Western Electric

333A Vacuum Tube

Classification—Three element cold cathode, gas-filled tube for use as a relay or rectifier in special circuits

This tube is similar to the 313C except for the base.

The elements of the tube consist of a cathode, an anode and a control anode. A 120,000 ohm resistor, mounted inside the base, is included in the control anode lead. The conduction path between the cathode and the control anode is known as the control gap. The conduction path between the cathode and the anode is known as the main gap.

Dimensions—The dimensions and outline diagrams are given in Figures 1 and 2.

Mounting—This vacuum tube employs a special base suitable for stud mounting on an 8-32 machine screw. A screw is furnished with the tube which allows for mounting on a bracket $\frac{1}{32}''$ to $\frac{1}{16}''$ thick. Connections to the electrodes are made through flexible, color-coded leads with spade terminals. The arrangement of electrode connections to the base terminals is shown in Figure 2.

It may be mounted in either a vertical or horizontal position.

Ratings

Maximum peak forward current	30 milliamperes
Maximum average forward current (average over 1 second)	10 milliamperes
Maximum peak reverse current	5 milliamperes

Characteristics

Nominal control-gap breakdown voltage	70 volts
Nominal control-gap sustaining voltage	60 volts
Nominal main-gap breakdown voltage	175 volts
Nominal main-gap sustaining voltage	75 volts
Transfer current	5 microamperes (max.)
Nominal deionization time	
Main gap	10 milliseconds
Control gap	3 milliseconds

The "maximum peak forward current" is the maximum value of current which may be drawn from the cathode.

The "maximum average forward current" is the maximum value of current (averaged over 1 second) which may be drawn from the cathode.

The "maximum peak reverse current" is the maximum value of current which may be drawn from the main anode in the reverse direction, that is when it is acting as a cathode. The reverse current rating is intended for use in designing rectifier circuits and is the maximum inverse current which it is permissible to draw from the tube in such circuits.

The "control-gap breakdown voltage" is the potential required to initiate ionization, thereby starting conduction in the control gap. Once ionization has occurred the potential across the gap will be reduced to the "control-gap sustaining voltage" and will be approximately independent of the current. The voltage between the tube terminals will exceed this value by the voltage drop across the base resistor.

The "main-gap breakdown voltage" is the potential required to start conduction in the main gap when no ionization is occurring in the control gap. After breakdown, conduction will take place at the "main-gap sustaining voltage" and will be practically independent of current.

The "main-gap sustaining voltage" is substantially independent of current when the current passes through the tube in the forward direction. When the current passes through the main gap in the reverse direction the sustaining voltage increases rapidly with increasing current. It is this asymmetry in the properties of the main gap of this tube which enables it to be used as a rectifier. The current-voltage characteristic of the main gap of a typical 333A tube in both forward and reverse directions is shown in Figure 3. This curve was obtained with a cathode ray oscillograph.

When the anode potential is maintained at a value intermediate between the "main-gap breakdown and sustaining voltages" the passage of a small amount of current in the control gap will produce ionization sufficient to initiate conduction in the main gap. It is this property of the tube which enables it to be used as a relay. The amount of current in the control gap required to initiate conduction in the main gap is known as the transfer current. This quantity varies considerably from tube to tube and during the life of a given tube but will in general be less than 5 microamperes and usually only a few tenths of a microampere.

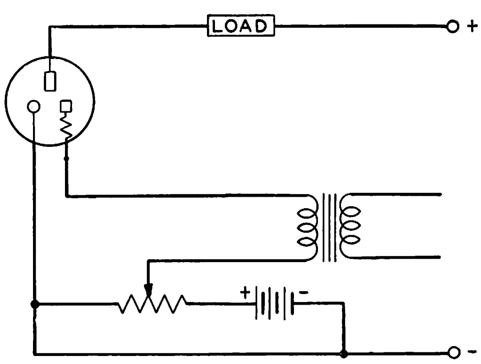
The "deionization time" is the time during which the voltage must be removed from the tube in order that the discharge shall not be reestablished when the voltage is restored. This time increases with increasing applied voltage and with increasing current through the tube before the deionization period. This rate of increase of deionization time is such that the tube will not deionize with a 60 cycle sine wave main-gap voltage if the load is inductive or if the peak voltage is near the main-gap breakdown voltage or the current near the maximum rated value.

The "transfer time" is the time during which the control gap must be energized in order that the discharge may transfer to the main gap. It depends upon the amount of current flowing in the control gap and on the main-gap voltage. For a control-gap current of 10 microamperes the "transfer time" is approximately 200 microseconds.

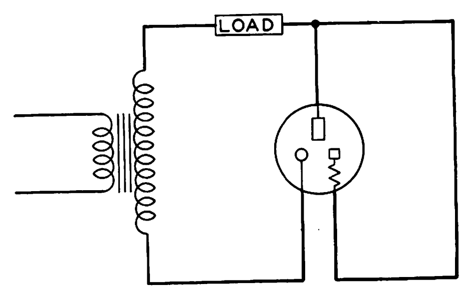
Typical Circuits

Circuit A shows a circuit using the tube as a relay. The supply voltage should be intermediate between the main-gap breakdown and sustaining voltages and the control anode may be biased at any desired potential less than the control-gap sustaining voltage. This circuit possesses a "lock-in" feature, since the main-anode potential must be removed momentarily to restore the tube to a non-conducting condition. When supplied from alternating current this circuit does not possess a "lock-in" feature unless the frequency of the supply voltage is so high that the tube is not allowed a sufficient interval to deionize.

