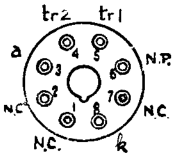
EN10

Ferranti

"NEOSTRON" STROBOSCOPIC LIGHT SOURCE

Designed for use in Stroboscopic applications, the Ferranti 'Neostron' is a cold cathode tetrode gas discharge tube emitting a reddish light. Operating frequency can be controlled by low voltage, low energy pulses. Also suitable for operation as a relay valve providing high peak current pulses.



Base Connections

Underside View of Base

PHYSICAL SPECIFICATION.

Base	International Octal.
Max. Seated Height	89 mm. (3½in.).
Max. Overall Length	103 mm. (4 1/16 in.).
Max. Base Diameter	32 mm. (1¼in.).
Length of Arc	24 mm. (15/16 in.).
Mounting Position	Any.

PIN CONNECTIONS.

Pin 1—No Connection.
Pin 2—No Connection.
Pin 3—Anode.
Pin 4—Trigger Electrode 2.
Pin 5—Trigger Electrode 1.
Pin 6—No Pin.
Pin 7—No Connection.
Pin 8—Cathode.

RATINGS (Maximum Ratings are 'Absolute' ratings).

Max. Anode Voltage (static)	440 volts.
Max. Anode Voltage (working)	380 volts.
Min. Anode Voltage (working)	240 volts.
Max. Peak Inverse Anode Voltage	350 volts.
Max. Average Anode Current	100 mA.
Max. Discharge Capacitance	16 μF.
Max. Average Trigger Current	10 mA.

CHARACTERISTICS.

*Static striking voltage (tr_2 to tr_1)	80–130 volts.
Max. flashing frequency	250 per sec.
Min. trigger current required at V_a 380	50 μA.
Min. trigger current required at V_a 240	300 μA.
†Peak Luminous Intensity	700 candelas.
†Flash Duration at ⅓peak	15 μSec.
†Peak Anode Current	400 amps.
§Triggering delay	< 40 μSec.

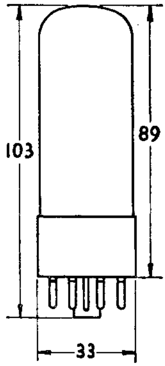
TYPICAL OPERATION as Stroboscopic Light Source:—

DC. supply voltage	300–330 volts.
Vtr_2 at triggering instant	70 volts.
Trigger pulse amplitude (Vtr_1)	–150 volts(min.).
Charging resistor	3000 ohms.

Discharge Capacitor for Operation at:—

	6–35 f.p.s.	4 μF.
Up to	50 f.p.s.	3 μF.
to	80 f.p.s.	2 μF.
to	150 f.p.s.	1 μF.
to	250 f.p.s.	0·5 μF.

The voltage applied to tr_2 should be positive with respect to the cathode and the trigger pulse applied to tr_1 should be negative.
The discharge capacitor should be a good quality type suitable for heavy current pulse operation.



All dimensions shown are in millimetres.

*tr_1 negative to tr_2 This range of trigger voltage quoted is for single flash operation or for operation with long intervals between flashes. For repetitive flash operation as in stroboscopic applications a higher trigger voltage is necessary.

†Va = 380 volts. C = 4 μF.

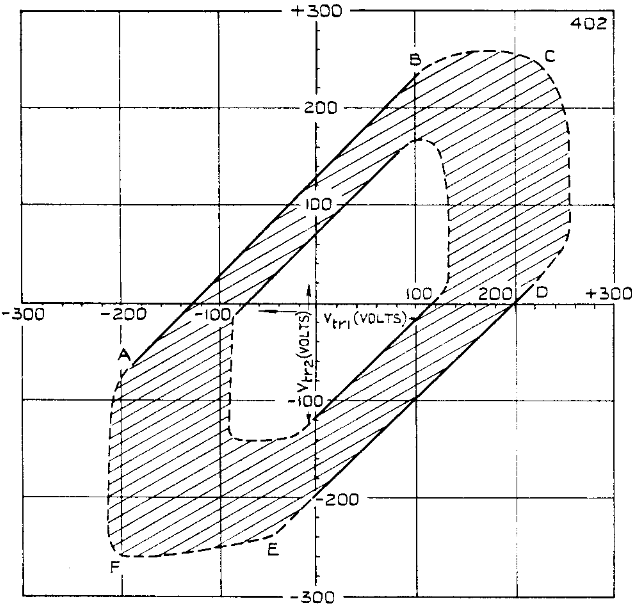
§See 'Notes on Operation'.

