BELL SYSTEM PRACTICES **ADDENDUM C31.122**
Station Installation and Maintenance **Issue 1, June, 1954**
AT&T Co Standard

SUBSCRIBER SETS
CONTAINING COLD CATHODE GAS-FILLED VACUUM TUBES

1. GENERAL

1.01 This addendum supplements Section C31.122, Issue 5. It is issued to bring information contained in paragraphs 2.05, 3.01, 3.03, 3.04, and 3.05 up to date and to add 2.07.

2. SUBSCRIBER SETS

2.05 Change to read as follows: The 425- and 426-type vacuum tubes and their associated mounting brackets may be added to metal or wooden sets having 1000-, 1400-, or 1500-ohm ringers. Sets with 1000-ohm ringers do not, however, provide as satisfactory a margin for operating the tripping relays in central offices as is provided by the 1400- or 1500-ohm ringers. The use of subscriber sets with vacuum tubes is subject to further limitations included in Section C63.252, Ringer Connection Limitations, Polarized Ringing Lines.

2.07 Add paragraph as follows: Where a loud ringing bell is required, use a 592C subscriber set containing a 359A tube.

3. VACUUM TUBES

3.01 Change to read as follows: The 426-type tube has three elements consisting of three electrodes: a cathode, a starter anode, and an operating anode. It contains a mixture of neon and other inert gases at low pressure. The cathode is coated with material that facilitates electron emission and, hence, ionization of the gas, which furnishes a path for current flow to the starter anode or operating anode.

3.03 Change to read as follows: The gaps between the electrodes are practically an open circuit at voltages below a value called the breakdown point. Voltages above this value will cause ionization of the gases, permitting current flow throug the tube. As used in the subscriber set, one of the control electrodes is always used as a cathode and the other is used as a starter anode to secure breakdown or ionization. This occurs in the control gap (see Fig. 4) of the tubes at potentials of 65- to 85-volts. A resistance of 120,000 ohms is connected in series with the starter anode to limit the current in the control gap to a value sufficient to ionize the gas. Ionization permits current to flow across the main gap through the ringer coils to ground, thus operating the ringer. If the tube were not first fired through the control gap to the starter anode, a minimum instantaneous value of about 180 volts would be required to break down the main gap.

3.04 Change to read as follows: Once the gas becomes ionized and a current carrying path is established, there is a "sustaining voltage" of 58- to 72-volts maintained in the control gap. In the main gap, a "sustaining voltage" of 63- to 75-volts is also maintained.

3.05 Change to read as follows: Both the starter anode and the operating anode are smaller and less emissive than the cathode so that both the control and main gap pass current more readily when the starter anode or operating anode are positive. In the usual operating range for this tube, it will pass only about 1/10 as much current when the anode is negative as it will when the anode is positive.

SUBSCRIBER SETS
CONTAINING COLD CATHODE GAS FILLED VACUUM TUBES

1. GENERAL

1.01 This section covers the use of cold cathode gas filled vacuum tubes in subscriber sets.

1.02 It is reissued to change the schematic drawing symbols for vacuum tubes used in Figs. 2, 3 and 4. These new symbols will also be used in other sections as they are revised.

2. SUBSCRIBER SETS

2.01 Subscriber sets with cold cathode gas filled tubes are intended for use principally on grounded ringing party lines where superimposed or pulsating ringing current is employed, as on four-party selective and eight-party semi-selective lines.

2.02 The 313 and 333 type vacuum tubes used for this purpose have essentially the same characteristics. The principal difference between them is in the mounting arrangements.

2.03 The 313 type vacuum tube is supported in the set by a 150A vacuum tube socket. The 150A vacuum tube socket comes equipped with a resistance of about 100,000 ohms assembled in the base of the socket, leads for making connections and a bracket for mounting the complete assembly in the subscriber set. Five mounting holes are provided in the bracket which facilitate mounting it in different types of sets.

2.04 The 333 type vacuum tube is mounted in the set by means of a relatively simple mounting bracket (P-456673). The connecting leads are soldered directly to the tube and a suitable resistance is either soldered to or contained in the base of the tube. The bracket has five notches instead of holes for mounting it in the sets. The vacuum tube is secured in place on the bracket by means of screw P-351132 with the locating pin on the tube engaging

the hole in the bracket. A 333A vacuum tube attached to its mounting bracket is shown in Fig. 1.

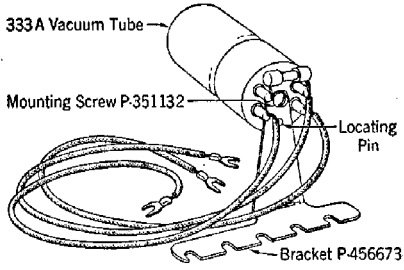

Fig. 1.

