Alarm system for No. 5 crossbar

C. E. GERMANTON
Switching Development

To give warning of conditions that might adversely affect telephone service, Bell System telephone offices have alarm systems which indicate by both audible and visual means the equipment in trouble. The indicators are so arranged that a maintenance man, regardless of what part of the building he might be in at the time, can find his way to the equipment in trouble with a minimum of effort. Alarm systems used previously in crossbar, and in the later panel and toll offices, have achieved this objective by using a system of bells, chimes, and colored lamps strategically placed whereby the floor, the main aisle, the aisle, and finally the circuit in trouble are indicated. In the No. 5 crossbar system, the same result is achieved but with a simplicity of design that makes possible economies in manufacture, installation, and job engineering. The components for the system are fabricated in the shop, and only a minimum of cabling is required to complete the system on the job.

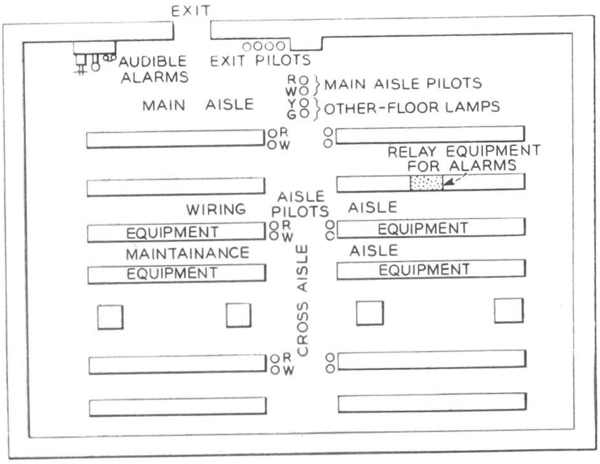
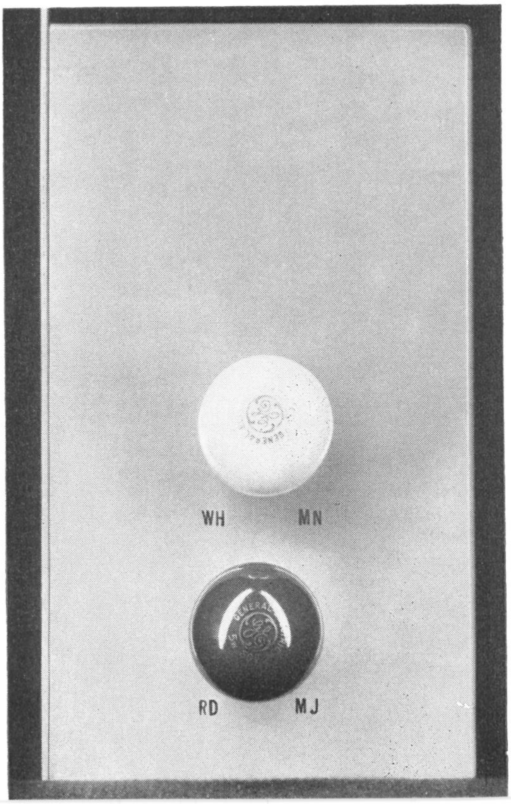


Fig. 1—Arrangement of alarm pilots in a hypothetical central office

Components do not depend on the types or number of circuits requiring alarm, and the special engineering required for each installation is reduced to a minimum. For any one building, the entire alarm equipment consists of a small aisle pilot unit having a red and a white lamp and two relays; a cluster of four lamps—red, white, yellow, and green—for each main aisle; a vertical lamp holder near the exit door having one lamp for each of the other floors in the building; a panel having a six-inch vibrating bell, two telephone ringers with distinctive gongs, and a large tone bar or chime signal; and relay control equipment consisting of one two-inch mounting plate for each floor of the building. Of the group of four lamps in each main aisle, two—the red and white—are the MAIN AISLE PILOTS that indicate trouble in some tributary aisle. The other two—green and yellow—are the

Fig. 2—The aisle pilot unit used in the No. 5 crossbar system



OTHER FLOOR lamps, which indicate the existence of trouble on one of the other floors in the building.

