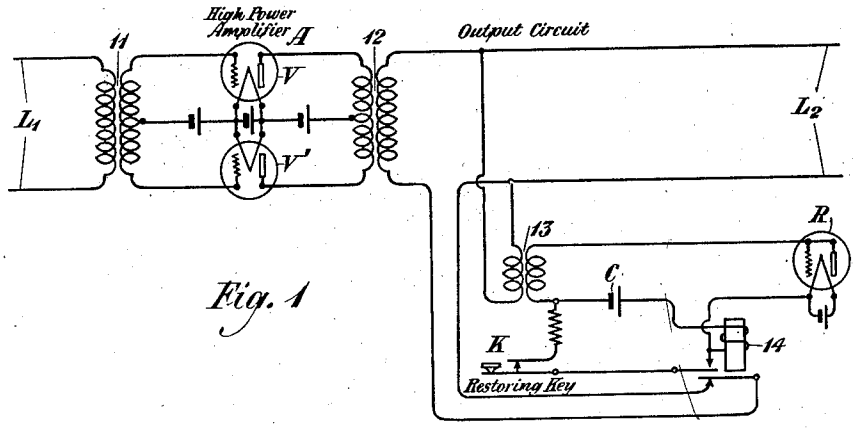


Fig. 1

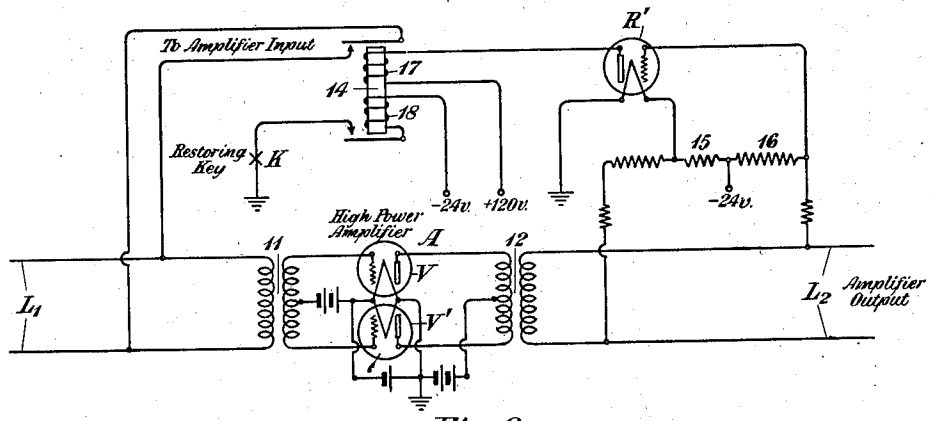


Fig. 2

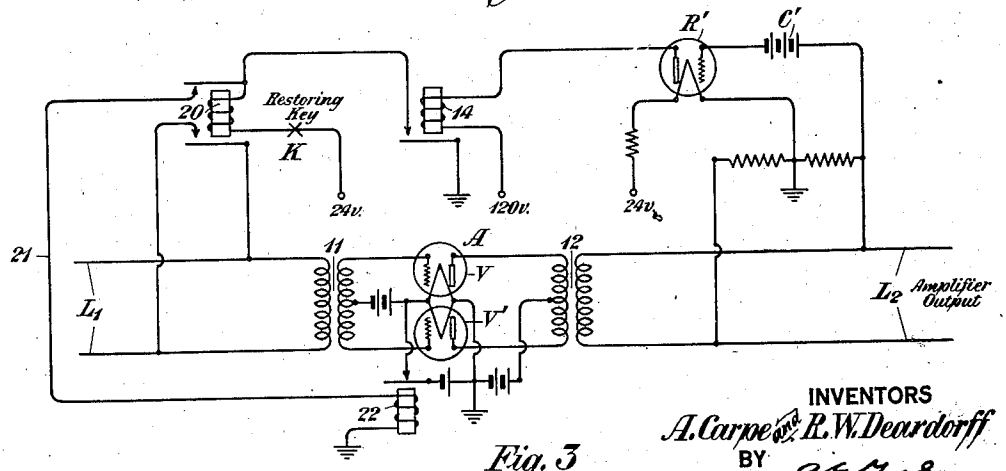


Fig. 3

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UNITED STATES PATENT OFFICE.

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PROTECTION CIRCUITS.

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This invention relates to protective apparatus and particularly to apparatus for protecting circuits from high voltages.

In the operation of telephone repeater circuits, particularly where it is desired to transfer from the output of the repeater considerable volumes of energy in order to bring the transmission up to a desired level, it is desirable to provide some means for protecting the outgoing circuit from abnormal voltages as such abnormal voltages might be dangerous to the plant equipment and the maintenance forces. One of the objects of the invention is to provide suitable protective apparatus for such an installation although the principle of the invention is applicable to the protection of other types of circuits.