2.05 The 333 type tube will be furnished in new and converted tube sets. A limited supply of 313 type vacuum tubes will be kept available for maintenance replacements in sets in service. The 333 type vacuum tube only is needed for maintenance replacements in sets containing the bracket P-456673.

2.06 The 333 type vacuum tube and its associated bracket may be added to metal or wooden sets having 1000, 1400 or 1500 ohm ringers. Sets with 1000 ohm ringers do not, however, provide as satisfactory margins for operating the tripping relays in central offices as is provided by the 1400 or 1500 ohm ringers. When sets with 1000-3000 ohm ringers are used the 3000 ohm non-inductive winding should be short-circuited. High impedance ringers are not suitable for use in vacuum tube ringing circuits. Where a loud ringing bell is required use 392M Subscriber Set in connection with a 313 or 333 type tube located in another subscriber set. The use of subscriber sets with vacuum tubes is subject to further limitations included in the section entitled "Ringer Connection Limitations—Polarized Ringing Lines."

2.07 In wooden subscriber sets the bracket is mounted in the upper right-hand corner of the box, with the bracket fastened to the back of the box by means of two 1/2 in. No. 6 R.H. blued wood screws in the two lower mounting notches. The upper mounting screw is located 1/4 in. from the right side and 2-7/8 in. down from the top of the box.

2.08 In 333 and 433 type sets the bracket is fastened under the upper hinge mounting screws with the hinge screws through the upper mounting notches.

2.09 In 334, 434, 533 and 633 type sets the lower hinge mounting screws and the 2nd and 3rd mounting notches from the lower end of the bracket are used to attach the bracket. In 534, 553, 634 and 653 type sets the bracket is also fastened under lower hinge mounting screws, but the two lower notches in the bracket are used.

2.10 The 313 type vacuum tube and the 150A vacuum tube socket may also be added to wooden and metal sets as covered in 2.06, 2.07, 2.08 and 2.09 if local supply conditions require it.

2.11 The following tables indicate the subscriber sets to which tubes may be added. (*) Indicates that ringer should be replaced with 1400 or 1500 ohm ringer. 85-type relays and 38-type resistances should be removed from sets so equipped when tubes are added.

Bell Boxes

Sidetone		Anti-Sidetone	
Present Code	**Code with Tube**	**Present Code**	**Code with Tube**
295BP	295CT	495BP	495CT
334A	334AT	434A	434AT
334AC	"	434AC	"
534A	534AT	634A	634AT
534P	"	—	—
534AC	"	—	—
534AR	"	634AR	634AT
534BR	"	—	—
554AR	"	—	—
554C	"	—	—
534Y	534YT	*634Y	634YT
*534YR	"	*634YR	"
		*634FR	634AT

Wall Sets

Sidetone		Anti-Sidetone	
Present Code	**Code with Tube**	**Present Code**	**Code with Tube**
333B	333BT	433B	433BT
533A	533AT	633A	633AT
533AR	"	633AR	"
533BR	"	—	—
553A	553AT	653A	653AT
553AC	"	—	—
553AR	"	653AR	653AT
533Y	533YT	*633Y	633YT
553Y	553YT	*653Y	653YT
*553YR	"	*653YR	"
		*653FR	653AT

Extension Ringers

Present Code No.	Code No. with Tube
334P	334DT
534D	534DT
534DF	"

3. VACUUM TUBES

3.01 The vacuum tubes mentioned in Part 2 are three-element tubes containing two control electrodes and a third electrode, called the anode. The tubes contain a mixture of neon and other inert gases at low pressure. The control electrodes are coated with a substance which facilitates starting a discharge in the gas.

3.02 The gaps between the electrodes are practically an open circuit, at potentials below a value called the breakdown point. Potentials above this value will cause ionization of the gases in the tube and consequently current will flow through it. The minimum instantaneous value of the potential required to break down the tube across the control electrodes varies from 65 to 85 volts, depending on the individual tube. If there is no discharge in this control gap, the minimum instantaneous potential required to break down the gap between the anode and one control electrode (called the main gap) will vary from 130 to 200 volts.

3.03 When a discharge has been started in the control gap the potential drop across it decreases to a value about 5 to 10 volts below the breakdown voltage and this "sustaining voltage" (60 to 75 volts) is maintained substantially constant over a wide range of current values. The "sustaining voltage" in the main gap is from about 5 to 15 volts higher than that in the control gap or about 65 to 90 volts. It is also constant over a wide range of current values.

3.04 The control electrodes pass current equally well in either direction, but the main gap between a control electrode and the relatively small anode passes current much better when the anode is positive. In the usual operating range for this tube it will pass roughly only 1/20 as much current when the anode is negative as it will when the anode is positive.

