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MEANS FOR PRODUCING TIME LAG IN ELECTRICAL CIRCUITS

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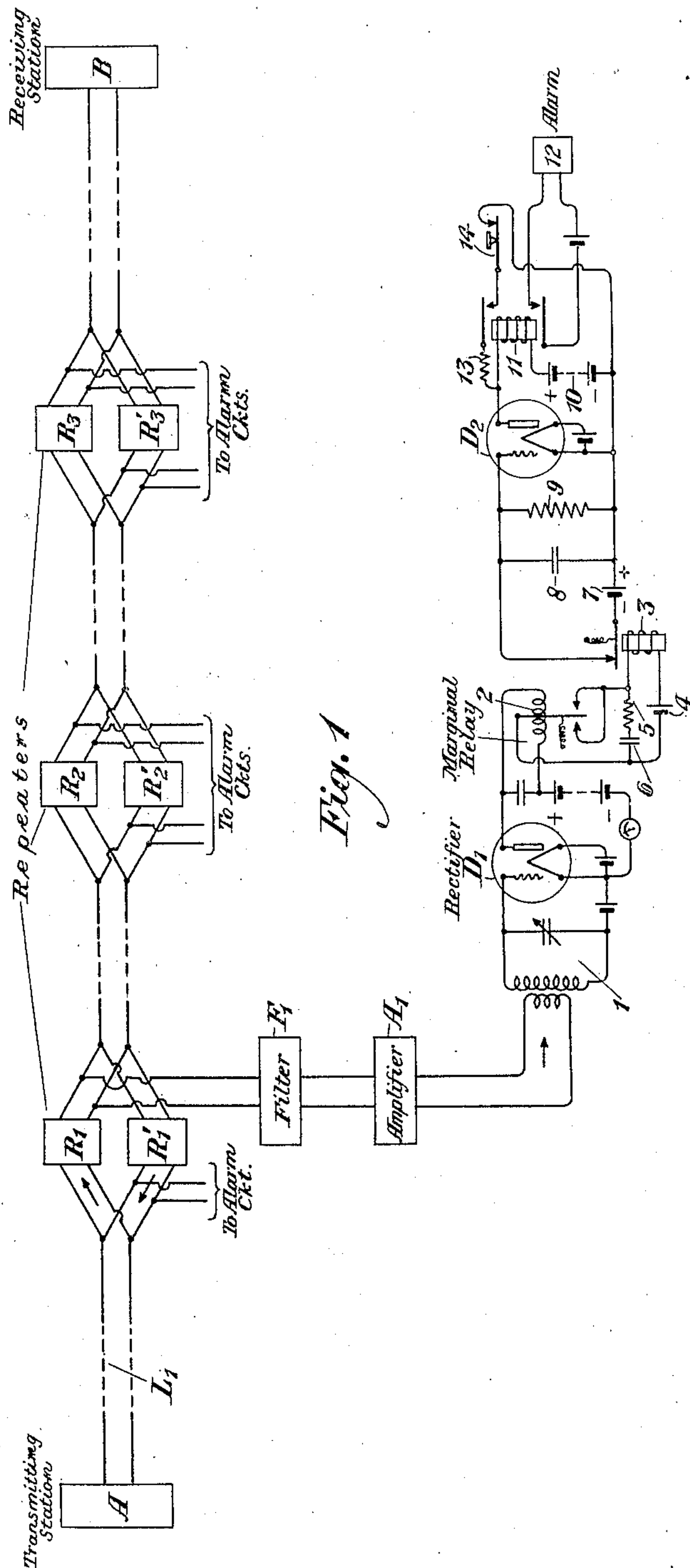
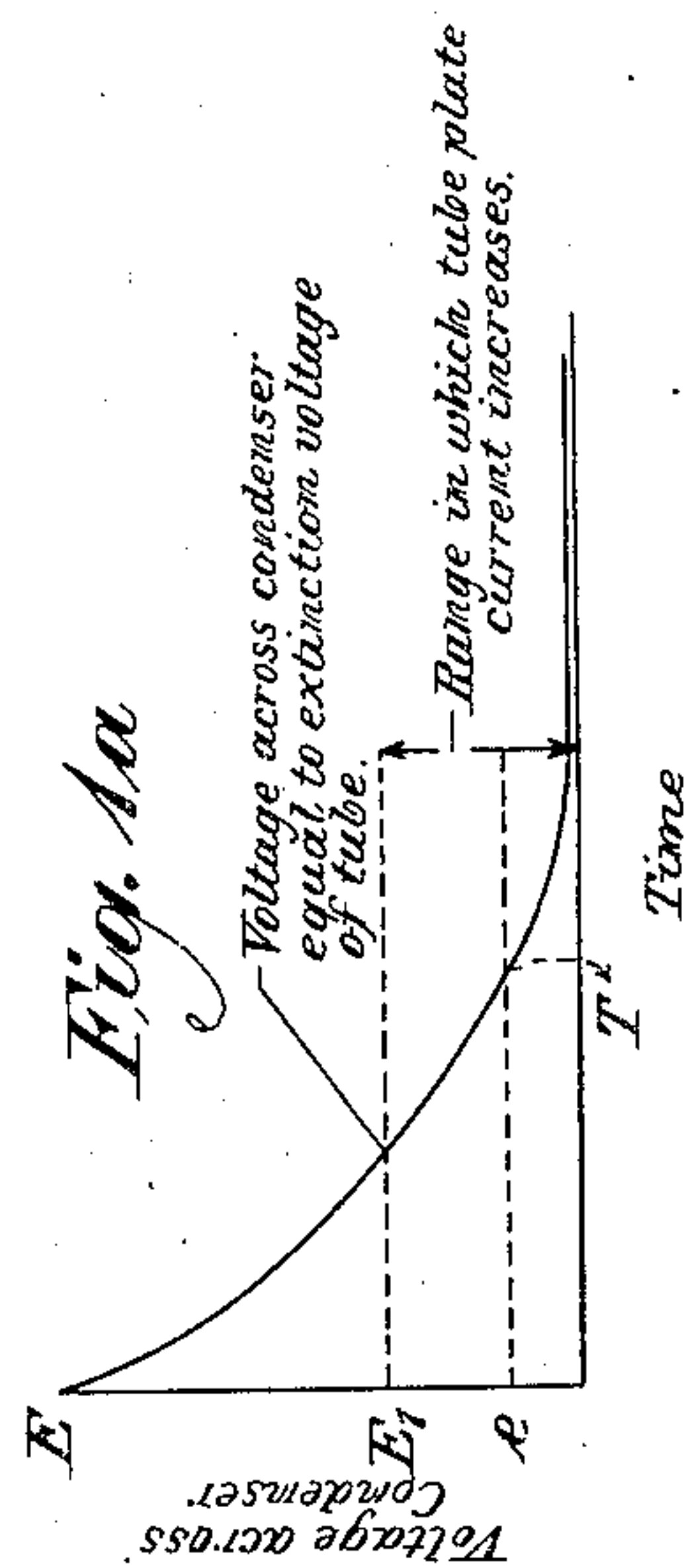


