Message register operation in No. 5 crossbar

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A feature of the No. 5 crossbar system* is the use of cold cathode gas-filled tubes to perform certain operations. Large numbers of them are employed for operating subscriber message registers in offices where these are required. Owing to the differences in the trunking plans of the two systems, the d-c method of control employed for registers in the No. 1 crossbar system was not practicable with the No. 5 system. Accordingly, an unusual type of control circuit utilizing cold cathode tubes has been developed to fit the simplified plan of the latter system.

Telephone message registers have been used for many years with certain classes of subscriber lines to indicate the number of calls completed. They are small magnetically operated counters that are operated once for each call completed, and in some cases once for each unit charge a call entails. Although automatic message accounting is being made available for the No. 5 crossbar system, it will be employed in general only in the larger areas where many outlying offices at varying distances result in a wide range of charges. In many offices there will continue to be a need for message registers, and circuits for operating them on both single and two-party lines are thus included in the No. 5 crossbar system, as they were in the No. 1 system.

If the method employed for operating the message registers in the No. 1 crossbar system were used in the No. 5 system, however,

* See page 5.

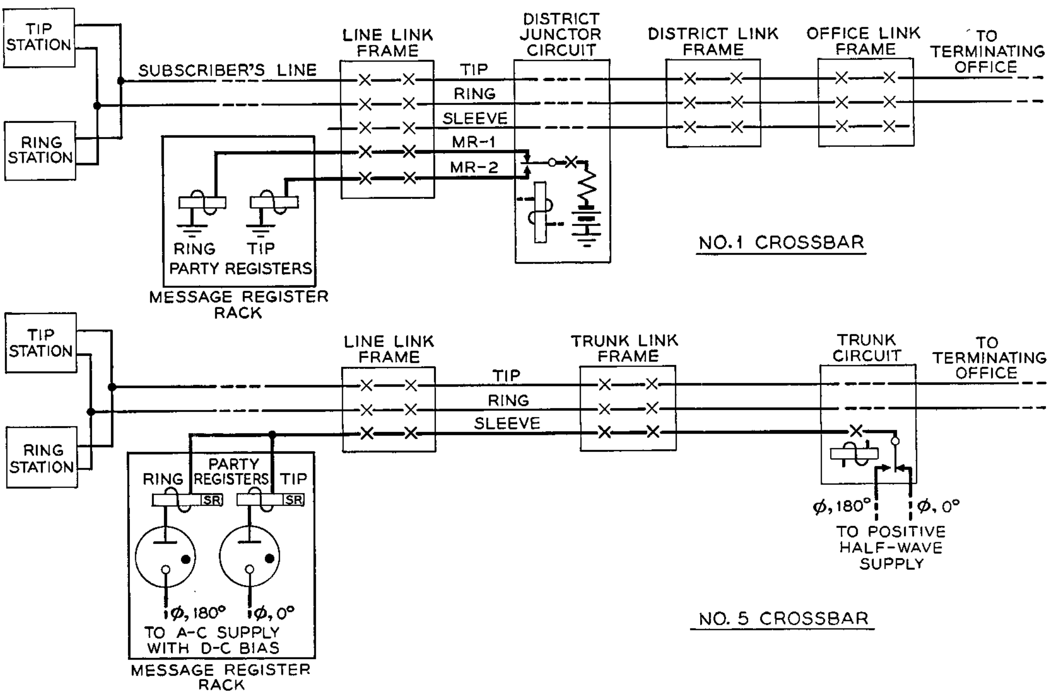

Fig. 1—Simplified circuit indicating method of operating message registers: above, in the No. 1 crossbar system; below, in the No. 5 crossbar system.

the crossbar switches on the line link and trunk link frames would have had to be equipped with five sets of contacts at each of the crosspoints instead of three. In the No. 1 system the registers are operated from the district junctor circuits over two leads—one for the two possible registers associated with a two-party line. These leads pass through the line link frames to reach the registers, and thus the crossbar switches on these frames must have two sets of contacts in addition to the three for the tip, ring, and sleeve conductors. This is indicated in the upper diagram of Figure 1.

