C. E. GERMANTON
Switching Development

Interoffice transfer of alarms in No. 5 crossbar

Since it was expected that many No. 5 crossbar offices would be maintained by off-premises personnel at least part of the time, such as nights and week-ends, it was necessary to design suitable circuits to transfer alarms* in unattended offices to some center where a maintenance force was available. Such a system has been designed, and was first used with the No. 5 crossbar office in Media, Pa. It has since been adapted for use with the panel system and with the No. 1 crossbar system, and should it be found desirable, it could be arranged for use with the step-by-step, community dial, crossbar tandem, and panel sender tandem systems.

In a trial of the transfer of alarms from a No. 1 crossbar office, it was found that a considerable amount of information was

*See page 126.

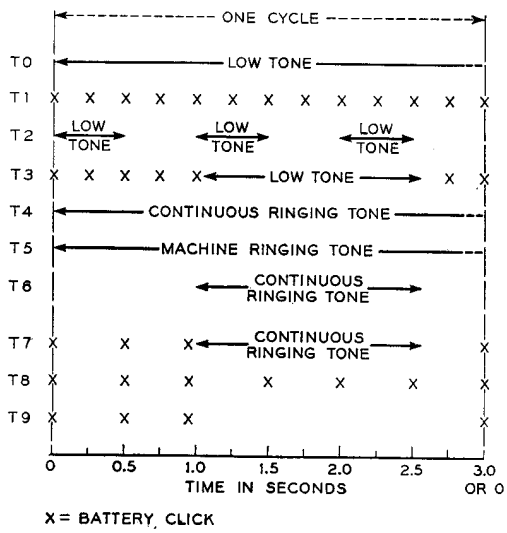

Fig. 1—Tone and click combinations

desirable, and twelve cable conductors were used. In addition, it was found that it should be possible to enable the transfer circuit from the receiving end whenever transfer had been neglected at the sending end. It should also be possible to determine whether the transfer had been enabled even if no alarm conditions existed, and to release locked-in temporary alarms so as to determine whether or not the trouble condition was of a continuing nature.

Another requirement was that any failure in the transfer circuit should not result in a no-alarm signal, or should not signal an alarm of less importance than that existing at the time. If the cable conductors were opened or grounded, for example, if a fuse blew, if a contact failed due to dirt, or if a wire were broken off, an alarm should be sounded, while if an alarm were being transmitted, it should be changed to a more important class if possible but never to a less important one.

These requirements were all met by an alarm sending and an alarm receiving circuit connected by only two interoffice conductors. Over these two conductors may be transferred as many as seventy different types of alarm conditions. At the sending end of the system, positive or negative 130-volt battery or open circuit may be applied to each of the two transfer leads under control of relays. At the receiving end of the system, each transfer lead connects to one side of the winding of a three-position polarized relay; the other side of each winding is grounded. Since each relay has three positions, there are nine combinations of positions for the relays taken together. These relays control a circuit which causes a specific lamp to light and an audible signal to sound for each of eight

of the combinations. The ninth combination with no lamp or audible signal is used to indicate that the circuit is in good working order. One of the eight lamps and audible combinations is used to indicate a failure in the alarm circuit itself. This leaves seven indications to be associated with various types of trouble conditions that may arise in the particular office that is being supervised.

Besides these two relays, a telephone receiver is bridged across the circuit through a repeating coil, and at the sending end provisions are made for applying any of ten possible tone or click combinations, which may be superimposed on the d-c current through the transfer leads. These combinations are shown in Figure 1. For each of the seven alarm positions of the relays, therefore, there are ten possible tones. There are thus seventy possible trouble conditions that may be given in addition to the signals for transfer-circuit failure and for the all-clear condition.

A simplified schematic of this transfer arrangement is shown in Figure 2, where the relays are in the positions they assume when no alarms are being transferred. Relays FA, L, L1, and A are operated at the sending end, while at the receiving end polarized relay T is operated to its positive position and relay R to its negative position. Under these conditions, the d-c signal relays and the tone and click circuit are disabled, and thus alarms arising in the office are not transferred.

