Westinghouse Grid-Glow Tube

DESCRIPTION

The KU-618 Grid-Glow tube is a grid controlled rectifier of the cold-cathode gas filled type. Its fundamental structural parts are an anode, a cathode and a grid. It contains a fourth electrode which is in the form of a shield around the anode, the purpose being to control the manner in which the tube falls at the end of its life, and to insure greater uniformity and stability in characteristics. The KU-618 is filled with neon at a pressure of about one one-hundredth of an atmosphere. A glow discharge is initiated inside the tube by means of ionization by collision within the gas, permitting a passage of considerable current with a drop of potential across the tube of approximately 180 volts which is practically independent of current.

The function of the grid is to control the potential at which the anode current begins. A sufficient negative bias (with respect to anode) will make the starting potential very high. Once the discharge is started, the grid has no appreciable effect in controlling the current. The grid will regain control, however, in a very short time if the anode current is interrupted.

On a-c, the anode current passes through zero during each cycle, thereby giving the grid an opportunity to regain control so that the starting potential on the next half cycle can be varied. By thus controlling the point on the a-c wave at which current starts to flow, the average rectified output of the tube may be varied from essentially zero to a maximum value. This control may be effected by either changing the magnitude of the grid potential or its phase with respect to the anode to cathode potential.

RATINGS

Maximum Crest Anode Voltage 800
Maximum Crest Anode Current I_p 0.1 amperes
Maximum Average Anode Current I_{ave} 0.015 amperes
Cathode Type Cold
Average Tube Voltage Drop 180
Maximum Overall Length 5 3/4"
Maximum Diameter 2 1/4"
Base (Industrial) $411$
Type of Cooling Air
Gas Neon

*The current ratings given here are the recommended maximum and will insure a long tube life. For occasional operation, they may be exceeded by as much as 100 to 200 per cent without seriously affecting the characteristics. The only ill effect will be a decreased tube life.

The tube voltage drop at higher current will be increased by 10 to 20 volts.
INSTALLATION

The KU-618 Grid-Glow tube is fitted with the standard four-prong industrial base. (1) The tube may be operated in any position, although in general the vertical position with the base downward is recommended.

FIG. 1—TYPE KU-618 GRID-GLOW TUBE
OUTLINE DIMENSIONS

If the tube is to be subjected to appreciable shock or vibration, the socket should be mounted on a good shock-absorbing medium.

To obtain best results the circuit and tube must be shielded from high frequency surges, excessive commutator ripple, etc., and protected from dirt and moisture which would cause excessive circuit leakage.

OPERATION

Cathode Circuit—The KU-618 has no filament, and therefore no time is required to put the tube into operation. It is ready for use immediately upon placing in the circuit.

Anode Circuit—There are three fundamental limits to be observed in the operation of the KU-618 Grid-Glow tube. These are the maximum crest voltage, maximum crest anode current and maximum average anode current.

The maximum crest voltage limit is given to avoid arc back and loss of grid control. It should be kept in mind that very short surges of voltage may be responsible for such failures. It is necessary in many cases to use a crest voltmeter or oscillograph to determine the actual crest voltages present.

The KU-618 has a de-ionization period of about 2000 micro seconds and is therefore limited to use on 500 cycles or less. If the frequency is higher than 500 cycles, the residual ionization after the passage of current will be sufficient to make the grid ineffective in controlling breakdown on the next positive half cycle of voltage.

The voltage drop between anode and cathode is of the order of 180 volts, varying to some extent from tube to tube. It will also vary in a given tube with life.

FIG. 2—GRID VOLTAGE-ANODE VOLTAGE CURVES

(1) A specially designed socket is available for use with these tubes. It should be ordered as "Industrial Tube Socket S#760732". Industrial tube sockets contact S#777222 are available for those who wish to assemble sockets directly on the panel.
It is very important in order that the tube shall give reasonable life, that the load present in the anode circuit shall be such as to limit the crest current to not more than 0.10 ampere and the average current to not more than 0.015 ampere.

Grid Circuit—To protect the grid from excessive current and to stabilize its characteristic, it is recommended that wherever possible a resistance of at least 5 megohms be used in series with the grid.

With the constants as shown in Fig. 2 a typical starting characteristic curve of anode Volts Ep, as a function of grid volts is obtained. The curve is taken with a-c. potentials. Note that the reference point for the grid potential is the anode.

