Permanent signals in No. 5 crossbar

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Ever since the first central office went into service, "permanent signal" has been one of the most prevalent conditions requiring the attention of the maintenance force. When a subscriber wishes to place a call, he must first send a signal to the central office to attract the attention of the operator or, more commonly at the present time, the automatic circuits, so that the connection he desires may be set up. This signal is now sent merely by lifting the handset from its cradle. When the handset is replaced at the termination of a call, this signal disappears, and thus normally the signal is present only while a call is in progress. Sometimes, however, the signal becomes permanent. Perhaps the subscriber started to place a call and then just after the handset was lifted, the baby cried, and the solicitous parent inattentively laid the handset on the table instead of putting it back on its cradle, and ran to her child. When the operator answers, no one is on the line and yet the signal remains there—a permanent signal now exists.

Although a receiver off the hook or a handset off the cradle is the most common source of a permanent signal, it is not the only one. Any line or equipment trouble results in a permanent signal if it grounds or shorts the line in a way that gives essentially the same condition as a receiver off the hook. Permanent signals on a large number of lines is often the first indication of a cable failure.

A permanent signal prevents any calls from being connected to the line since the line is in effect made busy by the permanent signal. As a result, not only is the party responsible for the permanent signal prevented from receiving calls, but on multiparty lines all subscribers are similarly restricted. Its effect on a central office and the apparatus there depends on the type of office. In a manual office, little harm is done. The answering lamp of the line in front of the operator remains lighted, and the line itself is made busy, but other lines and equipment are not affected. In a step-by-step office, each permanent signal ties up certain of the selectors, and with a large number of permanent signals existing at the same time, the reduction in the number of available selectors may become serious. In a panel or crossbar office, any appreciable number of permanent signals would be very serious if preventive steps were not taken, since each permanent signal would tie up a common control circuit, of which there are comparatively few in the office. This situation is avoided by the use of "time out" circuits that release the common control after a comparatively short interval. In panel and No. 1 crossbar offices the methods adopted for dealing with a permanent signal have been guided to a large extent by the fact that a maintenance force is generally available in the office. In the No. 5 crossbar office, however, there may often be no maintenance force in the office for comparatively long periods, and a different philosophy had to be adopted in designing methods of dealing with it.

In panel and No. 1 crossbar offices, the method of dealing with a permanent signal consists of two stages. The first comprises a number of tests made by the operator, such as testing for a grounded line, and ringing on the line or applying a howler tone to attract the subscriber's attention so that the receiver will be replaced if it is off the hook. If all these efforts fail, an interval of between 15 and 45 minutes is allowed before further steps are taken. If the permanent signal has not disappeared at the end of this interval, the circuit is turned over to a test man who can determine the nature of the trouble by measurements on the line and can take steps to have it cleared. These two

stages are retained by the No. 5 crossbar equipment, but the over-all supervision is made automatic, and since the operator to whom the line is first turned over may be in an office distant from the No. 5 crossbar office, a signaling system must be provided to transmit information back and forth between the No. 5 crossbar and the distant office.

When an originating register is connected to a subscriber line in a No. 5 crossbar office, it connects dial tone to the line and starts a timing circuit. If dial pulses are not received within approximately 25 seconds, the register calls in a marker and informs it that a permanent signal holding trunk at once takes a number of steps that will lead to the ultimate removal of the permanent signal conditions. It extends the line terminals to the master test frame at the maintenance center of the No. 5 office and lights a lamp there to indicate the number of the permanent signal holding trunk involved, and whether the trouble is on a PBX line, a coin line, or a noncoin line. This information is given to the permanent signal holding trunk by the marker and will be used in clearing the trouble, since different types of lines require different treatments. The holding trunk also extends the line to a test and selector circuit

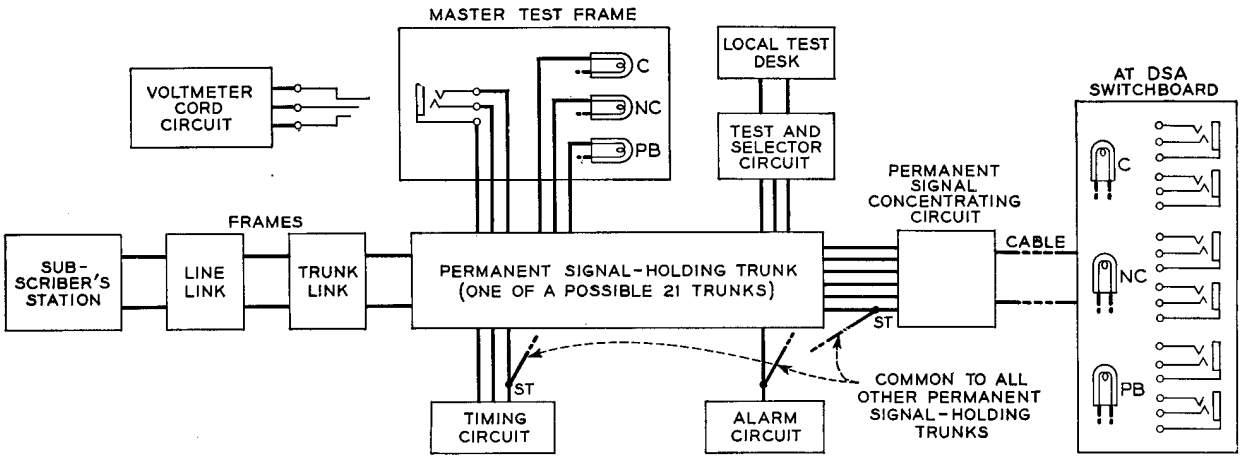

Fig. 1—Block schematic indicating method of handling permanent signal in a No. 5 crossbar office.