A hypothetical central office layout indicating the positions of these lamps is shown in Figure 1, and an aisle pilot unit in Figure 2. In addition to these lamps, there are individual lamps mounted on various switching and equipment frames that indicate the particular bay, panel, or circuit in which the trouble has arisen. Whenever a trouble arises that lights one of these individual lamps, an aisle pilot for that aisle, the main aisle pilot on that floor, and of the latter lamps is lighted, he will go to the exit, and the particular exit lamp lighted will indicate the floor on which the trouble has arisen. These exit lamps are arranged in a vertical row with one socket for each floor, the top representing the top floor and so on down. On each floor no lamp is in the socket for that floor, and thus the floor on which the trouble exists may be determined from the position of the lighted lamp relative to the socket that has no lamp. After he reaches the floor where the trouble has occurred, the main aisle and aisle pilots will guide him to the proper aisle, and the

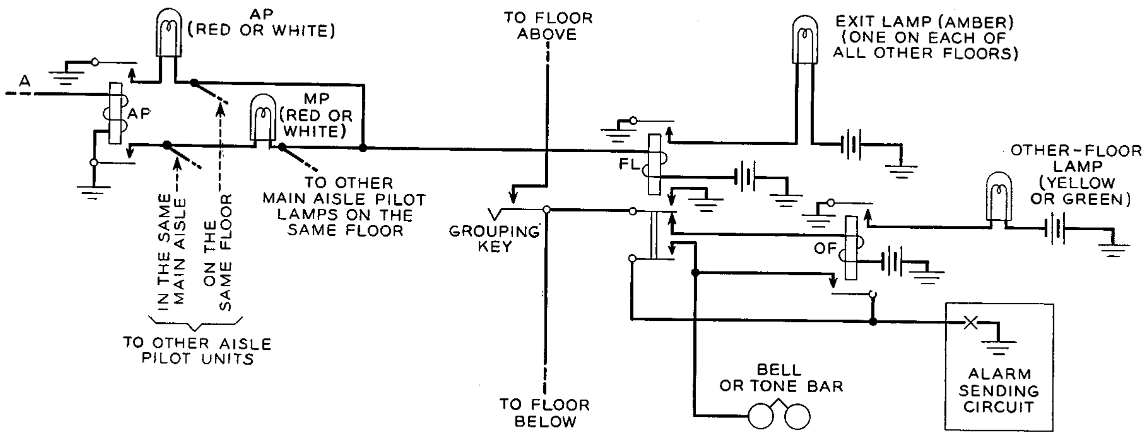


Fig. 3—Simplified schematic of the alarm circuit for No. 5 crossbar

the exit lamps on all the other floors also light, and an audible signal is sounded on the floor where the trouble has occurred. Lighting of the OTHER FLOOR lamps, and giving audible signals on other floors, is optional, and depends on whether or not a grouping key on each floor is operated. When these keys on all floors are operated, any trouble will also light the OTHER FLOOR lamps on all floors except that on which the trouble has occurred, and will sound the audible alarm on these floors. With the grouping keys all operated, therefore, a maintenance man on any floor will hear the alarm when trouble arises anywhere in the building.

By looking at the OTHER FLOOR lamps, he can tell whether the trouble is on the floor he is on or on some other floor, since an OTHER FLOOR lamp will be lighted only when the trouble is on another floor. If one lighted individual lamp on the frame will indicate the equipment causing the alarm.

The circuit by which the proper lamps are lighted when trouble occurs is indicated in Figure 3. When trouble arises, the local lamp will be lighted and battery through a resistance will be connected to lead A at the left of Figure 3. A connection to this same lead will be made for all troubles of same grade, major or minor, arising in that aisle. Battery on this lead operates the AP relay, thus lighting both the aisle pilot lamp for that aisle and the main aisle pilot lamp and operating the FL relay. The operation of this latter relay connects ground to the exit lamp multiple and thus lights all the exit lamps for that floor, sounds the audible signal on that floor and also connects ground to the grouping key. If the grouping key on any floor is operated, the audible signal will sound and the OTHER FLOOR lamp will light on the floor above. Conversely, an alarm on the floor above will sound the audible signal and light the OTHER FLOOR lamp on this floor. If all the grouping keys are operated, audible signals will sound and OTHER FLOOR lamps will light on all floors except the floor on which the trouble occurred.

Switching-trouble alarms are arbitrarily divided into two categories called major and minor alarms, and there is a circuit like Figure 3 for both types. Each circuit has lamps of a particular color associated with it. For major alarms, the individual circuit or fuse panel lamp, the aisle pilot, and the main aisle pilots are red, while for minor alarms, the corresponding lamps are all white. The OTHER FLOOR lamps are yellow for major alarms and green for minor alarms. A distinction is also made in the audible signals; for major alarms the audible signal is a tone bar operated by a relay interrupter, while for minor alarms it is a telephone ringer. The exit lamps, which are all amber, serve for both types of alarms, and are lighted by the FL relay of both the major and minor alarm circuits.