Circuit B shows a circuit with the tube used as a rectifier. The rectifying properties of the main gap are used but the control anode should be connected into the circuit as indicated. This will cause conduction in the forward direction to begin at a voltage much below the main-gap breakdown voltage. It is important to note that as a rectifier this tube possesses a unique property not common to other rectifiers in that its impedance is infinite for voltages below the breakdown voltage. In many applications that is of importance since the tube may be used to pass current at the higher potentials without placing a bridge across the line for signals of lower voltage.



CIRCUIT A



CIRCUIT B

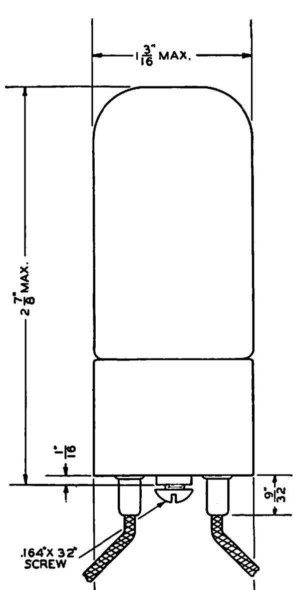


FIG. 1

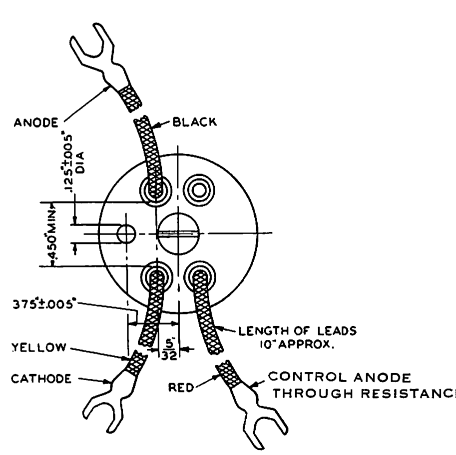


FIG. 2

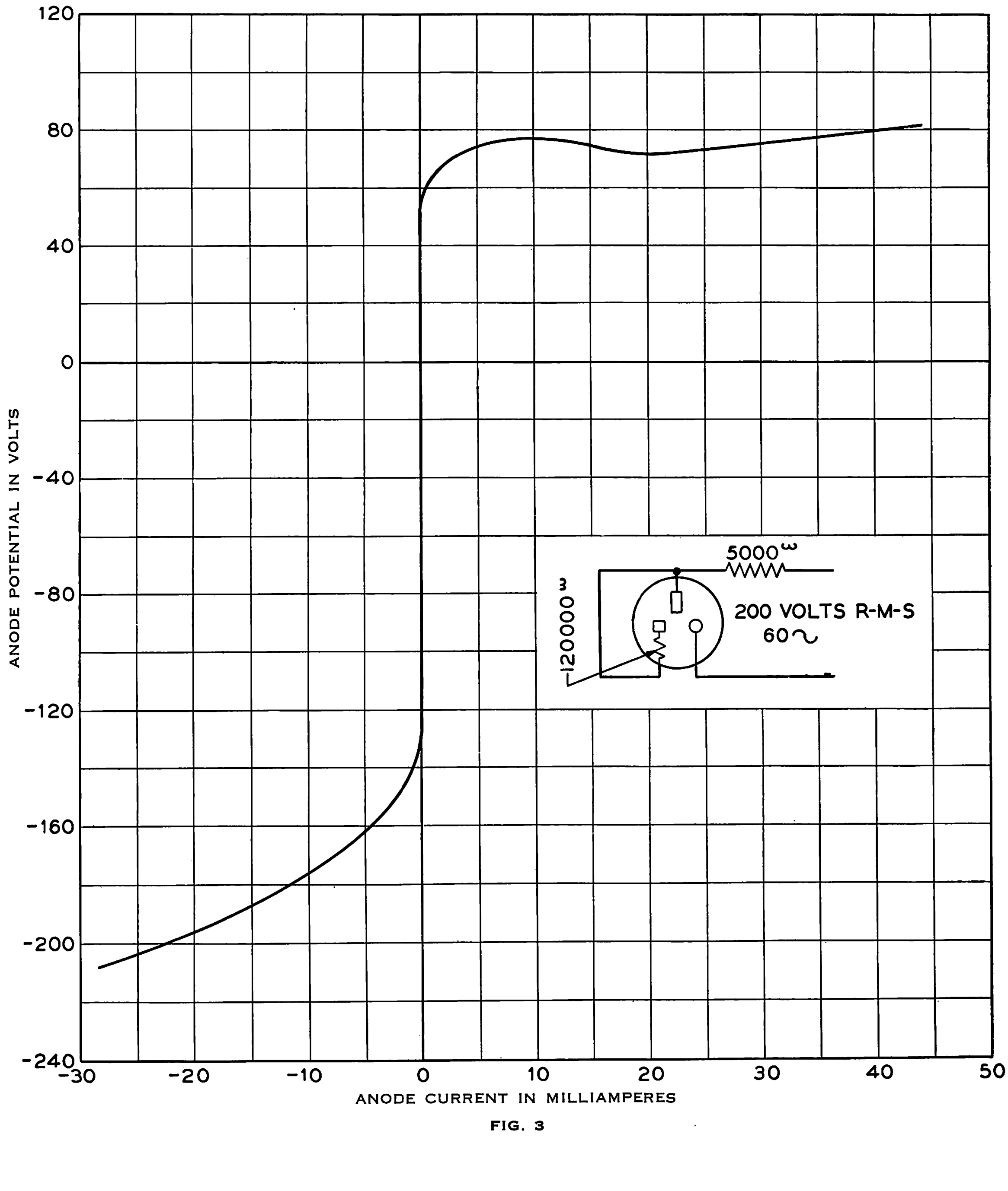


FIG. 3

A development of Bell Telephone Laboratories, Incorporated, the research laboratories of the American Telephone and Telegraph Company and the Western Electric Company