

July 18, 1939.

G. N. SAUL

2,166,536

SIGNALING SYSTEM

Filed March 26, 1936

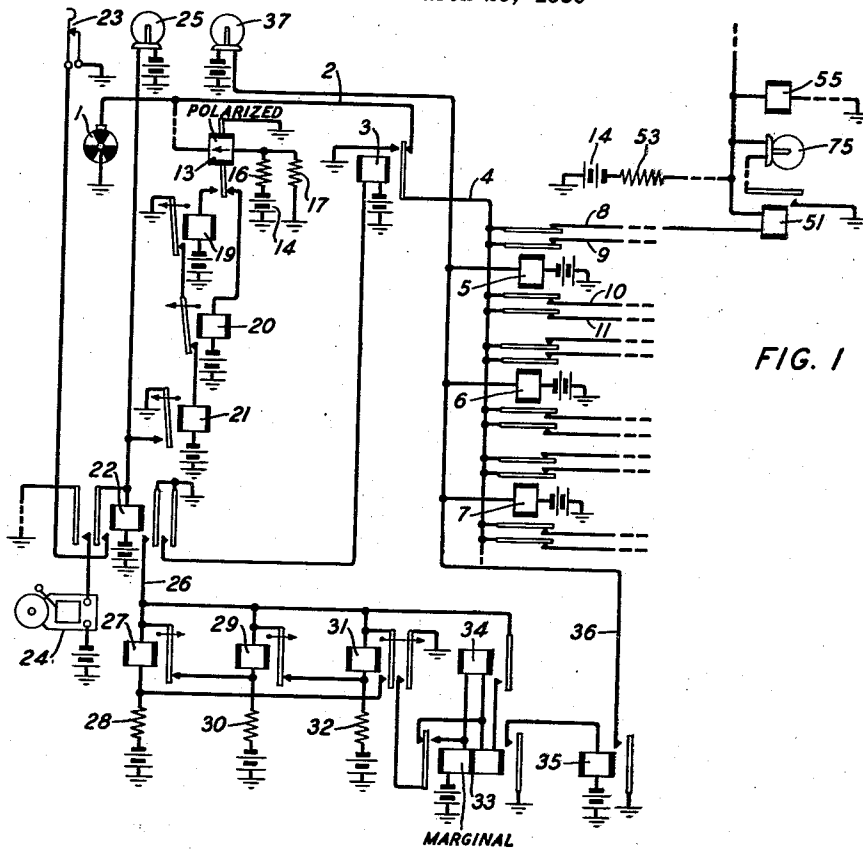


FIG. 1

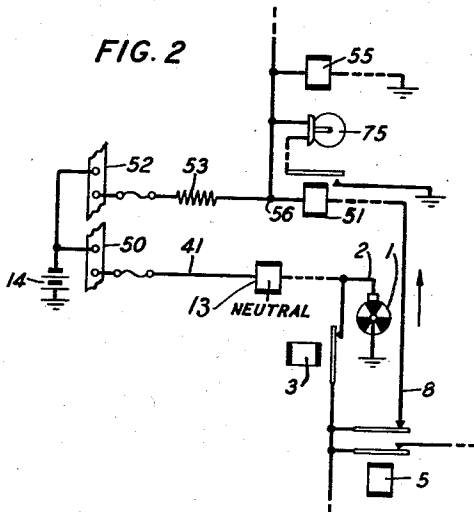


FIG. 2

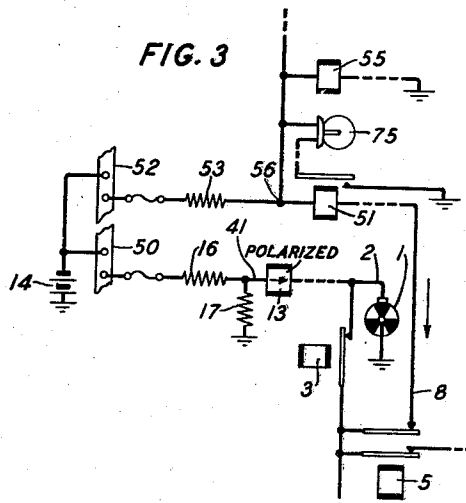


FIG. 3

INVENTOR
G. N. SAUL

BY
H. H. Kingman
ATTORNEY

UNITED STATES PATENT OFFICE

2,166,536

SIGNALING SYSTEM

George N. Saul, Brooklyn, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application March 26, 1936, Serial No. 71,056