In the No. 5 crossbar system, on the other hand, the message-register operating voltages are applied in the trunk circuits as indicated in the lower diagram of Figure 1, and the leads over which the registers are reached pass through the trunk link as well as the line link frames. If the method of the No. 1 system were employed, therefore, the crossbar switches on the trunk link as well as on the line link frames would have to be equipped with five sets of crosspoints instead of three. This has been avoided by a method of operating the message registers that requires no additional crosspoints on any of the switching frames.

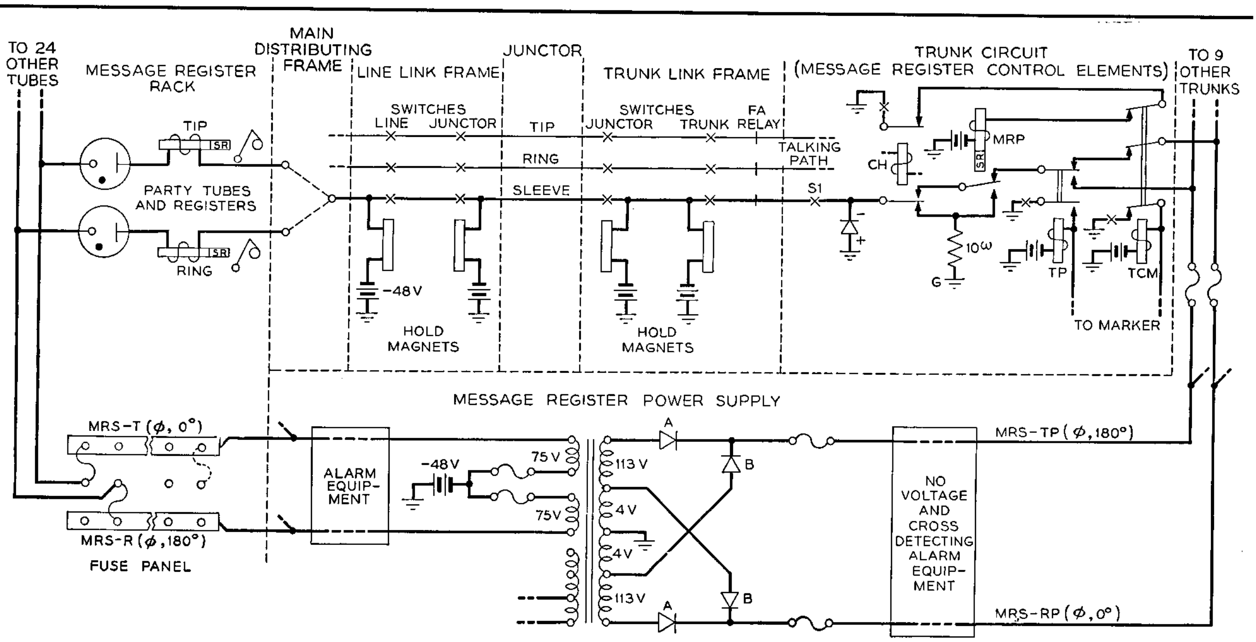

Fig. 2—Message register operating circuit in the No. 5 crossbar system.

Instead of using extra leads for operating the message registers, the sleeve lead is made to do double duty. Besides being used for operating the hold magnets of the crossbar switches and giving busy indications to the marker, it is also used for operating the message registers through 413A cold-cathode gas-filled tubes. The two registers associated with the line are both connected to the sleeve lead, but because of the cold-cathode tubes in series with them neither will operate on the potentials applied to the sleeve lead for operating hold magnets or giving busy or idle indications to the marker. They will operate only when a properly phased half-wave ac voltage is applied to the sleeve lead in the trunk circuit. Two voltages are made available for applying to this sleeve lead. They are alike in magnitude but differ in phase by 180 degrees. Each of the two registers on a line will respond to only one of these voltages, and a relay in the trunk circuit connects the proper voltage to the sleeve lead under control of the marker.

