The GT21 Glow Thyratron

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Details of a new switching tube developed on the Continent which has the advantages of thyratron operation without the necessity for a heater supply or warm-up time. The tube may, also, be transistor controlled.

A NOVEL TYPE OF COLD CATHODE tube has been recently produced by the Cerberus Company (of Switzerland), this being the GT21 glow thyraton. The GT21 is basically somewhat similar to a trigger tube, but it has the advantage that it can be controlled by input potentials of the order of 5 volts. It is therefore one of the few cold cathode tubes which can be operated from transistor circuits. Like all other cold cathode tubes with pure molybdenum cathodes, glow thyratrons have a very long life expectancy (exceeding 25,000 hours), are extremely reliable, give a clear and visible glow when conducting and require no warming-up time. In addition they can operate over a wide temperature range (−30° C to +90° C) and can be manufactured with very close tolerances.

In a trigger tube the input pulse initiates a discharge between the control or trigger electrode and the cathode, and the resulting ionisation causes the main anode-to-cathode gap to conduct. In a glow thyratron, however, there is a permanently maintained auxiliary discharge and the main discharge is controlled by the potential on a grid. The quiescent power required when the main gap is not conducting is very small.

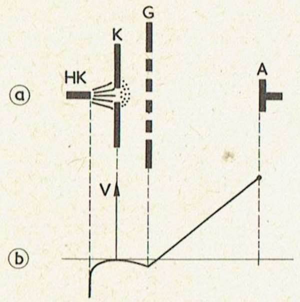


Fig. 1 (a). Electrode configuration of the glow thyratron. (HK=auxiliary cathode, K=cathode, G=control grid, A=anode) (b). Potential distribution along the tube axis

In Fig. 1 (*a*) the auxiliary discharge is maintained between the auxiliary cathode HK (Hilfskathode) and the main cathode K; the latter acts as an anode for the auxiliary discharge. Electrons from the auxiliary discharge are attracted towards the main cathode (since it is more positive than the auxiliary cathode) and some of them will pass through the hole in the main cathode into the cathode-grid space. In this region the electric field is a function of both the grid and and main anode potentials. If the grid is sufficiently negative with respect to the main cathode, the electrons will be decelerated and returned to the main cathode. In such a case the graph of potential against distance is as shown in Fig. 1 (*b*). If the grid potential is made less negative, a point will be reached at which the electrons pass through the grid towards the anode. After they have moved a short distance under the accelerating field of the anode, they acquire enough energy to knock electrons out of the atoms of the gas with which they collide, and positive and negative ions are formed. In the electric field the light negative ions are accelerated and gain enough energy to form more and more ions by the avalanche effect. A relatively large anode current can then pass through the tube. Instead of the discharge terminating at K (as in Fig. 1,(a) it now reaches the anode.

Characteristics

The firing characteristic of a GT21 tube is shown in Fig. 2. If the operating point is between the two lines of this graph the main gap will be non-conducting, whereas if it is above the upper line breakdown will have occurred. The graphs are for the average GT21. The point A is the minimum anode holding voltage for any tube at the maximum permissible negative grid potential. Point B shows the negative grid voltage which is required to ensure cut-off in all tubes at the minimum anode holding voltage. The critical grid voltage which will ensure firing at the minimum anode supply voltage is shown at point C, whilst D is the minimum inverse anode holding voltage at the maximum permissible positive grid voltage.

A magnified view of the most important section of the firing characteristic is shown in Fig. 3; this is usually called the control characteristic. At point B all tubes are cut off, whilst at point C all tubes will conduct. If all of the tubes were absolutely identical, B and C would, of course, lie on the curve.

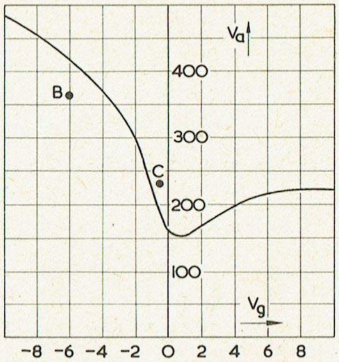


Fig. 3. The GT21 control characteristic

Once a glow thyratron has fired the grid loses its control in the same way that the grid of a thyratron or the trigger electrode of a trigger tube loses control once the tube has fired. In order to extinguish the tube, the anode voltage must be reduced below the maintaining voltage. If the tube is being operated from an alternating voltage supply, this will automatically occur towards the end of each alternate half-cycle.

The GT21 glow thyratron is a B9A based tube suitable for use with either a.c. or d.c. power supplies. It is especially suitable for the operation of relays and can itself be operated from various devices such as photocells or transistors, etc.