1 Claim. (Cl. 177—352)

This invention relates to signaling systems wherein electric circuits are controlled by an interrupter and more particularly to means associated with an interrupter alarm circuit to cause an alarm to be given and an emergency arrangement brought into service to control the electric circuits upon the occurrence of an abnormal or unstandard condition.

In systems of the character above described and as disclosed in Patent 1,990,569, issued February 12, 1935, to J. B. Shiel et al., it has been customary to utilize, as an alarm control device, a highly sensitive neutral relay whose armature constantly vibrates under control of the interrupter mechanism. So long as this constant armature movement is maintained, the alarm and the emergency supply circuit will remain idle, but as soon as it ceases, either through the relay being released or being steadily energized, the alarm will be operated and the emergency equipment will be brought into service.

It has been experienced in systems of such a type, that the associated circuits in which relays associated with the interrupter lead or conductor are located, frequently suffer an appreciable potential drop over the battery supply leads between the circuits and the power supply fuses. These leads are usually longer in length, hence higher in resistance, than the battery supply lead to the alarm control relay and usually carry a larger current with the result that the I. R. drop to the connected circuits is usually greater than that to the alarm control relay and in practice may reach a maximum of 1.5 volts. Under such a condition it has been found that the control relay will hold operated during the open period of the interrupter and bring in an alarm falsely. The false operation of the alarm has also been caused by inductive surges to which the alarm relay is subject and which are caused by the interruption of circuits which include inductively wound relays.

It is the object of this invention to provide an improved interrupter alarm circuit in which false operation of the alarm is reduced to a minimum. This object is attained in accordance with a feature of the invention by introducing in the battery supply lead to the alarm relay an artificial network which produces an I. R. drop equal to or greater than that of the battery supply lead to the connected circuits and utilizing a polarized relay for controlling the alarm. This combination results in an alarm circuit which functions in a positive manner to indicate unstandard or abnormal circuit conditions and which is immune to those conditions which heretofore were in-

strumental in causing the alarm to be actuated falsely.

The invention will be readily understood from the following detailed description made with reference to the accompanying drawing in which Fig. 1 is a diagrammatic representation of a circuit embodying the present invention;

Fig. 2 is a schematic illustration of the circuit condition which prevailed prior to the present invention; and

Fig. 3 is a schematic illustration of the circuit of Fig. 2 modified to include the features of this invention.

An interrupter 1, constantly rotating, creates a stream of periodic impulses in the conductor 2, herein identified as the signal interrupter circuit or interrupter lead. These impulses flow through the back contact and armature of relay 3 to conductor 4 herein identified as the distributing circuit. The distributing circuit is connected through the armatures and back contacts of a plurality of relays 5, 6 and 7 to a plurality of occasionally energized circuits, such as 8, 9, 10 and 11.

The interrupter circuit 2 is connected to the winding of a polarized relay 13, the other terminal of the winding of relay 13 being connected to battery 14 by way of resistance element 16. A high resistance 17 is connected to ground and is in shunt with the winding of relay 13 when interrupter 1 is in such a position as to connect ground to the relay winding. Relay 13 is poled in such a direction as to respond to interruptions effected by the interrupter 1 and its armature follows such interruptions. If the impulses supplied by the interrupter are at the rate of 40, 60 or 120 interruptions per minute, then the armature of relay 13 will be moved between its front and back contacts at the rate of 40, 60 or 120 times per minute.

During the periods that the armature of relay 13 is resting on its front contact, a circuit is closed for relay 19 and this relay, being slow to release, will in general maintain its armature in its operated position as long as relay 13 is constantly operating, as described.