Which party has originated the call, and which register should thus be operated after the call is answered, is determined by substantially the same means in both the No. 1 and No. 5 crossbar systems during the first phase of the call, when the line is connected to the dial pulse receiving equipment (not shown in Figure 1). When a call is originated by a tip station, a d-c path to ground is provided while for a call from a ring station there is no d-c path to ground. Message register control circuits in both the No. 1 and No. 5 systems use this difference to determine whether it is a tip or ring party that is calling.

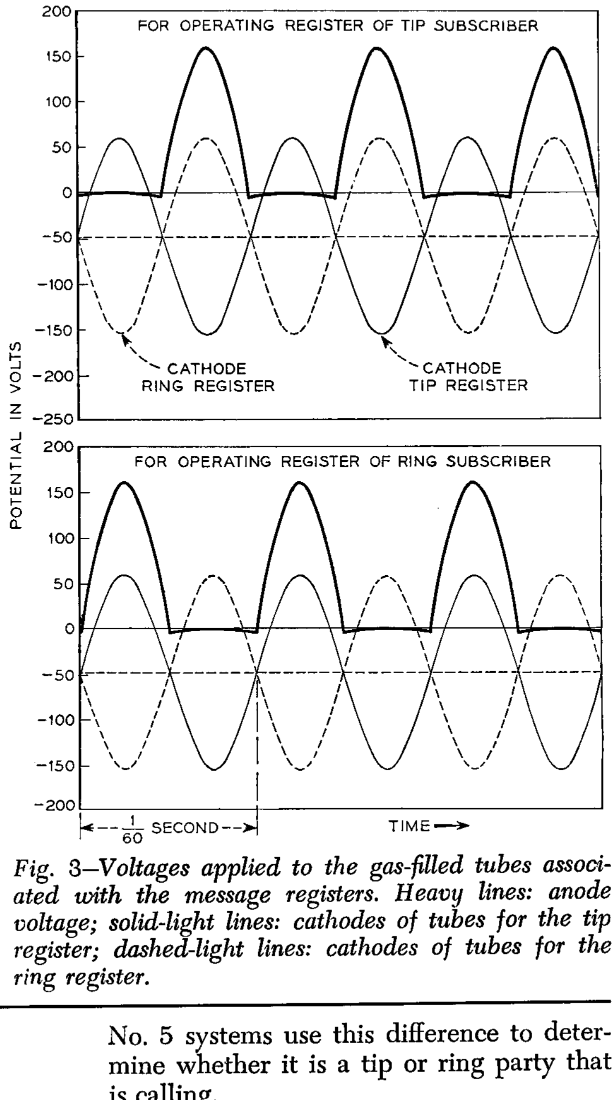

Fig. 3—Voltages applied to the gas-filled tubes associated with the message registers. Heavy lines: anode voltage; solid-light lines: cathodes of tubes for the tip register; dashed-light lines: cathodes of tubes for the ring register.

Standard sheet metal frames are used for mounting the registers and their associated cold-cathode tubes as shown in Figure 5. Each frame accommodates five hundred registers and tubes. A locking bar is fastened along one upright of each frame, and a key is required to open or remove the lucite covers from the message register frame.

The method of operating registers is achieved as follows:

The detailed plan of operation of the new message register circuit is indicated in Figure 2. Each message register is connected between the sleeve lead of the circuit with which it is associated and the anode of a gas-filled tube—a 413A. In Figure 2 only the two registers associated with one line are shown, and they both connect to the sleeve lead of that line. The cathodes of the gas filled tubes for all the registers connect to a 75-volt rms a-c supply with a negative 48-volt bias. As indicated in the diagram, there are two of these supplies, equal in voltage but differing 180 degrees in phase. The tubes for all tip subscribers connect to one supply and those for all ring subscribers to the other. The voltage on the cathodes of the tubes is indicated by the dashed and light solid curves of both the diagrams of Figure 3. Since a 75-volt rms sine wave has a peak value of 106 volts, these curves swing from −154 to +58 volts.

When a line is not in use, its sleeve conductor is connected to −48 volt battery through its holding magnet on the line link frame, and thus this voltage appears on the anode of all tubes while the lines are idle. This voltage is indicated by the light dashed horizontal lines in Figure 3. The gas tubes will not ionize and pass current unless the anode is about 200 volts more positive than the cathode, and thus under these conditions, no current passes through the tubes.