Fig. 1



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MEANS FOR PRODUCING TIME LAG IN ELECTRICAL CIRCUITS

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Original application September 14, 1926, Serial
No. 135,447. Divided and this application
March 19, 1930, Serial No. 437,209

4 Claims. (Cl. 177—311)

This invention relates to a method and means
for producing a time lag in the operation of a
device connected with an electrical circuit, and
particularly to means for preventing the unde-
sired operation of a current responsive device
such as an alarm signal connected with the pilot
channel apparatus of a carrier signaling system.

This application is a division of my copend-
ing application, Serial No. 135,447, filed Septem-
ber 14, 1926, and is intended to particularly cover
a pilot channel alarm system having a delay
circuit to prevent operation by transient dis-
turbances.

In carrier signaling systems, it is customary
to transmit, simultaneously with the channels
representing the telephone or telegraph signals,
a separate channel known as a pilot channel
consisting preferably of a single frequency of
constant amplitude. At the various repeater sta-
tions along the line, and also at the receiving
terminal, this pilot channel is filtered out, and
its variations from normal indicate the changes
in the transmission equivalent of the system re-
sulting from variations in the constants of the
line, and serve to determine the changes neces-
sary in repeater amplification to restore the
transmission equivalent to normal. At the re-
peater stations, it has been customary to use
the pilot channel to operate an alarm whenever
the pilot current in the output side of the am-
plifier at that station varied from normal by a
predetermined amount. It has been found that
a false alarm signal may sometimes be produced
as an indirect result of the speech or other sig-
naling channels that are being amplified, to-
gether with the pilot channel at the station at
which the alarm is produced. For example, the
heavy side band loads of the signaling channels
sometimes overload the repeater so as to cause
variations in the pilot channel current at the
repeaters and the receiving station, which varia-
tions momentarily exceed fixed limits. Those
side bands may be located in the frequency spec-
trum close to the side bands representing the
signaling channels, e. g. between a side band and
the carrier upon which the side band is predi-
cated. Unless the alarm circuits are protected
against such transient variations of the pilot
channel, false indications will be given by the
alarm circuit. Obviously, the pilot channel se-
lective network may be designed to prevent a
momentary surge of speech or signal frequency
current from affecting the alarm directly, but
it is not economical to go to the ultimate ex-
treme to effect such result, and furthermore,

this selectivity does not prevent interference
from overload. Therefore, since a certain
amount of interference from the speech or high-
er frequency signaling channels must be toler-
ated, an alarm circuit is required that is not
subject to abnormal currents of short duration,
and still will operate reliably upon an abnormal
current that persists a predetermined length of
time.

It is the object of this invention to provide
means for introducing a time lag in an alarm
circuit, whereby the alarm or other current re-
sponsive device will not operate upon transient
currents, but will operate upon currents continu-
ously applied for a predetermined length of time.

Other objects of this invention will be apparent
from the following description when read in con-
nection with the attached drawing, of which
Figure 1 shows schematically a simple form of
embodiment of the invention, and Fig. 1a is a
graph illustrating the principle involved in the
invention.

In Fig. 1, the line L_1 represents a signaling
circuit over which a plurality of carrier chan-
nels may be transmitted from station A to sta-
tion B, and vice versa. Interposed at various
points between the terminals of the line are a
plurality of repeaters designated R_1 , R_1' , R_2 ,
 R_2' and R_3 and R_3' . The repeaters R_1 , R_2 , and
 R_3 serve to amplify the channels transmitting
in one direction, and the repeaters designated
by the same symbols primed operate upon the
channels in the opposite direction. Connected
with the output of the repeater R_1 is an alarm
circuit which is connected with the line L_1 through
the filter F_1 and the amplifier A_1 . The filter is of
a type designed to pass the pilot channel fre-
quency which, when amplified, will be impressed
upon the rectifier D_1 . The grid circuit of this rec-
tifier contains the circuit 1 which is tuned to the
pilot channel frequency. The plate circuit in-
cludes a marginal relay 2 which is designed to
operate whenever the change in plate current ex-
ceeds a predetermined value, which value will be
dependent upon the magnitude of the voltage im-
pressed upon the grid of the rectifier D_1 . It is
desirable to make clear that while a vacuum tube
rectifier has been shown, any well-known form of
device to convert the alternating current of the
pilot channel to a direct current may be employed.

Connected with the armature and the contacts
of relay 2 is an auxiliary relay 3, the said connec-
tion including a source of potential 4, a resistance
5 and a condenser 6, the latter elements serving
as a spark killer for the contacts of relay 2. The

closing of either contact of the marginal relay 2 will close the circuit of the auxiliary relay 3, which is preferably slow-acting in order to avoid trouble arising from the jarring of the relay.

