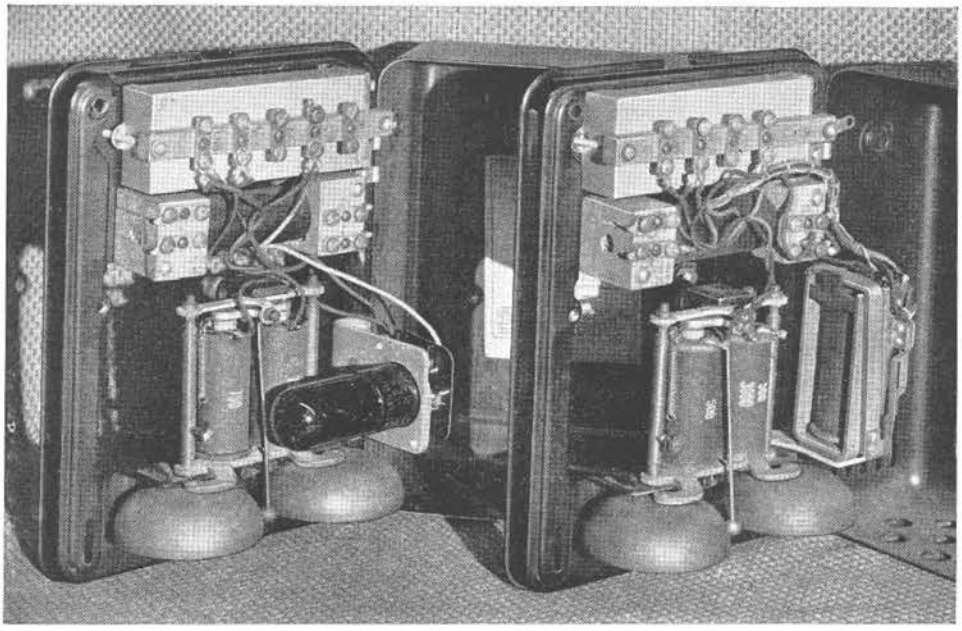

Vacuum Tube Improves Selective Ringing

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THE standard subscriber set used in the Bell System for four-party selective ringing employs a relay as well as a polarized ringer at each station. The arrangement of such a circuit is indicated in Figure 1, which shows the connections at the four subscriber stations on a full-selective circuit. Superimposed ringing current is employed, which uses an alternating current superimposed on either a positive or negative direct current. Ringing is applied across the line, and one side of the line is grounded. At the subscriber stations, the relays are all connected across the line through condensers, and all four relays operate whenever ringing is applied, and connect their respective ringers to ground. The ringers, however, are divided; half of them are connected to one side of the line and the other half to the other. While all of the relays operate for all calls, current will flow through only the two ringers connected to the side of the line not grounded during the application of ringing. The ringers are of the polarized type, however, and the two connected to the same side of the line are oppositely poled so that one will ring only with a positive superimposed current and the other only on a negative superimposed current. In this way only one bell will ring for any one call.

Recent improvements in the neon tube suggested that it might be used at the subscriber station to take the place of both the relay and the condenser in the subset, and at the same time to give better operating condi-

tions with a lower original cost and decreased maintenance expense. With this in view, the 313A vacuum tube (described in the following article) was developed. This is a three-element tube with two control electrodes, either of which may be used as an anode or cathode, and an operating anode. As used in the new subscriber set one of the control electrodes is always used as a cathode, and the other is used as a control anode to secure breakdown or ionization of the tube at a potential of about 70 volts. A resistance of 100,000 ohms is connected in series with this control anode to limit the current in the control gap to a value sufficient only to ionize the gas so as to allow current to flow in the main gap.

The connection of the tube at the four stations of a full-selective line is shown in Figure 2. When station 1 is to be rung, "negative" ringing current is applied to the "ring" side of the line, and the "tip" side of the line is grounded. Control gaps of tubes at stations 1 and 3 break down, but since "positive" current can flow only from the anode to cathode, the tube at station 1 alone will pass current enough to ring its bell. To ring station 3, "positive" current is applied to the ring side, and as the anode at the tube is connected to that side of the line, current will flow to operate the ringer. Stations 2 and 4 respond in like manner to ringing current flowing through the tip side. The tube set will operate on the same type of ringing and requires even less current than the relay set, so that no change is required in the central-office ringing supply. It will also operate on the same line with relay sets.