In the same manner, when the armature of relay 13 is resting on its back contact, a relay 20 is energized and this relay also being slow to release, will in general maintain its armature in its operated position as long as relay 13 is constantly operating. Through the operated contacts of relays 19 and 20, a circuit is closed for relay 21 and this relay being slow to release will main-

tain its armature operated even though relays 19 and 20 should release momentarily.

The conditions above described are normal and will be maintained as long as interrupter 1 operates properly and the circuit 2 maintained in a standard condition.

Let it now be assumed that conductor 2 becomes opened near the interrupter 1 or at any place between the interrupter 1 and relay 13; then relay 13 will cease to operate and its armature will rest steadily on its back contact. Under this condition relay 20 will be maintained energized but relay 19 will become deenergized and after a short interval of time will release its armature. The circuit for relay 21 is opened accordingly and this relay will allow its armature to return to normal.

It will now be pointed out that relay 21 will also be released when the conductor 2 becomes grounded. In such a case, relay 13 will become steadily operated and its armature will rest on its front contact continually. Under these conditions relay 19 will be maintained energized and relay 20 will become deenergized and after a short interval of time release its armature and cause relay 21 to restore to normal.

The grounding of conductor 2 may take place either on the conductor 2 itself, on the distributing circuit 4 or on any one of the circuits such as 8, 9, 10 or 11, etc.

It should be noted that in the case where one of the circuits such as 8 is grounded, this ground will be communicated to all other circuits such as 9, 10 and 11 and the associated apparatus of such circuits will be rendered inoperative.

It will thus be seen that when the interrupter circuit 2 is opened between the interrupter 1 and relay 13, or such circuit is grounded, relay 21 will restore to normal.

Upon the restoration to normal of relay 21, a circuit is established from ground, armature and back contact of relay 21, winding of relay 22 to battery. Relay 22 operates in this circuit and locks in a circuit extending from ground, normal contacts of key 23, front contact and inner left-hand armature of relay 22, winding of relay 22 to battery. Through the operation of its outer left-hand armature, relay 22 closes a circuit extending from ground, outer left-hand armature and front contact of relay 22 to battery by way of the alarm 24. At the same time a circuit is closed from ground, outer armature and front contact of relay 22, winding of relay 3 to battery. Relay 3 operates in this circuit and disconnects the interrupter circuit 2 from the distributing circuit 4 and grounds the distributing circuit by way of its armature and front contact.

Thus, upon the interruption of service over interrupter circuit 2, alarm 24 is sounded and the distributing circuit 4 is permanently grounded. At the same time, the ground for operating relay 22 is communicated to the visual signal 25 which is lighted steadily.

Through its inner right-hand armature, relay 22 places a ground on conductor 26 which finds a circuit through relay 27 and resistance 28 to battery whereupon relay 27 becomes operated. Upon the operation of relay 27, a short circuit about the winding of relay 29 is opened and this relay now becomes operated in series with resistance 30. In like manner, upon the operation of relay 29, a short circuit about the winding of relay 31 is opened and this relay in turn becomes operated in series with resistance 32. Relay 31, in operating, now closes a short circuit about the

winding of relay 27 and after a short interval of time this relay releases its armature. When relay 27 restores, it in turn short-circuits relay 29 and relay 29 in turn short-circuits relay 31. This cycle of operations occurs periodically.

Upon the first operation of relay 31, a circuit is closed from ground, outer right-hand armature and front contact of relay 31, left-hand armature and back contact of relay 33, winding of relay 34, left-hand winding of relay 33 to battery. Relay 34 operates in this circuit but relay 33, being marginal, fails to operate. Upon the operation of relay 34, a circuit to the right-hand winding of relay 33 is closed, but this only results in short-circuiting such winding, since a ground is to be found on conductor 26 which is communicated through the armature and front contact of relay 34 to one side of the right-hand winding of relay 33, the other side being grounded through the outer right-hand armature of relay 31.