The main power supply equipment is usually all located in the basement, and since it does not require a series of locating lamps, provided by the circuit in Figure 3, it has its own alarm circuit providing both major and minor alarms. It is tied in with the Figure 3 circuit, however, to the extent that for major alarms it lights the yellow OTHER FLOOR lamp and rings a six-inch gong on all floors whether or not the grouping keys are operated. For minor power alarms, it lights the green OTHER FLOOR lamp and rings the regular minor alarm bell on one of the floors which was arbitrarily designated as the floor from which power alarms are supervised. Of course, the grouping keys will also transmit minor power alarms to the other floors. For either major or minor alarms, it lights a separate amber exit lamp on each of the switching floors.

Also not part of Figure 3 are the alarms from the fuses that supply the alarm circuits themselves. A failure of one of these fuses rings a specially toned telephone bell on each floor, but no pilot lamps are lighted except in the alarm control equipment unit, since the blown fuses might prevent the pilot lamp from lighting and thus no dependence could be placed on them. The location of the alarm control equipment is always known to the maintenance man, and thus the sounding of the specially

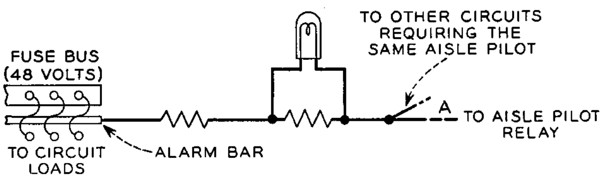


Fig. 4—The standard fuse alarm arrangement

toned bell is sufficient to indicate where the trouble has occurred.

Since in a 10,000-line central office there are about 15,000 fuses that may give an alarm, they are potentially the source of the greatest number of alarms. Experience has shown, however, that fuse alarms are of comparatively rare occurrence.

Alarm type telephone fuses connect the individual circuits to a common power bus, and when they blow, they establish a con-

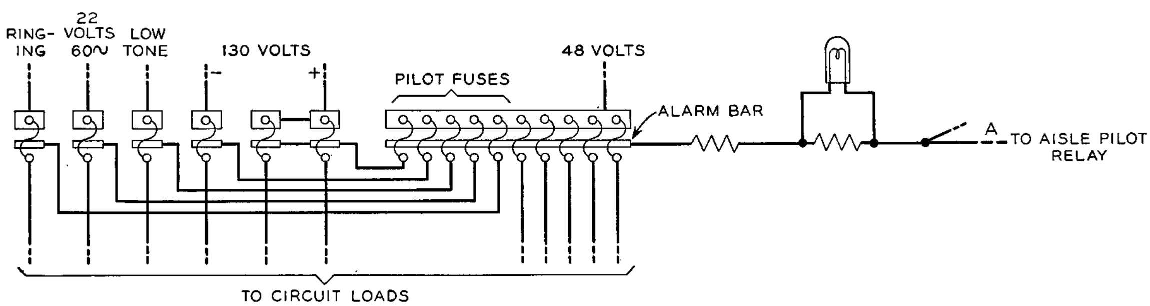


Fig. 5—Pilot fuse alarm system employed where more than one type of power supply is required

nection from the power bus to an alarm bar as has already been described in the RECORD.* This arrangement, together with a commonly used type of circuit to connect the alarm bar to the fuse panel lamp and the alarm system, is shown in Figure 4. Lead A connects to lead A of Figure 3. Such an arrangement has been used for many years, but it has been necessary heretofore to limit the number of fuse panels that can be connected to the same aisle pilot relay—relay AP of Figure 3. This is because with a number of simultaneous alarms, the current through the winding of the AP relay is the sum of all the individual alarm currents, and as a result with many simultaneous alarms, the relay not only overheats but may reduce the voltage across the lamps below the point for satisfactory illumination. By a careful selection of the type of lamp, the relay winding, and the two resistors in the lamp circuit, however, the permissible number of simultaneous alarms has been so greatly increased that all restrictions on the number of fuse panels have been removed. The panel lamps, indicated in Figure 4, are always red

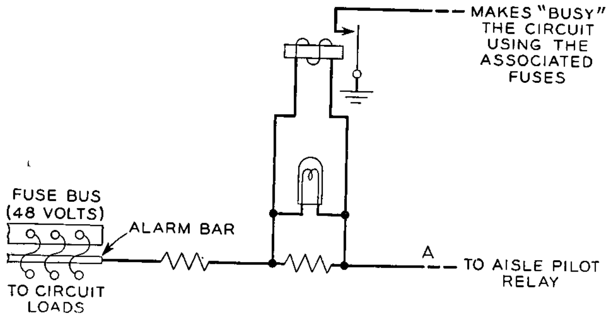


Fig. 6—A make-busy type of fuse alarm

since blown fuses in this system are arbitrarily classed under major alarms.