permanent signal condition exists on the subscriber's line. The marker then connects the line to a permanent signal holding trunk, and disconnects it from the register. This takes the line out of service and prevents it from making further use of the common control circuits until the trouble has been cleared.

These permanent signal holding trunks are connected to the trunk link frames as are outgoing, incoming, and intraoffice trunks, and usually two are provided for each frame, although more or fewer may be provided if conditions make it desirable. One of these permanent signal holding trunks is indicated in Figure 1, which shows in block form the general method of dealing with a permanent signal in a No. 5 crossbar office.

As soon as a line is connected to it, a permanent signal holding trunk at once takes a number of steps that will lead to the ultimate removal of the permanent signal conditions. It extends the line terminals to the master test frame at the maintenance center of the No. 5 office and lights a lamp there to indicate the number of the permanent signal holding trunk involved, and whether the trouble is on a PBX line, a coin line, or a noncoin line. This information is given to the permanent signal holding trunk by the marker and will be used in clearing the trouble, since different types of lines require different treatments. The holding trunk also extends the line to a test and selector circuit where it will be available for test from the local test desk.

Since the first attempt to clear the permanent signal condition will be made by an operator, the holding circuit also extends the line to a concentrating circuit through which it will be extended to a DSA operator. This concentrating circuit can serve as many as twenty-one lines and connect them one after another over a single trunk to a DSA operator for test. It also serves another purpose. The DSA board may be in an office a considerable distance from the No. 5 office, and if howler tone and the other tests the operator makes were applied at the DSA board, the line attenuation to the subscriber station would be too great to allow them to be effective. They are actually applied in the concentrating circuit therefore, but under con-

trol of the DSA operator. The concentrating circuit also permits simplification in the holding trunks, since certain of the control features are included in a single concentrating circuit instead of in a large number of holding trunks. At least two concentrating circuits are always supplied, and more may be used where conditions warrant it.

Besides extending the line to these various points, the holding trunk also places a high tone on the ring conductor of the line to make the line readily identifiable. At the same time it starts a timing circuit to provide an interval adjustable between 15 and 45 minutes before demanding active attention from the maintenance force. During part of this period an operator will attempt to attract the attention of the subscriber by ringing on the line or applying howler tone. She may also make certain simple tests to determine the cause of the trouble and to remove it if possible, as already mentioned.

As soon as a line is connected to the concentrating circuit from a holding trunk, the concentrating circuit passes a signal to the DSA board which lights a lamp associated with a pair of jacks at one of the positions. There are three lamps and three pairs of jacks—one lamp and one pair of jacks for each of the three types of lines already mentioned. All the jacks have access to the line from the No. 5 office, but only the lamp associated with one pair of jacks is lighted by the concentrating circuit. The operator plugs into one of the jacks under the lighted lamp and then, if she hears no distinguishable sounds and is unable to get a reply, proceeds to apply her tests. If the permanent signal disappears during one of these tests—indicating that the subscriber has hung up—the operator's type-of-line lamp goes out and the operator takes down her plug. This, together with the disappearance of the permanent signal on the line at the No. 5 crossbar office, disconnects that line from the concentrating circuit and holding trunk and restores all conditions to normal. Should the operator not succeed in clearing the trouble, she still will take down her plug, but under this condition the holding trunk remains connected to the affected line, but the concentrating circuit and switchboard is released.

To permit the concentrating circuit to indicate to the DSA operator the type of line involved, and also to receive the results obtained from the tests that the operator applies, it must be possible to pass six different signals from the concentrating circuit to the DSA board. To permit the operator there to control the application of the various tests at the concentrating circuit, it must be possible to pass seven different signals from the DSA board to the concentrating circuit. Since only one pair is used between these two points for each concentrating circuit, a special sig-

