ELECTRONIC FLASH GUN

by L. HICKINGBOTHAM

GAS FILLED discharge tubes are a common way these days of producing light. Various gases when subjected to an electric charge become ionised and emit light at a wavelength dependent on the type of gas. Sodium and mercury vapour lamps are two typical examples. Xenon is a gas which emits a particulary useful light in that it is analogous to daylight. This is useful in photography because it eliminates the need for a filter when using colour film. It is also much faster than the ordinary flash bulb.

Discharge tubes have the characteristic of presenting a high resistance to the passage of an electric current until ionisation of the gas takes place. Ionisation may be initiated by raising the voltage to a level prescribed by the manufacturer. When this occurs the resistance falls suddenly and a heavy current will flow which in the ordinary vapour discharge lamps is limited by a choke placed in series with the lamp.

Heat is also generated and the temperature of the glass envelope must be kept within limits. If the lamp is only to be used for a short duration flash then by suitable design a very much smaller size tube can be used. It is also desirable to have a more controllable method for initiating ionisation and so a trigger electrode is incorporated in the tube so that an easily controlled low power pulse can be used to fire the tube.

As only a flash is required then the power supply need only provide a small continuous current which may be stored in a capacitor until required. By choosing a suitable voltage and capacitance the total power dissipated by the tube can be controlled and the energy in joules stored in the capacitor is given by $J=\frac{1}{2}CV^2$ where C=capacitance in farads and V= the e.m.f. in volts.

Thus, when the tube is fired a high current flows momentarily through the tube, ionising the gas and discharging the capacitor. Under these conditions the frequency of flashing is limited to three per minute. By making the discharge tube small a compact light source can be made in which the energy is stored in a capacitor which is charged relatively slowly. The discharge occurs in about 1/1000 of a second producing an intense white light. The flash gun described here is rated at 27 joules.

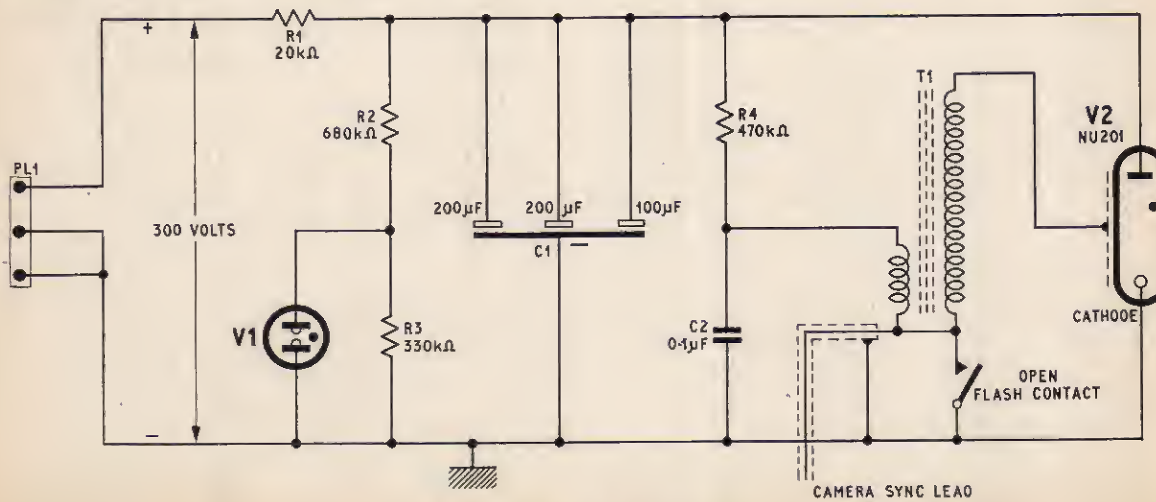


Fig. 1. Flash gun trigger circuit

SYNCHRONISATION

Thus a camera with a relatively slow shutter can be used for high speed photography, provided the ambient lighting is suitable.

In a practical circuit a means must be provided for synchronising the flash with the camera shutter. The synchronising circuit must be of low power to avoid damage to the camera synchronising contacts; this is achieved by discharging a small capacitor across a coil, the resulting pulse being converted by a pulse transformer and applied to the trigger electrode of the flash tube.

Fig. 1 shows the basic circuit, C1 being the flash capacitor which is permanently connected to the flash tube. With the power supply connected C1 will be charged up slowly to the required voltage, but the flash tube will not fire until a pulse is applied to the trigger electrode. R4 provides a high resistance path through which a smaller capacitor C2 is also charged.

When the camera contacts close C2 is discharged through the primary of the pulse transformer and a high voltage pulse appears across the secondary which fires the flash tube.

CONSTRUCTION

The circuit is made up on s.r.b.p., a small panel of which is drilled to suit the components and then soldered directly to the capacitor terminals. Fig. 2 shows the layout of the components. The connection to the flash tube should be insulated 16 s.w.g. wire to carry the high discharge current.

The pulse transformer T1 is made from an old i.f. transformer or long wave coil which is carefully dismantled to avoid breaking any of the leads to the coil. The type used had a wave wound coil on a piece of s.r.b.p. tube of $\frac{1}{16}$in internal diameter.