When a call has been placed and the line is connected to a trunk by operation of the crossbar switches, the sleeve is held grounded in the trunk circuit. This increases the anode voltage from minus 48 to 0, indicated by the light solid horizontal lines of Figure 3, and the peak voltage across the tube thus becomes 154. This is still too low to ionize the tube, however.

To operate a message register, the trunk circuit momentarily connects to the sleeve lead for that line one or the other of two positive half-wave supplies. These are derived from the same source that supplies the cathode voltages by the method indicated in the lower part of Figure 2. These two voltages have the same peak value of 165 at the supply transformer, but a drop of about 5 volts across the rectifiers A reduces it to about 160 volts at the register. Rectifiers A block the negative half cycle, but a tap on the winding for the voltage of the opposite phase connected through rectifiers B supplies a voltage of about 5 volts peak during the suppressed negative half cycle. The resultant voltage applied to the sleeve conductor—and thus to the anodes of both tubes of that line—when a tip subscriber is to be charged is shown by the heavy curve in the upper part of Figure 3, and that applied for a ring subscriber to be charged is shown by the heavy curve in the lower diagram. These two heavy curves are identical in magnitude but differ in phase by 180 degrees.

From the lower curves of Figure 3, it will be noticed that the voltage on the anode of the tip party tube is never more than 154 volts above the cathode, and thus the tube does not pass current. The voltage on the anode of the ring party tube, however, rises to 314 volts above the cathode every half cycle. As a result, this latter tube passes current and the ring subscriber register is operated. While a tube is passing current, there is a drop of about 70 volts across it, and thus the voltage across the register is reduced by this amount. This is indicated in the diagram of Figure 4 for the operating cycle of the ring subscriber. The shaded area on this diagram is a voltage-time graph per cycle for the ring register, and is proportional to the energy per half cycle that is available to operate the register. No current will start to flow until the voltage across the tube is about 210 volts, which is assumed to be the ionizing voltage for this particular tube. At this moment—as soon as current is passing—the voltage across the register becomes 140. Following the sine wave, it then increases to 244 volts and then drops to 0. About a hundredth of a second later, during the next positive half cycle, a similar spurt of current will flow through the register, and these spurts of current recurring every sixtieth of a second operate the register and, because of the copper sleeve that is placed around its core, hold it operated as long as the anode voltage is applied.

This operate current for the register is applied by the trunk using the circuit indicated at the upper right of Figure 2, which shows the conditions after the line has been connected to the trunk but before the register is operated. If a charge will be required for the call in progress, relay TCM will have been operated by the marker, and in turn will have operated relay MRP. Whether it is a tip or ring subscriber that is calling will also have been determined by the marker, and if a tip subscriber is calling, relay TP will be operated; if a ring subscriber is calling, or if it is a single party line subscriber, TP will not be operated.

After the called subscriber has answered, and a charge is to be made for the call, relay

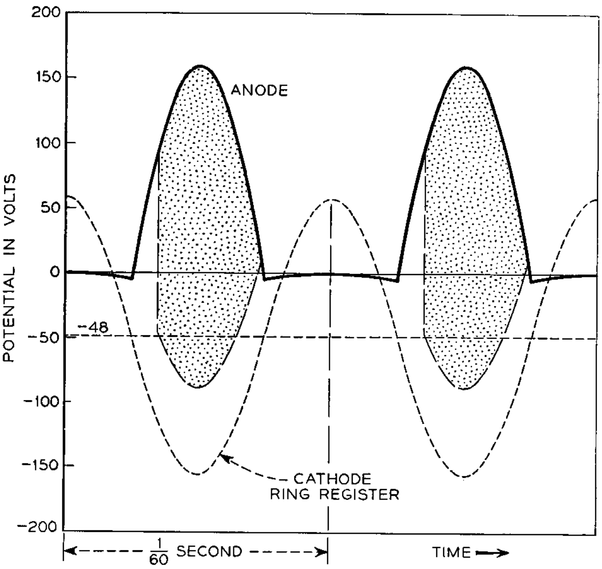

Fig. 4—Enlarged diagram of about two cycles of the voltages shown in Figure 3.