3.05 When the applied voltage in either gap is reduced below the sustaining voltage after a discharge has been started, the discharge stops abruptly and the gap restores to its original insulating condition. From a ringing system standpoint the time required for the current flow through the tube to drop to zero is negligible, and the time required for the tube to break down and pass full current is also negligible.

4. OPERATION

4.01 For convenient reference in connection with the circuit operation explanation which follows, the connections for subscriber sets with tubes are shown schematically in Figs. 2, 3 and 4.

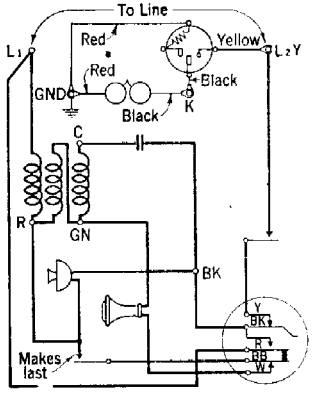

FIG. 2 - TYPICAL WALL SET

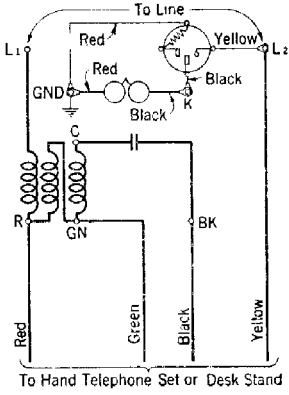

FIG 3 - TYPICAL BELL BOX

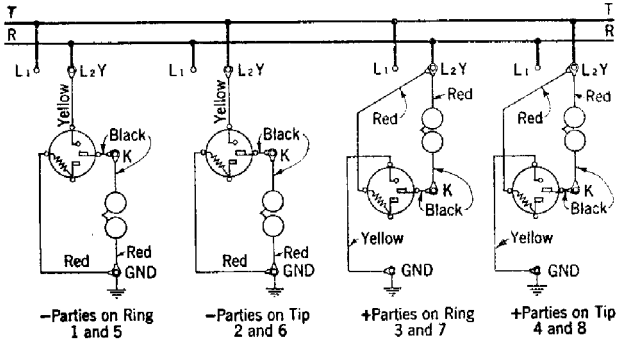

FIG. 4 - TUBE AND RINGER CONNECTIONS FOR GROUNDED POLARIZED RINGING LINES - SIDETONE AND ANTI-SIDETONE STATIONS.

4.02 Referring to Fig. 4 and considering first the + Tip party, if positive superimposed ringing current is applied to the tip, the ring being grounded, both tubes connected to the tip side of the line will break down and both will

pass a very small current in their respective control gaps, this current being limited by the resistances. At the + Tip station the ringer is poled to operate on positive current and since the anode is connected to the tip, the main gap will pass current sufficient to operate the ringer. At the — Tip station, however, the tube has its anode connected to ground, which is negative, and it will not therefore allow any appreciable current to flow through the main gap of this tube and the ringer. Furthermore, the ringer is poled for negative current on the tip and will not operate on positive current.

4.03 From the foregoing it is evident that only the ringer at the + Tip station will operate and that the — Tip station draws very little current from the line. The ring stations are, of course, inoperative when current is applied to the tip side of the line as the ring side of the line is grounded.

4.04 When negative superimposed ringing current is applied to the tip of the line, ground being positive, the + Tip station ringer will not operate since the main gap passes very little current and the ringer is poled against this current. Both tube and ringer at the — Tip station are, however, poled correctly in this case and the — Tip station ringer will operate.

4.05 The operation is similar for the ring parties when positive or negative superimposed ringing current is applied to the ring side of the line, the tip side being grounded.

4.06 It should be noted that with the tube system the operation of the ringers is substantially that which would be obtained on pulsating currents, as the reversals in polarity of the a.c. ringing voltage are at too low a potential to affect the ringers even though they may in some cases be sufficient to cause a momentary discharge in the tube. For example, at + Ring party stations, when negative superimposed ringing current is on the ring side of the line the anodes of tubes at these stations are at a negative potential equivalent to the effective voltage of the superimposed battery and during the positive cycle of the a.c. ringing current the effective potential across the main gap of the tube is roughly equal to the a.c. ringing voltage minus the voltage of the superimposed battery which is ordinarily too low a voltage to cause a breakdown.

4.07 Since the tubes convert the a.c. component of superimposed ringing current into a pulsating current for operating the ringers, pulsating ringing current may also be used to operate stations connected as shown in Fig. 4, negative pulsating current, of course, being employed to ring the negative stations and positive current to ring the positive stations.