The invention may now be more fully understood from the detailed description thereof when read in connection with the accompanying drawing, Figures 1, 2 and 3 of which illustrate circuit diagrams of three different embodiments of the invention.

Referring to Fig. 1, L_1 designates an incoming transmission line and L_2 an outgoing transmission line at a repeater station, these lines being interconnected through a high power amplifier stage A, comprising vacuum tubes V and V′ arranged in the usual type of push-pull circuit. The input side of the amplifier A is connected with the line L_1 through transformer 11 and the output side of the amplifier is connected to the outgoing line L_2 through transformer 12. In general, additional input amplifier stages will be included in the incoming line L_1, not shown in the drawing, to amplify the incoming signal voltages to the amplitude required to operate the power amplifier.

Ordinarily the amplifier is so designed that its internal impedance will be equal to the impedance of the outgoing line. Under these conditions the voltage drop across the line terminals is only half the total alternating voltage generated in the output circuit of the tubes. This will be clear when it is considered that the total generated voltage must be equal to the voltage drop through the internal impedance of the amplifier plus the voltage drop through the impedance of the line. The voltage drop across the terminals of the line will be equal to the drop across the internal impedance of the repeater which is one-half the total drop. If the line should accidentally become open at some point, either due to a line failure, or due to the operation of a plug at the test board or by the blowing of a fuse or heat coil, the entire applied voltage will appear across the terminals of the lines, or in other words, the voltage across the line equipment will be doubled. If the alternating peak voltage is normally adjusted to be within the safety limits by a narrow margin, such opening of the circuit would cause the limits to be exceeded with consequent possible damage to equipment constituting a hazard from a fire standpoint and even a danger to the maintenance force.

Another potential source of abnormally high voltages in an installation of this kind arises from the possibility of "singing" due to the large amount of amplification existing in the power amplifier and associated input amplifiers in tandem. It is well known that a relatively small degree of unbalance or "feed-back" between the output and input circuits of such an amplifier installation may cause the amplifiers to generate oscillations, whose amplitude may greatly exceed the normal output of the amplifiers. Such effects may arise due to line troubles, etc.

In order to eliminate these dangers a rectifier tube R is provided which is bridged across the circuit of the line L_2 through a transformer 13. A battery C is connected in circuit with the rectifier and is so poled that it tends to cause a flow of current in the direction opposite to that for which the rectifier tube is conductive. As a consequence no current can flow through the rectifier until the voltage peaks applied through the transformer 13 attain an amplitude greater than the voltage of the battery C. The half waves of alternating voltage having a direction opposite to the voltage of the battery C will then cause current to flow through the rectifier R and through the winding of a relay 14. If the voltage through the transformer 13 exceeds the voltage of the battery C by a sufficient amount, enough current will flow through the relay 14 to cause it to attract its armature. The current thus drawn from the line tends to reduce the voltage across the line terminals and to this extent acts as a protection. Furthermore, the operation of the relay is such as to open the cir-

cuit adjacent to transformer 12 so that no voltage can be applied to the line conductors beyond this point.

The relay 14 may have its circuit so arranged that it will be locked up through a key K whereby when the voltage limits once have been exceeded the apparatus will operate automatically to open the output circuit and prevent the voltages from being applied to the line equipment. When once operated the circuit will remain in the condition just described until the trouble is located and repaired whereupon the key K may be opened to restore the relay 14 and the repeater circuit will function in the normal manner.

Fig. 2 illustrates a modified arrangement in which the protector circuit operates in response to abnormal voltages to disable the input side of the repeater. In this circuit, instead of using a rectifier R a three-element vacuum tube R′ is employed. The filament of the tube obtains its current from a 24-volt battery connection applied to a potentiometer as indicated. The resistance 15 of the potentiometer is in series with the filament of the tube. The grid of the tube is connected to the 24-volt lead through the resistance 16 of the potentiometer so that the grid is made negative with respect to the filament. The grid is made sufficiently negative by this connection so that normally no current can flow in the plate circuit due to the voltage of the 120-volt B battery.

When, however, the voltages applied to the line L_2 become abnormal, as for example, when the repeater sings, or the line is opened, the positive peaks of the voltage will tend to make the grid less negative and will permit current to flow in the plate circuit through the winding 17 of the relay 14. The relay 17 when operated is locked up through its winding 18 and the contact of restoring key K, thereby maintaining a short circuit connection at the upper contact of the relay 14 across the input circuit of the amplifier. This prevents alternating voltage from being transmitted through the amplifier and consequently protects the circuit L_2 from excess voltage. When the trouble has been located and repaired the restoring key K can be operated to release the relay 17, whereupon the short circuit is removed and the repeater functions in a normal manner.