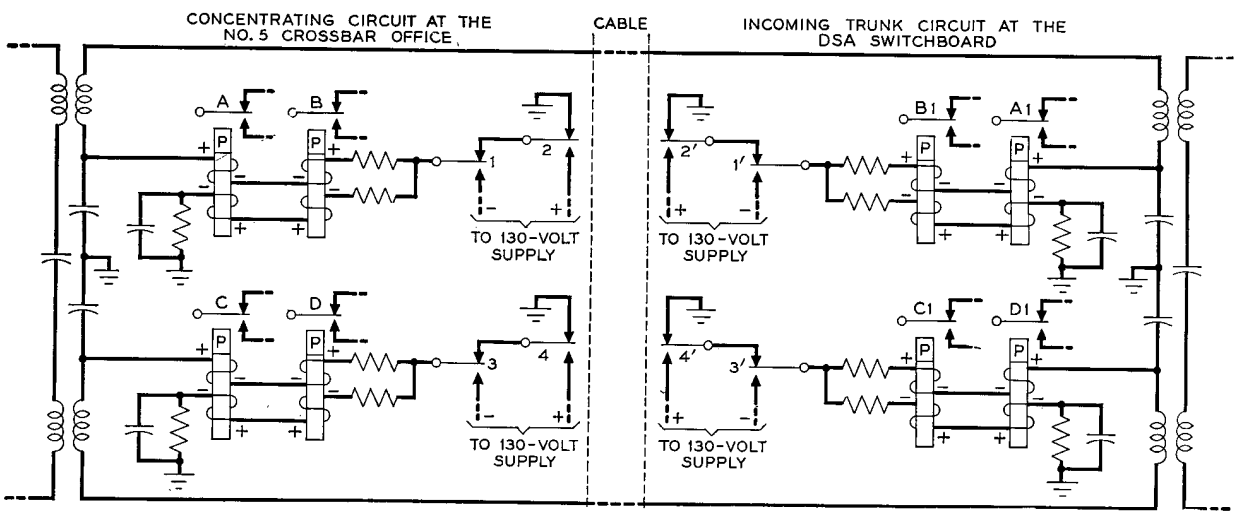

Fig. 2—Method by which six different signals may be passed from the concentrating circuit to the DSA operator and seven different signals may be passed from the DSA operator to the concentrating circuit.

naling circuit had to be developed. This is shown in simplified form in Figure 2.

This circuit permits as many as eight d-c signals to be sent in each direction over a single pair without interfering with voice transmission over the pair, and signals may be sent in both directions at the same time. Four polarized relays are used at each end of the circuit—two in series being connected to each side of the line at each terminal. To either or both of these pairs of relays—through contacts 1, 2, 3 and 4 or 1′, 2′, 3′ and 4′—either positive or negative battery is applied to transmit the signals. With positive voltage applied at contact No. 2 at the concentrating circuit, for example, only relay A1 at the DSA board will operate. Because the current is of the wrong polarity, B1 will not operate, and A and B will not operate because opposing currents pass through both the windings of each. If at the same time a positive potential is applied at contact 2′ at the switchboard, relays A and A1 will operate because of current flowing through their lower windings while no current is flowing through their upper windings. By using combinations of these relays, eight different signals can be received at the switchboard: A1, B1, C1, D1, A1 and C1, A1 and D1, B1 and C1, and B1 and D1. Similarly, eight different signals can be received at the concentrating circuit from the switchboard by using the same combinations of A, B, C, and D.

The operator will have concluded her tests before the end of the timing period that was started when the holding trunk was seized. At the end of the timing period, the holding trunk starts flashing the lamp at the master test frame that it had lighted when it was first seized. The lamp is changed from steady to flashing as soon as the trunk has timed out, but it may flash at either of two rates. It flashes at a lower rate when a connection has been made to the trunk either by the clerk at the repair service desk or by the maintenance man at the master test frame, but it flashes at a higher rate when such connections have not been made. When the trunk times out, it also gives an alarm in the No. 5 office. If there is a maintenance force in attendance at this time, the number of the line and of the permanent signal holding trunk will be reported to the repair service desk.

For economy reasons, permanent signal holding trunks, which are twelve-relay circuits, are provided only in sufficient quantity to handle the normal traffic. When an abnormal number of permanent signal conditions occur at the same time, all permanent signal holding trunks will become busy. Under these conditions, the marker will connect the subscriber line to a common overflow trunk circuit. This common overflow circuit consists of only five relays and is very liberally provided. It not only handles overflow from the permanent signal holding trunks but also the overflow from certain other trunk circuits. When the marker connects a subscriber line having a permanent signal condition to a common overflow circuit, however, it operates a class relay in the trunk which supplies high tone on the ring conductor, and also extends the line conductors to a jack located at the master test frame, and lights a lamp associated with the jack.

When an abnormal number of permanent signal conditions occur at the same time, it is necessary to attract the attention of the maintenance personnel since they may be due to a cable failure. Each permanent signal holding trunk when connected to a subscriber line and each common overflow trunk circuit when connected to a subscriber line on which there is a permanent signal, connects a resistance ground to a permanent signal alarm circuit. This alarm circuit is an integrating type of circuit and only functions when a definite preset number of low resistance grounds are connected to it at the same time. Thus, when an abnormal number of permanent signal conditions occur at the same time, the permanent signal alarm circuit causes an audible and visual alarm circuit to function, thus bringing this condition to the attention of the maintenance personnel. Should the maintenance force not be in attendance, the alarm will be extended to the distant maintenance center, and the nature of the trouble will be indicated as has already been described.*

* See pages 126 and 131