When the alarms are to be transferred to the distant point, the transfer key TR is operated, thus releasing the A relay. This supplies enabling battery to both the tone and d-c relay circuits and disables all audible alarms in the local office, but makes no other changes so long as there are no alarms to be transferred. Should a maintenance man now listen at the receiver at the maintenance center, he would hear a low tone, which in conjunction with the no-lamp condition would indicate that a transfer had been made, that the circuit was in good working condition, and that there were no alarms. When alarms occur, they operate relays in the d-c and tone sig-

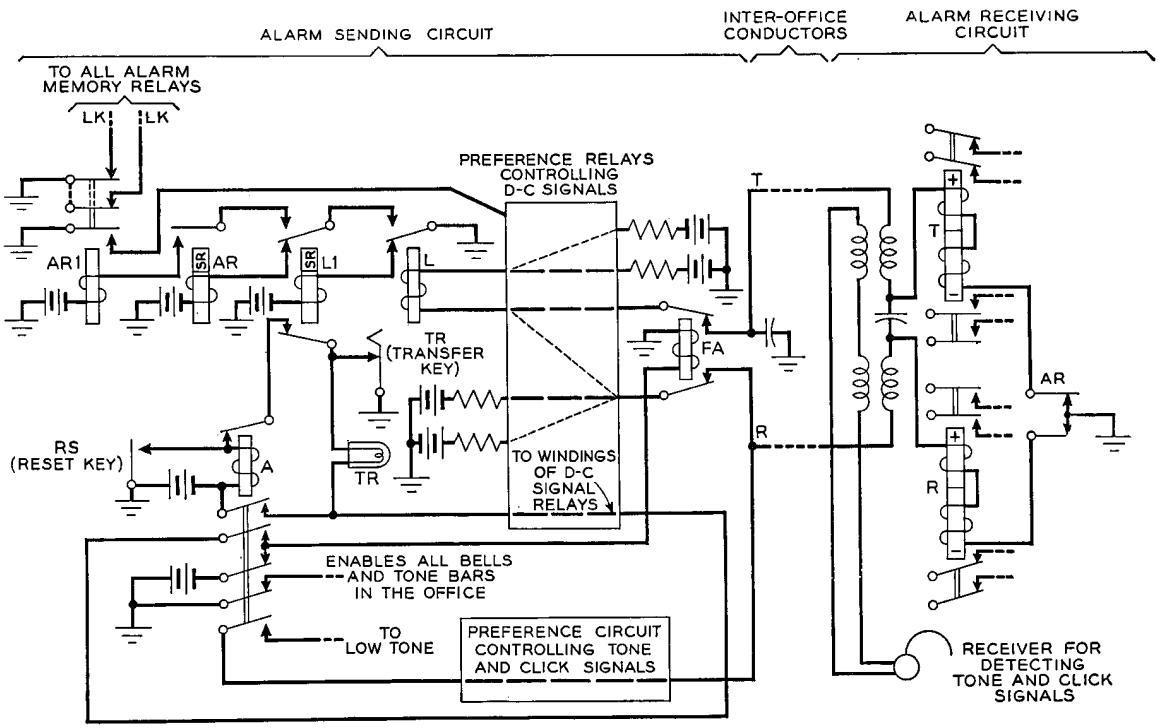

Fig. 2—Simplified sketch of the alarm sending and receiving circuits

LEAD	ALARM CONDITION								
	ALARM TRANSFER FAILURE	TROUBLE RECORDER SEIZURE		ALARM					NORMAL
		1 ST TRIAL	2 ND TRIAL	MAJOR POWER	MAJOR SWITCHING	PERMANENT SIGNAL	LOAD	MINOR	
T	OPEN	–	OPEN	–	OPEN	+	+	–	+
R	OPEN	OPEN	–	–	+	OPEN	+	+	–
	8	7	6	5	4	3	2	1	0

DECREASING SEVERITY →

Fig. 3—D-c signal combinations

nal circuits to send the proper signals to indicate the type of trouble existing.

When the maintenance man returns to the unattended office, he releases key TR. This causes lamp TR to light. Then he momentarily operates the reset key RS. This operates relay A which locks itself in through the transfer key, extinguishes lamp TR, removes battery supply from the tone and d-c relay circuits, and enables the local audible alarms. The extinguishing of TR lamp is a check that relay A operated and remained locked after RS was released.

It is not sufficient, however, only to provide for sending the required alarms. Every possible contingency must be foreseen and provided for. One obvious one is that the maintenance man might neglect to operate the transfer key when he left the No. 5 office. Under such conditions, the transfer may be accomplished from the receiving circuit by operating the AR key at the extreme right of Figure 2. A maintenance man at this point would know that the transfer had not been made by absence of tone when he listened on the telephone receiver, and knowing from the schedule of nonattendance at the distant No. 5 office that transfer should have been accomplished, he would at once operate key AR. This opens the transfer circuit and thus releases relay L which in turn releases relay LI. The release of LI in turn releases relay A and thus effects the transfer.

