

# FERRANTI COLD CATHODE TETRODE

A miniature cold cathode gas filled tetrode. It is an arc discharge valve. The cathode is designed for pulse operation and is capable of passing up to 250 amperes peak. It is equally suitable as a stroboscopic light source or for relay applications where high peak current, short duration, pulses are required.

### PHYSICAL SPECIFICATION.

Base	...	...	B7G.
Max. Seated Height	...	...	70 mm.
Max. Overall Length	...	...	77 mm.
Max. Diameter	...	...	19 mm.
Length of arc	...	...	22 mm. (approx.)
Mounting Position	...	...	Any.*

### PIN CONNECTIONS.

Pin 1—Trigger Electrode 1.	Pin 5—Cathode†
Pin 2—I.C.	Pin 6—I.C.
Pin 3—I.C.	Pin 7—Trigger Electrode 2.
Pin 4—Cathode†	Top Cap—Anode.

### RATINGS.

Maximum Anode Voltage (Static)	...	440 volts.
Maximum Anode Voltage (working)	...	400 volts.
Minimum Anode Voltage (working)	...	250 volts.
Peak Inverse Anode Voltage	...	350 volts.
Max. Mean Anode Current	...	50 mA.
Maximum Average Current	...	10 mA.
Minimum $R_{tr1-k}$	...	1000 ohms.
Minimum $R_{tr2-k}$	...	1000 ohms.

### CHARACTERISTICS.

‡Static Trigger Voltage ( $tr_2$ to $tr_1$ )	80–130 volts.‡
Max. Repetition Frequency	... 250 per sec.
Min. Trigger Current required at $V_a$ 400	50 $\mu$ A.
Min. Trigger Current required at $V_a$ 250	300 $\mu$ A.

§Peak Anode Current  
Peak Luminous Intensity  
Flash Duration

The discharge of a 1  $\mu$ F capacitor charged to 330V. gives a peak anode current of approx. 150 amp. and a Peak Luminous Intensity of approx. 270 candelas with a flash duration of 15 microseconds at half the peak light output.

Delay Time ... Less than 40 microseconds, dependent on circuit conditions. With higher energy pulses the delay time can be considerably reduced

### TYPICAL OPERATION as Stroboscopic Light Source :

Anode Supply Voltage	...	300–330 volts DC.
**Trigger Electrode No. 2 Voltage	...	70 volts.
††Trigger Pulse Amplitude ( $V_{tr1}$ )	...	150 volts min.
Charging Resistor	...	6000 ohms.
Discharge Capacitor for operation	...	
at 6–35 c.p.s.	...	2 $\mu$ F.
30–50 c.p.s.	...	1.5 $\mu$ F.
45–80 c.p.s.	...	1 $\mu$ F.
80–150 c.p.s.	...	0.5 $\mu$ F.
140–250 c.p.s.	...	0.3 $\mu$ F.

For basic circuit and further information refer to "Notes on Operation" on Pages 3 and 4.

\*Vertically base up or horizontally is preferred.

†The cathode circuit should be connected to both pins 4 and 5.

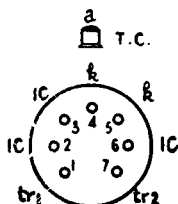
‡The limits quoted are to cover production variations, and refer to the triggering voltage for a low rate of change of electrode voltages, with  $tr_1$  negative to  $tr_2$ . For pulse operation a higher trigger voltage is generally necessary. See under "Typical Operation."

§A minimum peak current of 5 amp. is recommended. This ensures the formation of an arc discharge with an anode-cathode volt drop of approx. 20 volts. If the peak current is less than 5 amps. a glow discharge is likely to form with a volt drop of 70 volts which may result in permanent damage to the valve.

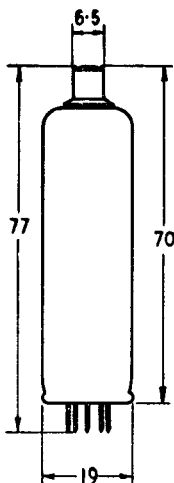
\*\*At instant of triggering.

†† $V_{tr1}$  negative with respect to cathode.

EN30



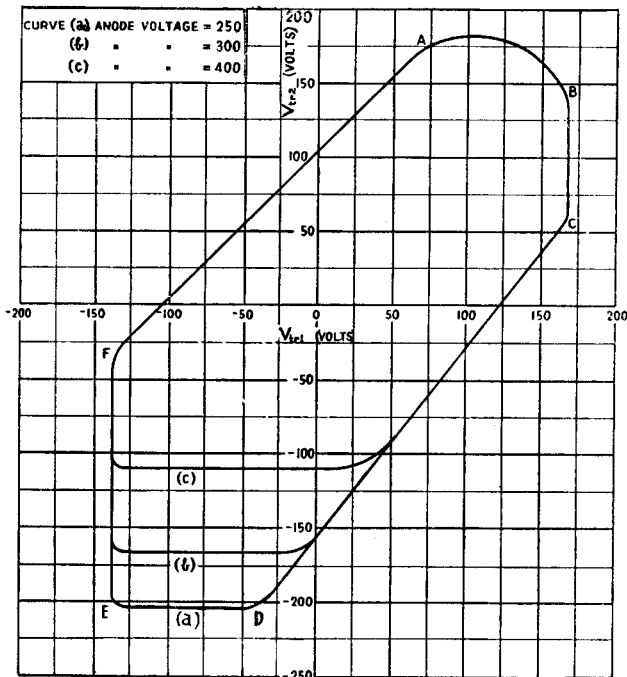
Base  
Connections  
Underside View  
of Base



All dimensions shown are in millimetres (max.).