Whenever relay 3 is energized, the circuit controlled by its armature will be open. When it is deenergized and the circuit is closed, the source of potential 7 will be connected across the terminals of the condenser 8, which is of normally large capacity. This connection, however, is shunted by the resistance 9 of fairly large magnitude which provides a path through which the condenser may discharge whenever the contact of relay 3 is open. The grid and filament terminals of the rectifier D₂ are connected across the source 7, the resistance 9 and the condenser 8 in such manner as to reduce the plate current of the tube either to zero or to a negligibly small value. The plate circuit of the rectifier D₂ includes a source of current 10 and a relay 11, which relay controls an alarm 12 which may be a buzzer or other suitable device. Connected in parallel with the battery 10 and the winding of relay 11 is a circuit including a resistance 13, a key 14 and a contact of relay 11. The contact of key 14 is normally closed. Consequently, when relay 11 operates and closes both its upper and lower contacts, it will cause the alarm 12 to operate, and will also lock itself over a circuit which includes the source 10, the winding of relay 11, resistance 13, upper contact of relay 11, and the normally closed contact of key 14. The purpose of this locking circuit is to cause the alarm to operate continuously once it has begun to operate, thereby ensuring that the repeater attendant will respond to the alarm and take such action as is necessary to adjust the repeater circuit. The opening of the key 14 restores the alarm to its normal condition.

The manner in which the alarm circuit operates in order to introduce the necessary time lag to avoid false operation is as follows: Let it be assumed that signaling channels and a pilot channel of normal magnitudes are operating between station A and station B through the repeater R₁ and the repeaters at subsequent points operating in the same direction as R₁. The normal pilot channel voltage impressed upon the filter F₁ would be transmitted therethrough and amplified by A₁. This voltage would then be impressed upon the rectifier D₁. This grid voltage, which results from the normal pilot voltage, causes a current of predetermined magnitude to flow through the plate circuit of the tube. This current flowing through the winding of the marginal relay 2 would tend to cause the armature thereof to move in a certain direction, but such movement would be prevented by a biasing spring, the tension upon which would be just sufficient to neutralize the magnetic pull due to the normal plate current so that the armature of relay 2 remains at a point midway between its contacts. When this condition exists, the circuit including relay 3 is open, so that its armature is not attracted. Accordingly, the voltage of the source 7 will be applied to the condenser 8 and serves to charge the condenser to the full voltage of the source. This voltage will also be impressed upon the grid of the rectifier D₂ inasmuch as the resistance 9 is of very large value. The negative voltage of the magnitude E, shown in Fig. 1a, is more than sufficient to reduce the plate current of the rectifier D₂ to zero. Consequently, relay 11 will not be energized and the circuit of the alarm device will not be closed. Relay 11

is adjusted to operate at the plate current that results from the negative grid voltage e, shown in Fig. 1a. From this figure, that represents the relation between voltage across the condenser and time, it will be seen that after the opening of the contact of relay 3 an appreciable amount of time elapses before the voltage of the condenser 8 drops from E₁ to e. It is by virtue of this fact that the operation of the alarm 12 may be delayed until the voltage of a magnitude necessary to set in operation the alarm circuit has continued a predetermined length of time.

The manner in which the time-lag arrangement operates is as follows: Let it be assumed that by overloading of the amplifiers, or for some other reason, the voltage of the pilot channel rises above normal to the extent that is considered undesirable. When such voltage is applied to the grid of the rectifier D₁, the plate current of that tube will cause the marginal relay to move its armature to one of its contacts, which will close the circuit of relay 3 and in turn will open the circuit between the source 7 and the condenser 8. The disconnection of the source of charging voltage will cause the condenser 8 to discharge, and the rate of discharge depends upon the resistance 9, size of condenser, and the voltage ratio

$$\frac{E_1}{e}$$

The elements are so proportioned that the time elapsing between the opening of the contact of relay 3 and the instant when the voltage across the condenser 8 reaches the value e is greater than the longest interval in which speech currents flowing through the amplifier R₁ would exceed the normal level. That is to say, if the abnormal variation of the pilot channel voltage is due to the overloading of an amplifier by the speech or the carrier signal channels, the discharge rate of the condenser may be so controlled that the overloading of the amplifiers will cease before the condenser voltage drops to e. The relay 11 and the alarm device 12 will not operate because, as stated above, it required a plate current corresponding to the grid voltage e to operate relay 11. It will be seen that the alarm was not produced even though the pilot channel voltage exceeded normal to such extent as to operate the marginal relay 2.