When transfer has been accomplished in this manner from the receiving end, the TR lamp at the sending end will be lighted through a back contact of relay A and the TR key. When a maintenance man returns to the No. 5 office, therefore, this lighted TR lamp will show that transfer was made from the receiving end, and he will momentarily operate the RS key to reoperate relay A and thus enable the local alarms. When relay A operates, the TR lamp will be extinguished.

Key AR need be operated only momentarily, since once relay A has released, it will not be reoperated by closure of LI because normal connection to the winding of A is made through one of its front contacts. Once released, relay A can be reoperated only by operation of the reset key RS.

The primary function of key AR, however, is to open momentarily the locking paths for all memory relays—in this way determining whether some alarm received is of a temporary nature or whether it continues or recurs. Examples of the former are a trouble recorder seizure, momentary failure of the regular power service to the building, or an overload of the switching equipment such as may result from a flurry of calls in case of a fire in the neighborhood. The slow-release relays LI and AR in Figure 2 insure that the locking leads LK are not opened if relay L releases momentarily when the alarm signals change, and that these leads do not remain open continuously in case of a cable failure.

Since there is always the possibility of two or more alarms occurring simultaneously, and since only one alarm can be transferred at a time, it has been necessary to associate preference circuits in the tone and d-c signal circuits to select only one of possibly several alarms for transfer. Under such conditions, it is desirable to select the most important alarm, that is,

one requiring the most prompt attention. The nine possible combinations of conditions that can occur on the transfer leads to the maintenance center are thus arranged in a preference sequence as shown in Figure 3, where the importance decreases from left to right. At the extreme right is the normal condition, indicating that the transfer circuit is normal and that no alarms are being transferred. At the extreme left, on the other hand, are the conditions that would exist if the power fuses on the alarm circuit had blown, or if the transfer leads were open. Since, under this condition, no alarms at all would be transferred, this is the worst condition possible. Between these two extremes are the seven conditions used for various classes of alarms.

TABLE I—CHANGE IN ALARM GIVEN IF EITHER TRANSMITTING LEAD IS OPEN

	T	*R*
0	6	3
1	4	7
2	4	3
3	8	-
4	-	8
5	6	7
6	-	8
7	8	-
8	-	-

These seven alarm conditions have been so selected that should an open occur in either of the transfer leads, the resulting alarm indicated at the receiving office would be of a more serious nature than the alarm existing when the trouble occurred. This is shown in Table I. At the left are listed the various classes from zero to eight, corresponding to Figure 3. The next column to the right indicates the alarm class that would result were the tip lead opened, while the third column indicates the alarm that would result were the ring lead open. A dash indicates that no change occurs, since the battery signal has already been removed from that lead. It will be noticed that in all cases the importance of the alarm is either unchanged or increased, but is never decreased by the opening of the circuit. The absence of tone would give a clue if this trouble is caused by severance of a conductor. However, the trouble may be due to a dirty contact or a broken wire, in which case the tone may still be audible. A factor of safety resides in the fact that any alarm which is transmissible over one lead is severe enough, unless of short duration, to warrant dispatching a maintenance man to investigate its cause.

If while relay A is operated, a momentary break should occur that would release it, the transfer of alarms becomes enabled and the audible alarm devices in the building are disabled. This feature does not appear desirable at first glance but the alternative—to disable the transfer under a similar failure condition—would be dangerous, since the alarm signals would then not reach any maintenance people. The present arrangement insures that in case of such trouble, the alarms are transmitted to the distant point where maintenance personnel are always in attendance. In addition, the pilot lamps at the originating point will light, which, without the audibles, will be indication of an alarm sending circuit failure.

At the receiving end of the transfer arrangement, the lamp and audible signals remain locked-in, even if the received signal has been retired. If the signal should be changed before attention can be given, all lamps and audibles remain locked-in. In addition to the alarm release key already referred to, there is an audible cutoff key which, when operated, will silence the audible and extinguish the lamps unless an alarm signal is still in effect, in which case the corresponding lamp remains lighted. If the alarm signal is subsequently replaced by the normal signal, the lamp is extinguished and the circuit is again normal. If, however, the lamp signal is changed, the original lamp is extinguished, a new lamp lights, and the audible is sounded.