By way of clarification, the starting characteristic curve may be explained by saying that current flows at any condition lying to the right and above the curve and that no current flows at points below and to the left of the curve. In other words, at any given value of grid bias Eg, current will not flow unless the anode potential Ep equals or exceeds the value corresponding to that point on the starting characteristic curve.

It should be noted that the algebraic sum of the anode voltage Ep and the grid voltage Eg is a constant at 325 volts. In other words if there is sufficient voltage between anode and cathode the tube will always start when the voltage between grid and cathode is approximately 325 volts a-c.

This constant depends on the grid resistance, being about 200 volts when Rg equals 30,000 ohms. 325 volts when Rg equals nine megohms, and continues to increase at still higher resistance.

A properly designed grid circuit is one of the most important factors in the successful operation of the KU-618 Grid-Glow tube. It is characteristic of the tube that the grid current before and at the point of breakdown varies considerably from tube to tube. Little reliance can be placed upon any type of operation which depends largely upon grid current. It is, therefore, essential to choose constants of the grid biasing circuit of such a magnitude that the current flowing through this circuit will be large in comparison with the grid current. (Grid current at breakdown 0.01-0.0 microamperes.)

Shield Circuit—The shield is not intended as a control electrode. It should at all times be connected to the cathode through a resistance of at least 2 megohms. It is usually desirable to increase this resistance to about 10 megohms.

MAINTENANCE

The KU-618 in operation gives a reddish orange glow at the surface of the large cylindrical electrode or cathode.

If a rapid and continual change in the operating characteristic is noted, the tube is approaching the end of its life.

TYPICAL CIRCUITS

Circuits employing KU-618 tubes may be divided into four general classes according to output; namely, half wave rectifiers, full wave rectifiers, a-c. or symmetrical circuits as shown in Figs. A, B and C respectively, and d-c. lock-in circuits.

The output shown in these three figures is for the condition where current passes through the entire half cycle. This is the case only when the tube is used as a relay or as an ordinary rectifier.

The discharge passing through these tubes may be controlled by varying the magnitude or the phase of the grid voltage and thus determining the point in the cycle at which current still start to flow.

A few specific circuits using half wave rectification follow. Resistance or Capacity Control—If the tube is to be used as a relay, being operated by a change in resistance or capacity, the circuit shown as Fig. D will usually be found.
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satisfactory. C should have a value of 25 $\mu\mu\mu$ (f) or more, and R should be between 10 and 100 megohms. If capacity control is to be used, it may be found more convenient to substitute a variable condenser for the resistor. In the circuit as shown breakdown occurs followed by an increase in output current as the resistor R is still further decreased or the condenser C is decreased beyond the critical value.

If more abrupt starting is desired the resistor and condenser may be interchanged. For the latter circuit resistors of the order of 15 to 50 megohms and condensers of the order of 150 to 50 micro-farads are recommended.

**Photo Tube Circuit**—Fig. E shows a circuit in which a change in illumination on a photo tube causes the Grid-Glow tube to operate. With the connections as shown the control is positive; that is, increasing the light on the photo tube causes the Grid-Glow tube to start.

**Contact Control**—Fig. F shows a circuit in which the opening or closing of a delicate contact causes the tube to operate. If closing the contact is to start the tube, connect (a) to (b) and with contacts open, adjust (c) by increasing it from its minimum value until the tube does not glow. If opening the contact is to start the tube, connect (a) to (f) and with contacts open, adjust (c) by decreasing from a maximum until tube glows.

**D-C. Lock-In Circuit**—A useful property of the KU-618 is the lock-in characteristic that it exhibits when used on d-c.

In other words if a d-c. potential is used instead of a-c. on the anode the tube will not breakdown until the grid potential reaches the critical value. After breakdown, even though the grid excitation may have been brief and may subsequently change, the anode current will continue to flow until it is interrupted by other means.

The critical constants are approximately 2.4 times the values given in Fig. 2. This characteristic makes possible the recording, measuring or indicating of short voltage surges, contacts and the like.

The foregoing circuits are intended only to illustrate the types of applications for which the KU-618 may be used rather than to give exact design data. If undue difficulty is experienced in obtaining the operation desired from these or other similar circuits, communicate with the agency from which the tube was purchased.