Upon the following release of relay 31, the short circuit about the right-hand winding of relay 33 is removed and relay 33 now operates in a circuit from ground, middle right-hand armature and front contact of relay 22, conductor 26, armature and front contact of relay 34, right-hand winding of relay 33, winding of relay 34, left-hand winding of relay 33 to battery. Relay 33 now operates its armatures and prepares a circuit wherein relay 34 will become deenergized. As soon as relay 31 again becomes operated a ground is connected directly to the left-hand winding of relay 33, and the winding of relay 34 and the right-hand winding of relay 33, in series therewith are short-circuited. Relay 34 becomes deenergized and relay 33 holds operated.

Upon the next deenergization of relay 31, relay 33 releases.

Thus it will be seen that for each two complete cycles of operation of relay 31, relay 33 will go through one complete cycle of operations.

Upon each energization of relay 33, a circuit is closed for relay 35, which relay operates and places a ground on conductor 36 which is communicated in parallel to each of the relays 5, 6 and 7 and to the signal lamp 37. The design and adjustment of relays 27, 29 and 31 are such that the rate of operation of relay 35 is the same as the rate of interrupter 1.

Since the distributing circuit 4 is permanently grounded at the front contact of relay 3, each of the circuits 8, 9, 10 and 11, etc. will be grounded during the deenergization of relays 5, 6 and 7 with the result that the circuits are intermittently grounded as before.

It should be noted that even though a particular circuit such as 8 becomes permanently grounded, this ground cannot be communicated to the other signaling circuits during the operation of the emergency interrupter comprising relays 27, 29, 31, 33, 34 and 35.

An attendant noting the steady illumination of signal 25, the intermittent illumination of signal 37 and the audible alarm 24 is thus informed of an alarm condition on the interrupter supply lead. If the trouble which occurred was of a temporary nature and has been corrected by this time, relay 21 will be in its energized condition and if the attendant actuates key 23, relay 22 is deenergized and the circuit will assume its normal condition and begin to operate properly. If, however, the trouble is of a more permanent nature, then the actuation of key 23 does not result in the restoration of the circuit to normal. The alarm 24 and the visual signals 25 and 37

will remain operated and the trouble will have to be traced to its source and corrected. When the trouble is cleared, the circuit may be restored to normal by a momentary actuation of key 23.

In previous systems of this nature, relay 13 was a sensitive neutral relay and the battery supply lead 41 (see Fig. 2) to this relay was connected directly to battery 14 by way of the bus-bar 50, that is, no resistances 16 and 17 were associated therewith.

The previous system of this type is illustrated in the schematic shown in Fig. 2. The connected or work circuits with which this interrupter circuit functions may include relays or any other type of equipment which may be actuated by the interrupted ground from interrupter 1 or directly to steady ground. In any event, the connected circuits as well as the control relay 13 receive current from the same supply battery 14. For purposes of illustration only, Fig. 2 shows a relay 51 which operates from battery 14, by way of bus 52, battery supply lead 53 (herein indicated as a resistance), winding of relay 51, back contact and upper armature of relay 5, armature and back contact of relay 3 to interrupted ground at the interrupter 1. The relay 51 may be utilized to control the flashing of a lamp such as 75. Relay 55 is shown to illustrate other apparatus in the circuit of which relay 51 is a part, which draws its current from battery 14 by way of bus-bar 52 and supply lead 53. Due to the relative locations of the alarm relay 13 and the equipment such as relays 51 and 55, the battery supply lead 53 to the latter will frequently be of greater length and, therefore, of greater resistance than the battery supply lead 41 to the alarm relay 13. It will also be noted that due to the extensive equipment served by the lead 53, this lead will carry current in excess of that carried by lead 41. Under these conditions the potential drop to the connected circuits, that is, over the battery supply lead 53, is greater than that to the alarm relay 13 over battery supply lead 41.