If, on the other hand, the nature of the trouble is such as to cause the abnormal pilot channel voltage to persist for a length of time greater than that represented by T, the grid voltage of D₂ will fall below e and the plate current will rise to a value sufficient to operate relay 11. This will operate the device 12 which continues to give an alarm signal until the attendant responds and opens the locking circuit of relay 11 by pressing the key 14.

In like manner, if the level of the pilot channel voltage dropped to or below the predetermined lower limit, the plate current through the relay 2 would be diminished and the armature would be drawn to its other contact by the tension of the spring. This operates relay 3 and causes the operation of the alarm 12 in the same manner in which an over-voltage effected such operation.

The invention resides broadly in a method and means for preventing the operation of a current responsive device unless and until the primary operating force has persisted a predetermined length of time. In the circuit arrangement chosen

en to describe the invention the current responsive device has been styled an alarm signal. It is, of course, obvious that the current responsive device, by which is meant the element whose time of operation is controlled, may take any one of a number of different forms. For example, it may be an automatic control device, the function of which is to automatically adjust the repeater so as to control its gain, and thus keep constant the overall equivalent of the system.

While I have described this invention in connection with the control of a current responsive device upon pilot channel circuits of carrier signaling systems, it is, of course, obvious that the invention is not limited to this particular use, but may be applied in other fields where it is desirable to introduce a time lag in an electrical circuit in order to prevent the operation of a device until the cause of such operation has persisted a predetermined length of time.

Furthermore, while the invention has been disclosed as embodied in a particular form and arrangement of parts, it is capable of embodiment in other forms and arrangements without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a system to delay the operation of a device until the operating voltage has persisted a predetermined length of time, the combination with a source of potential the variations of which from normal are to be indicated, of a marginal relay having an armature the position of which for normal currents is midway between its contacts, an auxiliary relay having its winding effectively connected to a source of current and to the contacts of the marginal relay so as to be energized upon the closing of either contact, a condenser, a source of voltage, a vacuum tube having its input connected with the said condenser and the negative pole of the said source of voltage through the armature and contact of the said auxiliary relay, and an alarm circuit connected with the output of the said vacuum tube.

2. In an arrangement for controlling the time of operation of an electro-responsive device, the combination with a source of alternating voltage, of an alarm device, the operation of which depends upon the predetermined duration of the voltage of the said source at a predetermined level above or below normal, means to rectify said

alternating voltage, switching means responsive to the said rectifying means operable whenever the rectified currents depart to a predetermined extent from normal, an energy storage circuit including a condenser, a source of direct current to charge the said condenser and a high resistance to control the rate of discharge thereof, a vacuum tube having its input circuit connected across said energy storage circuit and its output circuit connected with the said alarm device and means controlled by the said switching means to effectively disconnect the said source of direct current from the said condenser whenever the rectified alternating current departs from normal to a predetermined extent.

3. In a system to delay the operation of a device until an operating voltage of a predetermined magnitude has persisted a predetermined length of time, the combination with a source of potential the variations of which from normal are to be indicated, of a relay responsive to said variations of potential, an auxiliary relay adapted to be energized by the operation of said first-mentioned relay, a vacuum tube amplifier having connected between the filament and grid thereof a source of negative biasing voltage shunted by a condenser and also by a resistance, a third relay connected to the plate circuit of said tube and an alarm controlled thereby, the said auxiliary relay being arranged to effectively disconnect the said source of negative biasing voltage from said grid whenever the potential variations of said source exceed prefixed limits.

4. In a carrier signaling system in which a pilot channel is employed to determine variations in the transmission conditions existing in such system, the combination with a line over which the carrier channels are operated, of means connected to said line to select the pilot channel frequency, means to amplify and to rectify the selected frequency, a vacuum tube amplifier having a signaling device connected to the plate circuit thereof, an input circuit connected to the grid of the vacuum tube, and including a negative biasing source shunted by a condenser and also a resistance, means responsive to the rectified pilot channel voltage to effectively disconnect the said biasing source from said input circuit when the variations of the pilot channel voltage exceeds prefixed limits.

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