Telephone offices require a number of power supplies other than 48-volt battery, and heretofore a relay has been used for each panel for each type of supply since the panel lamps had to be lighted through relay contacts. For the No. 5 crossbar alarm system, however, the arrangement indicated in Figure 5 is employed. It is

*RECORD, *October,* 1925, *page* 78; *September,* 1933, *page* 27; and *February,* 1939, *page* 178.

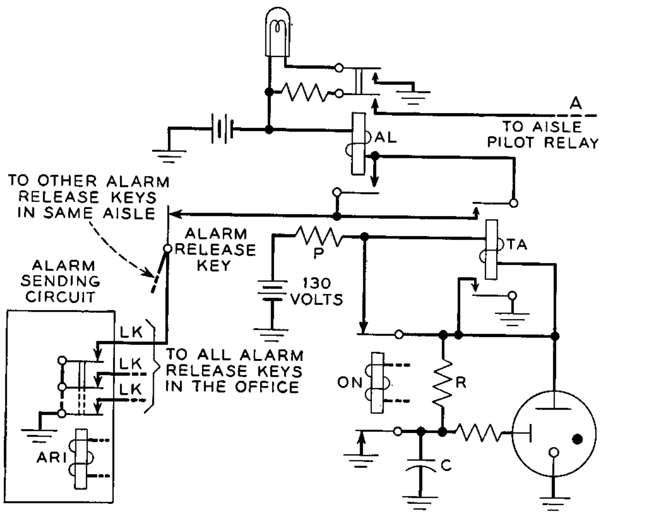


Fig. 7—A typical time alarm

known as the "pilot fuse" method since it employs a fuse in the regular 48-volt section of the panel as both a relay and indicator to give the alarm when a fuse in any other part of the panel blows. Five types of power supply besides 48-volt battery are shown in Figure 5, and the alarm contact or stud for each of the fuses in these five sections of the panel is connected to a separate pilot fuse in the 48-volt section of the panel. When a fuse blows and connects its particular power supply to its alarm stud, the pilot fuse is placed directly in series between the 48-volt battery and the other power supply. As a result, the pilot fuse blows and gives an alarm in the regular manner.

Some circuits, such as the marker or transverter, have a large number of fuses since it is not desirable to design them with a single fuse large enough to carry the entire load. However, should even one fuse blow, the effectiveness of the circuit is impaired and since the circuit is involved in a large percentage of the calls handled by the office, it is of the utmost importance not only to indicate an alarm if a fuse blows, but also to prevent the circuit from being selected for further use until the defective fuse is replaced. For such circuits, therefore, the arrangement shown in Figure 6 is employed.

A relay is connected in shunt with the

panel lamp, and if any fuse blows, not only will the regular alarm be actuated, but, in addition, the relay will operate and make this circuit busy. The relay has practically no effect on the fuse alarm, and thus does not affect the high reliability of the original arrangement. If a failure should occur in the wiring to the relay or in the relay winding, or if the adjustment of the relay is faulty, the regular fuse alarm in the system is still operated.

In addition to fuse alarms, many circuits are arranged to indicate other types of trouble, particularly an inability to complete functions within a reasonable time. To measure such time intervals, a condenser-timed cold-cathode-tube circuit is usually employed. One type of circuit is shown in Figure 7. When the circuit is selected, relay ON operates and remains operated during the entire in-use time. This removes the ground connection from capacitor C and allows it to charge from the 130-volt battery through the P resistance, the winding of relay TA, and resistance R. As the capacitor charges, the voltage between the control anode and the cathode increases. When this voltage is high enough to cause ionization, current will flow between the main anode and the cathode, thus operating relay TA. The operation of TA in turn operates relay AL, which lights a local alarm lamp and connects battery to lead A, which in turn connects to lead A of Figure 3. Through circuit components not shown in Figure 7, relay ON is then released, thus releasing TA, stopping the flow of current through the tube, and restoring the circuit to its original condition. Relay AL has locked itself in, however, and will remain operated to remember the trouble until it is manually released.

Another common source of alarms is the trouble recorder, since each time a trouble record is made, an alarm is given. These also are classified as major and minor, and light indicating lamps leading to the master test frame.

Since the No. 5 system was designed to serve small as well as large areas, it was planned to extend the alarms a large portion of the time to off-premises personnel. It has been necessary, therefore, to provide for transferring the alarms to a distant office where a maintenance force will always be available. All the alarms, therefore, are connected to an alarm sending circuit, which is indicated in both Figures 3 and 7. The alarm sending and receiving circuits, which are capable of identifying as many as seventy distinct types of trouble, are described on page 131.