Due to the fact that the potential drop between the bus-bar 50 and relay 13 by way of battery supply lead 41 is less than the drop between bus 52 and the connected circuit indicated by the point 56, by way of the battery supply lead 53, there exists a difference of potential across the winding of relay 13 when the interrupter 1 is on open circuit, which is of sufficient magnitude to hold relay 13 operated when it should be released. This difference of potential causes current to traverse a path from battery 14, bus-bar 50, battery supply lead 41, winding of relay 13, back contact and armature of relay 3, upper armature and back contact of relay 5, windings of relays 51 and 55 to ground. It is to be understood that relays 51, 55 and lamp 75 and their circuit connections have been chosen merely to illustrate some of many conditions which may exist and to more clearly identify the condition which causes the relatively high potential drop over the battery supply lead 53. Actually there is more equipment, such as relays 55, 51, etc., which is supplied by the battery 14 by way of the supply lead 53.

The current traversing the path traced in the preceding paragraph is sufficient to hold operated the sensitive neutral relay 13 of Fig. 2. Such an untimely operation of relay 13 results in a false operation of the alarm circuit.

To overcome this difficulty, the present invention provides for the introduction of an artificial

potential drop in the supply lead to relay 13 which is equal to or greater than the known drop over the supply lead 53 to the connected circuits, and utilizes a polarized relay 13 in place of the neutral relay 13 of Fig. 2. This condition is illustrated in Fig. 3.

The artificial potential drop is effected by including a resistance 16 in series between the polarized relay 13 and bus-bar 50 and a relatively high resistance 17 in shunt with relay 13 to ground, the shunt effect prevailing only when the interrupter 1 is on a grounded segment. Under this condition, that is when interrupter 1 is on a grounded segment, the polarized relay 13 operates in a circuit extending from battery 14, bus-bar 50, resistance 16, winding of relay 13 to ground at the interrupter. When the interrupter 1 is on an ungrounded segment current from the battery 14 traverses resistances 16 and 17 to ground creating a potential drop over resistance 16 to relay 13. Since the maximum potential drop over the supply lead 53 is known, the values of the resistances 16 and 17 are selected so as to effect a potential drop over resistance 16 when the interrupter is on an ungrounded segment, which is equal to or greater than the maximum known drop over the lead 53.

It will now be noted that with a potential drop over resistance 16 to relay 13 equal to or greater than that over the supply lead 53 of a connected circuit there will either be no potential difference across the winding of relay 13 when the interrupter 1 is on open circuit, or it will be of such a nature as to cause the flow of current through relay 13 in a direction such as to aid its release, if operated. The arrow shown on relay 13 (Fig. 3) indicates the direction of flow of current in the relay necessary to cause its operation. Due to the fact that the drop over resistance 16 is now equal to or greater than that over lead 53 there will either be no flow of current in the lead 8 or it will be in the direction indicated by the arrow associated therewith which is opposed to the direction necessary to effect the operation of relay 13. The result attained is that polarized relay 13 will always release its armature whenever the interrupter lead is ungrounded.

The arrangement just described also prevents the false operation of the alarm relay on inductive surges which result from the opening of a circuit such as 8, for example, which may include an inductively wound relay such as relay 51. Such surges will be in a direction opposite to the direction of the normal operating current for polarized relay 13 and hence such surges will not cause this relay to falsely operate during the open period of the interrupter as they did with the neutral relay 13 in Fig. 2 which was caused to occasionally respond under this condition after a reversal of its flux.

What is claimed is:

In combination, a grounded load circuit including a load having one terminal grounded, a source of current having one terminal grounded and a supply lead of appreciable resistance interconnecting the ungrounded terminal of said load and the ungrounded terminal of said source of current, said load drawing a known maximum current from said source and producing a known maximum potential drop over said supply lead, a polarized relay, a second supply lead interconnecting one terminal of said relay and the ungrounded terminal of said source of current, means connecting the second terminal of said relay to the ungrounded terminal of said load,

and interrupter, means connecting said interrupter between the said second terminal of said relay and ground, a resistance, means connecting said resistance between the first-mentioned terminal of said relay and ground, a second resistance included in said second supply lead, said second resistance having a value such as to produce a potential drop over said second battery

supply lead greater than the known maximum potential drop over said first battery lead whereby current flows through said relay in the non-operate direction when said interrupter removes ground potential from said second terminal of said relay. 5

GEORGE N. SAUL.