Ferranti

Issue 2.
Dec., 1961

FERRANTI LIMITED, GEM MILL, CHADDERTON, OLDHAM, LANCS.

AVERAGE STATIC TRIGGERING CHARACTERISTICS.



The unshaded area enclosed by the loops is an area of non-conduction. If the vector sum of the voltages on 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.

The inner loop is applicable to tubes with trigger voltage at the lower limit and the outer loop applies to tubes on the upper trigger voltage limit.

To ensure reliable operation and interchangeability with any tube, the vector sum of the two trigger electrodes must fall outside the outer loop.

For repetitive pulse operation it is usually necessary to ensure that the pulse has a sufficient excess voltage (See 'Notes on Operation').

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:—

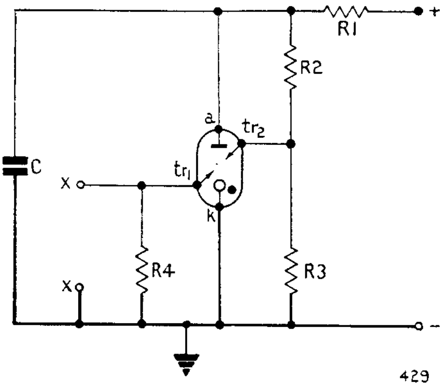
Between BC Trigger Electrode 2 to Cathode.
CD Trigger Electrode 1 to Cathode.
DE Trigger Electrode 1 to Trigger Electrode 2.
EF Cathode to Trigger Electrode 2.
FA Cathode to Trigger Electrode 1.
FB Trigger Electrode 2 to Trigger Electrode 1.

The portion of the loops shown broken indicate regions in which triggering is erratic and the limits are ill defined.

The most reliable operation is ensured by triggering between tr_2 and tr_1 with tr_1 negative to tr_2 i.e. between A and B on the diagram.

NOTES ON OPERATION.

Method of Operation.



Operation of this type of flash tube is as follows:—

The capacitor C (Discharge capacitor), connected between anode and cathode is charged through a resistor R1 (Charging resistor). A voltage of sufficient amplitude applied between the two trigger electrodes tr_1 and tr_2 will initiate a glow discharge between these electrodes. This discharge will in turn cause breakdown of the main gap between anode and cathode, discharging the capacitor C and producing a bright flash of light. Operating with maximum rated anode voltage and a 4 μF capacitor the duration of the current discharge is approx. 4 to 5 microseconds at one third of peak light output. The light duration is longer, approx. 20 microseconds.

When the trigger voltage between tr_1 and tr_2 is obtained from a controlled pulse the frequency of flashing will be determined by the trigger pulse frequency.

Trigger Pulse. As noted on Page 2, the tube may be triggered in a variety of ways, some of these are however likely to prove erratic and unreliable. The recommended method of triggering is to apply a positive voltage to Trigger electrode No. 2 (tr_2) and a negative pulse to Trigger electrode No. 1 (tr_1).

The voltage applied to tr_1 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 negative trigger pulse amplitude (applied to Trigger Electrode 1) 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 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 very short pulses high values of current may be necessary.

The duration of the trigger pulse is not critical, subject to the minimum quoted above. However, the duration of the pulse must not exceed 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. This second spurious discharge may cause loss of control and the tube will flash at a repetition rate quite independent of the trigger pulse or the discharge may be 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 a less intense colour than the required arc discharge).