Typical GT21 Circuits

(1) *Temperature Control with a Thermistor*

Thermistors are semiconductor devices which have a resistance which decreases with increasing

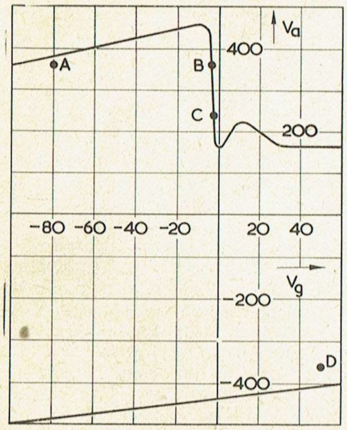


Fig. 2. The firing characteristic of the GT21

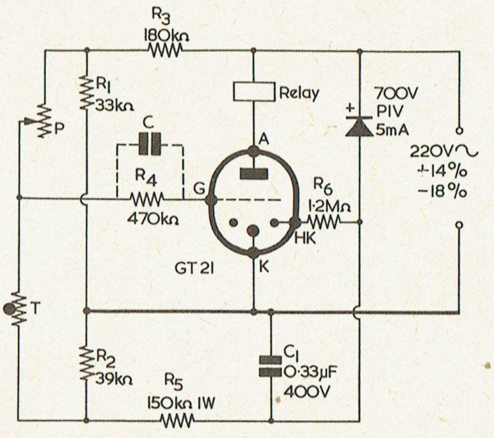


Fig. 4. A temperature control circuit

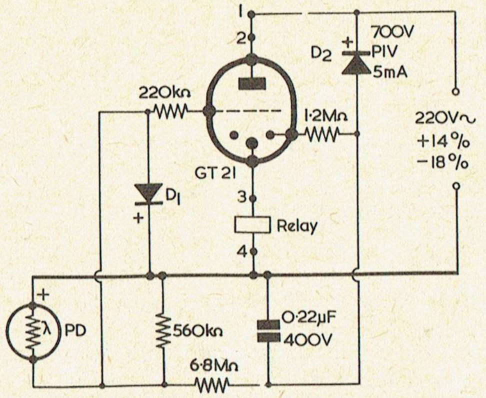


Fig. 5. Operation of a relay from a photodiode

temperature. They are very suitable components for temperature control, since they are small, have constant characteristics and can be obtained in a range of resistance values. The maximum temperature which can be controlled is, however, about 150° C.

A suitable circuit for temperature control using a thermistor and a glow thyratron is shown in Fig. 4. Potentiometer P selects the temperature at which an enclosure containing the thermistor T is to be stabiliisd. The heater which warms the enclosure is switched on and off by means of the relay in the anode circuit of the GT21.

Principle of Operation

An alternating potential is applied across the relay in series with the GT21 tube. The diode rectifies the a.c. supply in conjunction with the capacitor C_1. The negative potential thus obtained is used to supply the auxiliary cathode via R6 and a portion of it is tapped off from the potential divider R_5 and R_2 to provide the grid bias for the tube via the thermistor T.

The GT21 will not strike unless its anode is positive with respect to its cathode at a time when the grid potential is not too negative. If the temperature is low, the resistance of the thermistor will be fairly high. At the moment the anode is positive, a positive supply will be fed through R_3 to the potential divider formed by P and T. The potential at the grid tapped off this potential divider is not appreciably negative when the resistance of the thermistor is high and therefore the tube ignites. The relay thus switches on the power supply to the heater. As the temperature of the enclosure rises the resistance of T falls and, owing to the potential dividing action of P and T, a point will be reached at which the grid is so negative (even during the time a positive pulse is applied to the anode) that the GT21 no longer strikes. The relay is then not energised and the power supply to the heater is cut off until the temperature has fallen to a point at which the glow thyratron can conduct again.

If the thermistor is interchanged with the potentiometer P, the relay will be energised when the temperature is high. This enables the circuit to be used with a relay whose contacts are normally closed. A capacitor C may be placed across R_4 to obtain a switching interval between the energising and de-energising point of the relay; it may have a value of about 6,800pF. A diode may be connected from the junction of P, T and R_4 to the cathode of the tube to bypass the positive voltage that is generated at the grid of the fired tube, and thus prevent additional loading (and consequent heating) of the thermistor.