A slightly modified arrangement is illustrated in Fig. 3. In this figure the connection of the tube R′ to the output circuit L_2 is similar to that shown in Fig. 2 and normally no current flows in the plate circuit. When excess voltage is applied, however, the negative potential due to the grid battery C′ is counteracted and current flows in the plate circuit and through the winding of the relay 14 thereby energizing said relay. Relay 14 in turn closes a circuit through relay 20 and through the restoring key K. Relay 20 is locked up over its upper contact and over conductor 21 through the winding of the filament control relay 22. The filament control relay 22 is thereupon locked up in series with the relay 20, said relay 22 opening the filament circuit of the amplifier while at the same time relay 20 closes a short circuit across the input line L′.

Upon the condition causing the abnormal voltage being overcome the key K can be actuated, thereby releasing relays 20 and 22 to remove the short circuit from the incoming line L_1 and to again close the filament circuit of the amplifier A. The repeater is now restored to normal condition and will function in the normal manner.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a protection system, a translating device, means to apply a voltage thereto to be translated, an outgoing circuit connected to said translating device, the impedance of the outgoing circuit being so related to the impedance of said translating device that the voltage across the outgoing circuit will normally be less than the translated voltage, means responsive to an increase in the voltage drop across the outgoing circuit to operate a relay, and means controlled by said relay for preventing the abnormal voltage from being applied to the terminals of said outgoing circuit.

2. In a protection system, a translating device, means to apply a potential thereto to be translated, an outgoing circuit connected to said translating device, the impedance of the outgoing circuit being so related to the impedance of said translating device that the voltage drop across the terminals of the outgoing circuit will normally be less than the translated voltage, a vacuum tube connected to said outgoing circuit, means associated with said tube for preventing the current from flowing therethrough in response to normal peak voltages applied to the outgoing circuit but permitting current to flow through said tube when the peak voltages exceed the normal flow, and a relay controlled by said tube and energized when current flows therethrough to prevent the excess voltages from being applied to the terminals of said outgoing circuit.

3. In a protection system for telephone repeaters, an amplifier, an incoming circuit over which voltages may be applied to said amplifier, an outgoing circuit connected to the output side of said amplifier, a translating device connected to said outgoing circuit, said translating device being so arranged

that no current will flow therethrough in response to a normal voltage applied across the terminals of said outgoing circuit but permitting current to flow when the normal voltage across the terminals of said outgoing circuit is exceeded, and means controlled by said translating device in response to current flow therethrough for preventing the excess voltages operating said device from being applied to said outgoing circuit.

4. A protection system for telephone repeaters comprising an amplifier, an incoming circuit over which voltages may be applied to said amplifier, an outgoing circuit connected to the output side of said amplifier, a vacuum tube connected to said output circuit, means associated with said tube for preventing current from flowing therethrough when a normal voltage exists across the terminals of said outgoing circuit, but permitting current to flow therethrough when said normal voltages are exceeded, and means controlled by said vacuum tube in response to current flowing therethrough to prevent the abnormal voltages causing said current flow from being applied to the terminals of said outgoing circuit.

5. In a protection system for telephone repeaters, an amplifier, an incoming circuit over which voltages may be applied to said amplifier, an outgoing circuit connected to the output side of said amplifier, a vacuum tube connected to said outgoing circuit, means associated with said vacuum tube for preventing current flow therethrough in response to a normal voltage across said outgoing circuit but permitting current to flow through said tube when said normal voltage is exceeded, and a relay operated by current flowing through said tube, said relay operating to disable said amplifier.

6. In a protection system for telephone repeaters, an amplifier, an incoming circuit over which voltages may be applied to said amplifier, an outgoing circuit connected to the output side of said amplifier, a vacuum tube connected to said outgoing circuit, means associated with said vacuum tube for preventing current flow therethrough in response to a normal voltage across said outgoing circuit but permitting current to flow through said tube when said normal voltage is exceeded, and a relay operated by current flowing through said tube, said relay operating to disable said incoming circuit.

7. In a protection system for telephone repeaters, an amplifier, an incoming circuit over which voltages may be applied to said amplifier, an outgoing circuit connected to the output side of said amplifier, a vacuum tube connected to said outgoing circuit, means associated with said vacuum tube for preventing current flow therethrough in response to a normal voltage across said outgoing circuit but permitting current to flow through said tube when said normal voltage is exceeded, and a relay operated by current flowing through said tube, said relay operating to short circuit said incoming circuit.

8. In a protection system for telephone repeaters, an amplifier, an incoming circuit over which voltages may be applied to said amplifier, an outgoing circuit connected to the output side of said amplifier, a vacuum tube connected to said outgoing circuit, means associated with said vacuum tube for preventing current flow therethrough in response to a normal voltage across said outgoing circuit but permitting current to flow through said tube when said normal voltage is exceeded, and a relay operated by current flowing through said tube, said relay operating to disable said incoming circuit and to disable said amplifier.

In testimony whereof, I have signed my name to this specification this 5th day of August, 1925.

ALLEN CARPE.

In testimony whereof, I have signed my name to this specification this 15th day of August, 1925.

RALPH W. DEARDORFF.