Trigger Delay. In conventional circuits the delay in triggering the main gap after the application of the trigger pulse is less than 40 microseconds. It is however dependent on circuit conditions and low energy trigger pulses may lengthen the delay time, whilst high energy pulses with normal circuitry can considerably reduce the delay time.

(Cont.)

Notes on Operation (Cont.)

Charging Resistor. The minimum value of charging resistor should be approx. 3,000 ohms, and must be rated for at least 8 watts dissipation.

Discharge Capacitor. This capacitor should be a good quality foil type, preferably non-inductive. Electrolytic types are quite unsuitable.

The Discharge Capacitor value 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 complete range is preferably covered in steps by switching different capacitor values in accordance with the recommendations regarding the charging time in the last paragraph under the heading 'Trigger Pulse' and in the

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 (deionization) rate, a spurious discharge will occur. As noted under 'Trigger Pulse' this discharge may initiate a series of uncontrolled flashes quite independent of the trigger pulse and at a higher repetition rate.

Anode Voltage. The operating anode voltage should be preferably in the range 300—340 volts. In frequency controlled operation when it is required to operate over a wide range, a low impedance power supply is desirable to avoid large fluctuations of the anode voltage and the voltage applied to tr_1 if this is obtained from a potentiometer across the anode supply voltage.

Peak Anode Current. The peak anode current must be sufficient to ensure the formation of an arc discharge which gives an anode-cathode volt drop of approximately 20 volts. If the peak anode current is low a glow discharge is probable and the volt drop will then be around 70 volts which will result in permanent damage and serious deterioration. A recommended minimum value of peak anode current is 2 amperes.

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

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

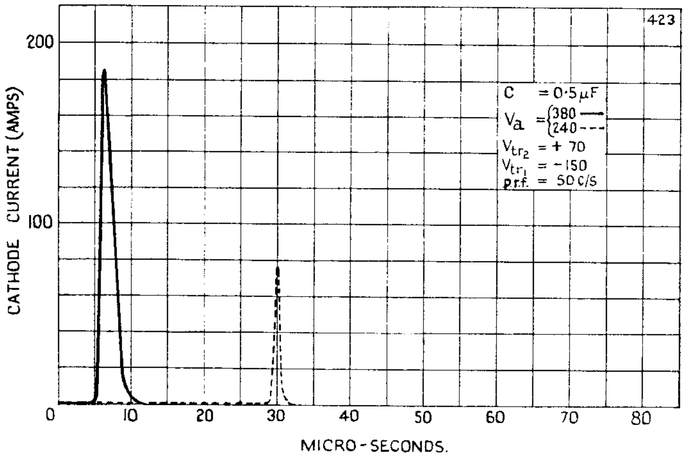
where C = discharge capacitor in μF.
V = voltage to which capacitor is charged at instant of triggering.
f = flash frequency per second.

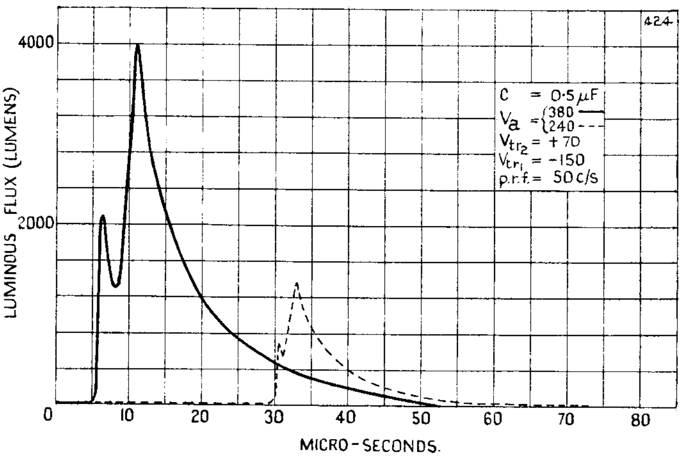
Trigger Electrode/Cathode Connections. The tube must not be operated without a DC. connection between each trigger electrode and cathode.