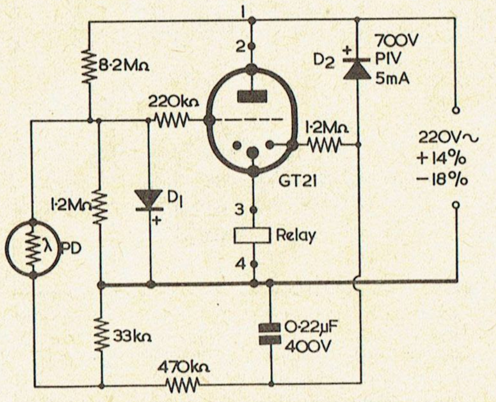


Fig 6. In this circuit the relay is energised when little or no light falls on the photodiode

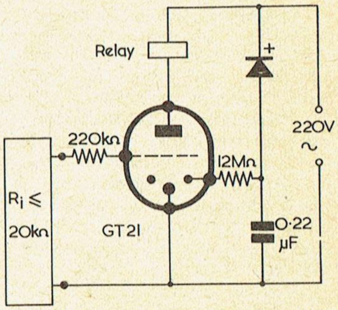


Fig. 7. Operating a GT21 from a transistor circuit

(2) *Photoelectric Relay with Photodiode and GT21*

The circuit of Fig. 5 is controlled by the light falling on the photodiode PD. When the amount of light falling on this diode is fairly large, the relay will be energised and will automatically be de-energised when the light intensity falls. The circuit of Fig. 6 is similar except that the relay is energised when the amount of light falling on the photodiode is small, and is de-energised when it is large.

If a high speed of response is required, the relay should be connected between points 1 and 2, and points 3 and 4 should be short-circuited.

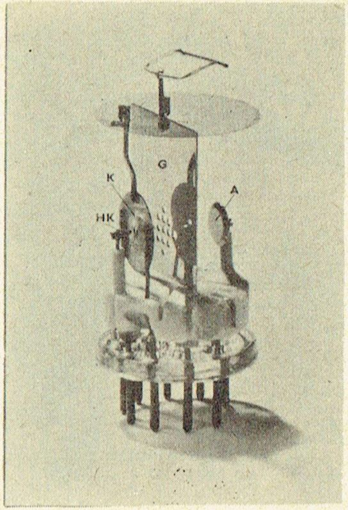
The circuits of Figs. 5 and 6 are somewhat similar to the circuit of Fig. 4. When light falls on the photodiode of Fig. 5 it conducts and short-circuits the negative bias

TABLE
The basic characteristics of the GT21 glow thyratron

Auxiliary cathode current	100 to 250μA
Maximum auxiliary discharge breakdown voltage	180V
Maximum mean cathode current	40mA
Minimum mean cathode current	10mA
Typical maintaining voltage at I_a=20mA.	115V
Minimum anode supply voltage	180V alternating or 250V d.c.
Maximum anode supply voltage	250V alternating or 350V d.c.
Grid voltage for cut-off	−6V minimum −80V maximum
Grid voltage to ensure conduction	−0.5V minimum +50V maximum

Base Connections

1	2	3	4	5	6	7	8	9
A	IC	IC	G	K	HK	K	G	IC



The internal construction of the GT21

applied to the grid, so that the glow thyratron conducts. In Fig. 6 a conducting photodiode will apply a negative bias to the grid of the glow thyratron and prevent the latter from conducting.

The photodiode used should have a minimum working voltage of 30 volts, a maximum dark current of 25μA and a minimum light current of about 50μA. Suitable photodiodes are the Siemens TP5111 and the Texas Instruments H11. If a photodiode with a higher dark current is used, or if the relay is required to respond only at a higher illumination level, the values of the 6.8MΩ and 560kΩ resistors of Fig. 5, or the values of the 8.2 and 1.2MΩ resistors in the grid circuit of Fig. 6, should be reduced in value.

(3) *Operation from Transistors*

The basic type of circuit for the operation of a GT21 from a transistor circuit is shown in Fig. 7. When the input to the GT21 grid is between −5 and −80 volts, the glow thyratron is cut-off, but it conducts if the grid potential is raised from −0.5 to +50 volts. If the grid potential of the GT21 is between −0.5 and −5 volts, some GT21 tubes will conduct, but others will not.

Further details of the GT21 tube have been published in *Cerberus Elektronik*, Nos. 17 and 18. These publications and others giving details of the GT21 and its circuitry are available from the tube manufacturers, Cerberus A.G., Werk für Elektronentechnik, Männedorf, Switzerland. Cerberus tubes are available from Walmore Electronics Ltd., 11–15 Betterton Street, Drury Lane, London, W.C.2. The circuits described in this article have been designed by the manufacturers of the tube.