Several advantages arise from the use of this new tube. With the relay-type subscriber set, current flowed through two ringers and four relays at each call, while with the vacuum-tube set, because of the asymmetry of the tube, which makes it conductive to current passing in one direction only, current flows only in one ringer for each call. This reduces the voltage drop due to line resistance, and permits a longer ringing range for four-party service.

The tripping relay at the central office, whose function is to open the ringing circuit when the subscriber answers, must be adjusted not to operate on the ringing current, but to operate promptly on the small additional current that flows when the subscriber lifts his receiver from the hook. Since, with the vacuum-tube set, current flows through only one ringer at any one time, the amount of ringing current is less, and as a result the adjustment of the tripping relay is simplified.

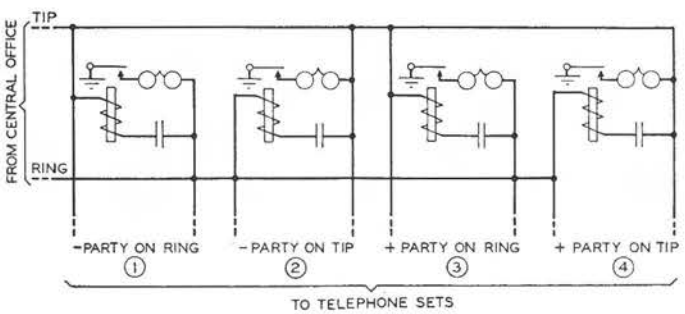

Fig. 1—Substation connections for a four-party full-selective circuit using relay-type subscriber sets

The new circuit completely eliminates bell tapping and false ringing sometimes caused by dialing or switching operations on the line. Another advantage of the tube is that it can be mounted in any position, and requires no adjustment. The relay, on the other hand,

has to be mounted vertically to insure proper action, and in addition a certain amount of adjustment is required to insure its proper functioning.

Several years ago, an eight-party semi-selective ringing system was adopted using relay sets and superimposed ringing current. One of the essential differences between the eight-party semi-selective relay sets and the four-party full-selective relay sets is that higher impedance relays and ringers are used for the eight-party set. These impedance requirements were imposed partly by the adjustment requirements for the tripping relay, and partly by the necessity for high impedance to noise induction, such as from power lines. Since the use of the tube set leaves the connection to ground at the subscriber station open to normal voltages, no noise induction results even with the use of low impedance ringers, and since as previously pointed out, the tripping conditions for the tube set are considerably less severe than with the relay set, the vacuum tube subscriber set gives appreciable improvement for eight-party semi-selective service as well as for four-party full-selective service.

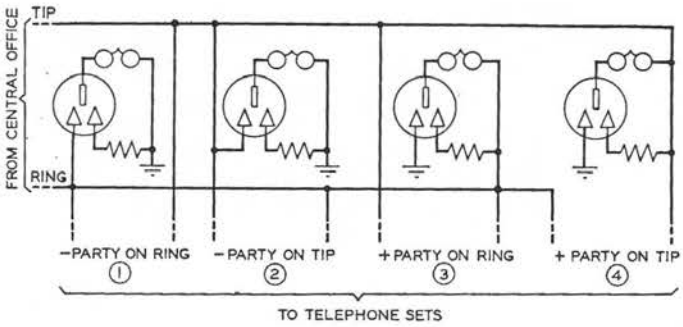

Fig. 2—Connections for the vacuum-tube subscriber set for a four-party full-selective circuit

Another application of the vacuum-tube subscriber set is in areas where relay sets are now used on two-party lines to avoid interference from foreign a-c. earth potentials or induction. Since the vacuum tube is open-circuited except for the duration of the ringing, the new sets put the subscriber's station on the same footing as in individual line service, so far as noise is concerned. Also, in two-party service, the new sets avoid false ringing from foreign voltages up to the breakdown voltage of the main gap, which is of the order of 175 volts peak. In four-party service protection against false ringing extends to the breakdown voltage of the control gap, about 70 volts peak.

The 313A tube can be provided more cheaply than the relay now used, and since it requires no adjustment, considerable savings both in first cost and maintenance of subscriber sets will result from its use. Accelerated life tests on the 313A tubes have indicated that the tubes will permit satisfactory ringing service for at least 300 hours actual operation. Average station traffic requires the tube to conduct current for only about 6 hours per year of service. After long usage or excessive current flow, both breakdown and sustaining voltages of the tubes rise, thus reducing the current through the ringer. So far no tubes have been destroyed during test except by mechanical breakage.