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.

FERRANTI LIMITED, GEM MILL, CHADDERTON, OLDHAM, LANCS.

TYPICAL DISCHARGE CHARACTERISTICS

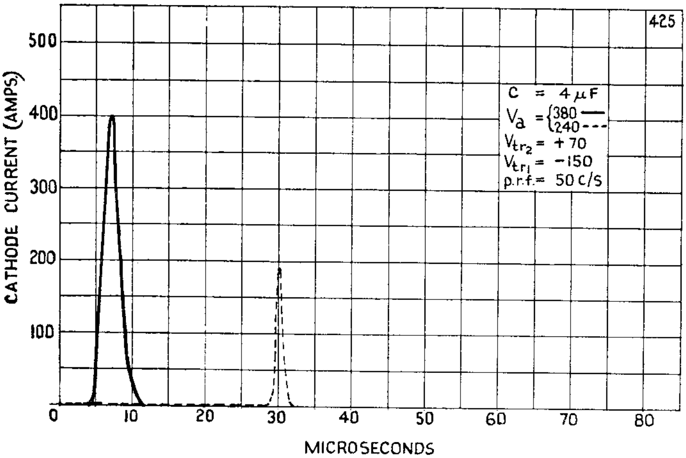


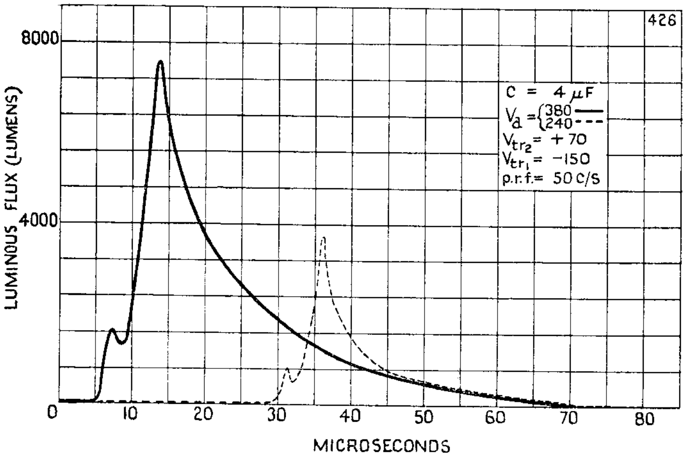


Issue 2.
Dec. 1961

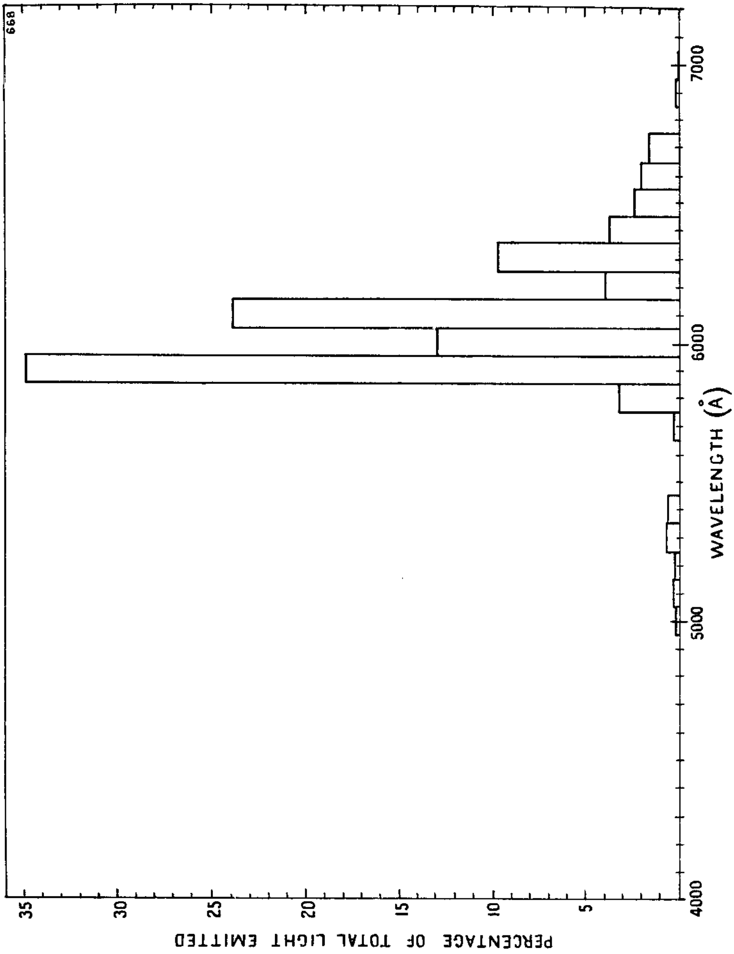
Ferranti

TYPICAL DISCHARGE CHARACTERISTICS





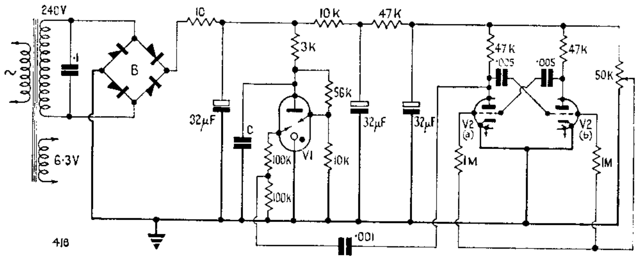
SPECTRAL DISTRIBUTION OF VISIBLE LIGHT



FERRANTI LIMITED, GEM MILL, CHADDERTON, OLDHAM, LANCS.

NOTES ON OPERATION—RECOMMENDED CIRCUITS

STROBOSCOPE.



C — Discharge Capacitor (see pages 1 and 4)

B — Single Phase Bridge (4 Ferranti Silicon Rectifiers ZS74)

V1 — Ferranti EN 10

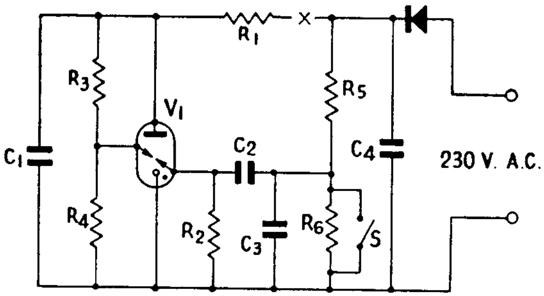
V2(a), V2(b) — Ferranti ECC 81

A typical circuit using a multivibrator as frequency control is shown above The frequency of operation is determined by the suitable choice of component values as indicated. The square pulses are differentiated by using a 1000 pF. capacitor with 100,000 ohm resistor.

The above circuit may require slight modification in practice to allow for such variations as impedance of power supply, tolerances of components, etc. High impedance power supplies result in large variations of the HT. line voltage as the frequency is varied, and consequent variations in tr_2 voltage and pulse height at tr_1.

The HT. voltage line during operation should preferably be in the range 300–330 volts.

RELAY CIRCUIT.



R1	3300 ohms.	C1	3 μF.
R2	100K ohms.	C2	1000 pF.
R3	56K ohms.	C3	0·1 μF.
R4	10K ohms.	C4	8 μF.
R5	100K ohms.	S	External switch.
R6	100K ohms.	V1	EN10

The above circuit is for operation of an electro-magnetic relay in which triggering is effected by closure of external contacts.

Closing of switch S causes a single flash, and operates an electro-magnetic relay which should be inserted at the point 'X'.