## AVERAGE STATIC TRIGGER CHARACTERISTICS



It should be noted that the above quadrant diagram is for an average EN30 and due allowance should be made for trigger voltage tolerance (see page 1).

The area enclosed by the loops is an area of non-conduction. If the vector sum of the voltages on the two trigger electrodes lies within the loop the valve will not fire. Any change of either or both of these voltages which causes the vector sum to fall outside the loop will trigger the valve.

For pulse operation it is usually necessary to ensure that the pulse has a sufficient excess voltage (See under "Trigger Pulse" on page 3.)

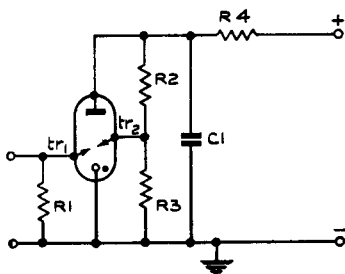
As the triggering impulse carries the vector sum of the applied voltages outside the loop the point at which it crosses the loop indicates the manner in which the valve is triggered as follows :-

- Between AB Trigger Electrode 2 to Cathode Breakdown.
- BC Trigger Electrode 1 to Cathode Breakdown.
- CD Trigger Electrode 1 to Trigger Electrode 2 Breakdown.
- DE Cathode to Trigger Electrode 2 Breakdown.
- EF Cathode to Trigger Electrode 1 Breakdown.
- FA Trigger Electrode 2 to Trigger Electrode 1 Breakdown.

The most reliable operation is ensured by triggering between  $tr_2$  and  $tr_1$ , i.e., between F and A.

**NOTES ON OPERATION.**

The basic circuit for operation of this tube is shown below :—



The capacitor C1 (Discharge capacitor), connected between anode and cathode is charged through a resistor R4 (Charging resistor). A voltage of sufficient amplitude applied between the two trigger electrodes tr1 and tr2 will initiate a glow discharge between these electrodes, which will cause breakdown between anode and cathode, discharging the capacitor C1 and producing a bright flash of light. The current duration of this discharge is of the order of 5 microseconds, with a peak current up to 250 amperes. The light duration is longer, approximately 20 microseconds at half peak light output, operating with maximum anode voltage.

When the trigger voltage between tr1 and tr2 is obtained from a controlled pulse the frequency of flashing will be determined by the trigger pulse frequency.

The following points should be noted in designing equipment incorporating EN30.

**Trigger Pulse.** Whilst as noted on page 2, the tube may be triggered in a variety of ways some of these are likely to be erratic and unreliable. The recommended method of triggering is to apply a positive voltage to trigger electrode No. 2 (tr2) and a negative pulse to trigger electrode No. 1 (tr1).

The voltage applied to tr2 is conveniently obtained by means of the potentiometer chain R2, R3, shown in the diagram above, but must always be lower than the minimum trigger voltage and should have a maximum value of about 70 volts.

To ensure reliable operation at all frequencies, the trigger pulse amplitude should be at least 150 volts, with a width of 30 to 100 microseconds at half amplitude; a suitable pulse may be derived by differentiation of a square pulse from a multivibrator. If a square pulse is used, the pulse width may be slightly less (down to 20 microseconds).

The minimum values of trigger current quoted on page 1 are for pulses of long duration. For short pulses higher values of current are necessary.

The duration of the triggering pulse is not critical, subject to the minimum quoted above, but certain factors should be noted. The duration of the pulse must be limited to the time required for the anode discharge capacitor to recharge to about 80 volts as, during deionization time, pulses of greater length are liable to cause a second discharge when the anode reaches 80 volts, or to initiate a glow discharge in the main gap with consequent serious deterioration of the cathode. (A glow discharge is characterised by a more diffused appearance and is of a less intense colour than the required arc discharge).



**Discharge capacitor.** This should be chosen in accordance with the recommendation on Page 1, dependent on the frequency range required.

In equipments required to operate over a wide frequency band, the whole range of frequency is preferably covered in steps by switching different capacitor values.

**Charging resistor.** The minimum value of charging resistor should be approx. 6,000 ohms, and must be rated for 8 watts minimum dissipation.

For maximum light output, the time constant of the discharge capacitor and its charging resistance, must be such as to ensure a nearly complete recharge between flashes. This requires that the time constant is not greater than about one third of the flash interval (for a 96% recharge). At higher frequencies it may not be possible to ensure such a complete recharge as, if the charging rate is faster than the valve recovery rate, a spurious discharge will occur. This discharge may in turn initiate a series of uncontrolled flashes, quite independent of the trigger pulse and at a higher repetition rate. Suitable values of discharge capacitor and charging resistance are given on Page 1 of this data sheet.

**Anode voltage.** The operating anode voltage should be preferably in the range 300—330 volts. In frequency controlled operation when it is required to operate over a wide frequency range, a low impedance power supply is desirable to avoid large fluctuations of the anode voltage and also of course the  $tr_2$  voltage in conventional circuit.

**Mean anode current.** The mean anode current may be calculated as follows :—

$$I_a \text{ (mean)} = \frac{CVf}{1000} \text{ mA}$$

where C = discharge capacitor in  $\mu\text{F}$ .

V = voltage on discharge capacitor at instant of triggering.

f = flash frequency per second.

**Trigger Electrode/Cathode Connections.** The tube must not be operated without a D.C. connection between each trigger electrode and cathode.

The circuit resistance between cathode and  $tr_1$  and between cathode and  $tr_2$  must have a value of at least 1000 ohms in each instance. A resistance of the order of 100,000 ohms is recommended.

Additional circuits shown on NSP2 data sheets may be adapted to EN30 operation by modification of circuit values in accordance with the foregoing notes.