CH is operated. This transfers the sleeve lead from the holding ground at G to lead MRS-RP of the power supply through front contacts of MRP and TCM and a back contact of TP. This establishes voltages on the registers for this line as indicated by the lower curves of Figure 3, and the message register for the ring subscriber will operate while that for the tip subscriber will not.

The circuit to the winding of relay MRP is opened when CH operates, and since MRP is a slow-release relay, the message register operating current is applied only during the release period of this relay, which is ample time to operate the register. After the release of MRP, the sleeve lead is returned to its normal holding ground at G. While the message

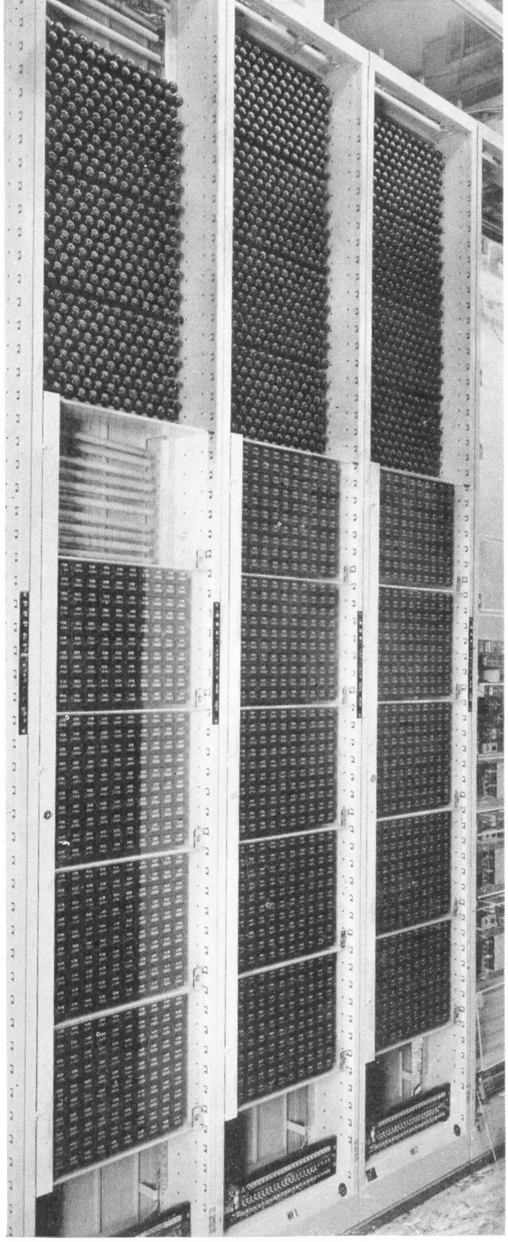

Fig. 5–Message register equipment.

register is being operated, the hold magnets are held operated from ground at the center tap of the transformer in the lower part of Figure 2. The varistor shown in the trunk circuit keeps the hold magnets operated while the sleeve lead is being transferred to the anode power supply by the operation of CH and while it is being transferred back to the hold ground by the release of MRP. It also prevents an undesirable negative discharge of the holding magnets from being impressed on the gas tubes during this switching.

At the end of the call, the trunk circuit removes the sleeve ground, thus releasing the crossbar switch hold magnets. Where they are required, trunk circuits may also be provided with equipment for timing the duration of conversations and for advancing the message register an additional step after each measured time interval. In such cases, a motor driven contact controls the relays that apply the operating voltages for the message registers.

A special fuse panel at the bottom of the message register frame, evident in Figure 5, provides either tip or ring party voltage to each group of twenty-five tubes and permits changing the assignment of any group from tip to ring supply without recabling or restamping. This is done by providing one lead to carry the superimposed a-c supply to each tube group. This lead may be connected to either tip supply or ring supply by connecting its associated fuse to either the tip supply bus bar or ring supply bus bar of the fuse panel as shown in Figure 2.