It was estimated that there were 950 turns of 41 s.w.g. wire on the coil. This forms the secondary of the flash gun transformer. The primary has 80 turns of 30 s.w.g. silk covered wire wound in two layers on a suitable piece of ferrite rod $\frac{5}{8}$in long. This may then be slipped inside the secondary and held in place with wax as shown in Fig. 3. The whole assembly is mounted on the component board by means of a rubber grommet and the leads soldered to the appropriate connections.

A piece of white faced laminated plastics is used to mount the tube and provide the bottom section of the reflector. When mounting the tube take care not to bend the leads close to the glass. The holes must be drilled accurately to suit the tube so that there is no strain on the glass otherwise it will crack. It should be mounted so that the cathode is connected to the negative side of the supply. This is seen as the larger of the two electrodes inside the tube, the trigger electrode being a metallised strip on the outside which is connected to a much finer wire.

It is important that the whole of the high voltage circuit be completely enclosed and insulated because the power stored in the capacitor may prove to be fatal to anybody touching this part of the circuit. Care must be taken to ensure that the capacitor cannot be inadvertantly shorted by any of the components or wires. Insulate all wires thoroughly. The power stored in the capacitor is sufficient to produce an effective weld if brought into contact with bare wire.

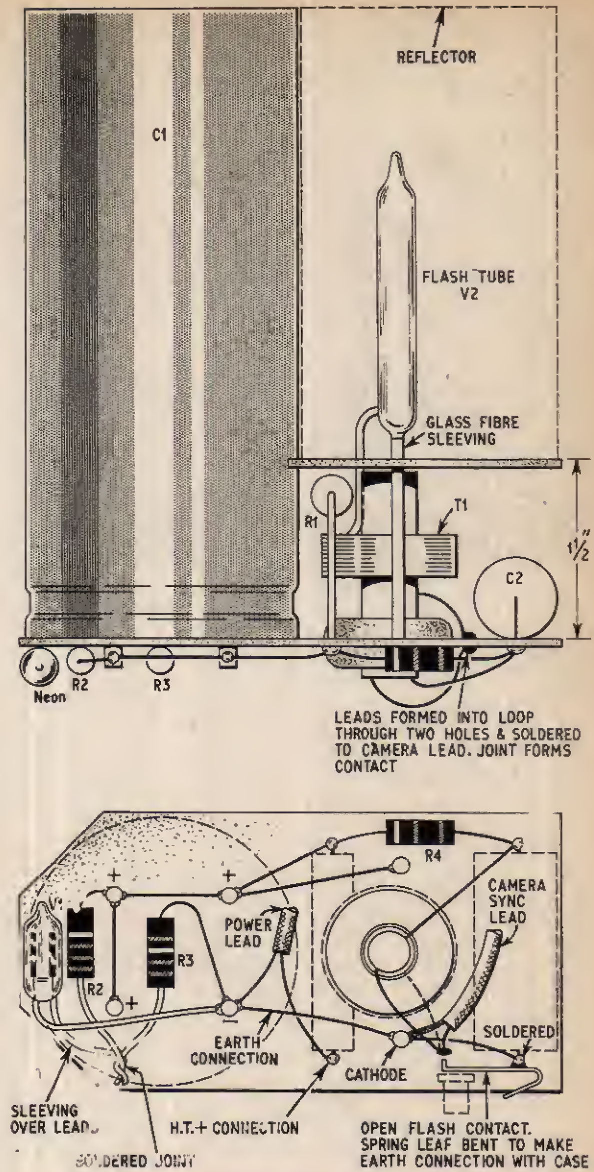


Fig. 2. Side and underneath views of the flash unit

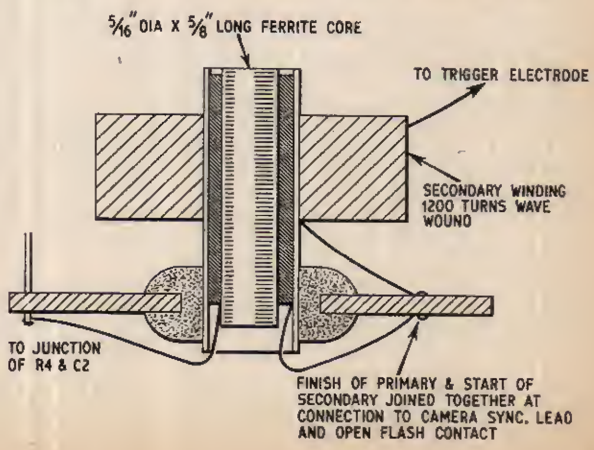


Fig. 3 (right). Construction details of the pulse transformer T1

THE CASE

The case is made from 27 s.w.g. tinplate, the top being soldered to form a rigid box (Fig. 4). The reflector is a piece of bright tinplate bent to half an ellipse as shown in the diagram. The base which carries the shoe for mounting on the camera is held in place by four self-tapping screws.

It was found that there was a variation in the size of the accessory shoe in different makes of cameras and it is suggested that this be filed to suit the particular camera the constructor is using. In addition, some cameras have the synchronising contacts built into the accessory shoe. In this case the method of construction shown in Fig. 5 is suggested. If the constructor wishes to use the open flash technique then a small phosphor bronze spring contact may be fitted in parallel with the camera synchronising lead and operated by a small push button as shown. The case can then be painted or covered with leathercloth to match the camera. A piece of ⅛in reeded Perspex 4½in × 1 13/16in is used for the front to protect the flash tube and give a diffused light when the tube is fired.

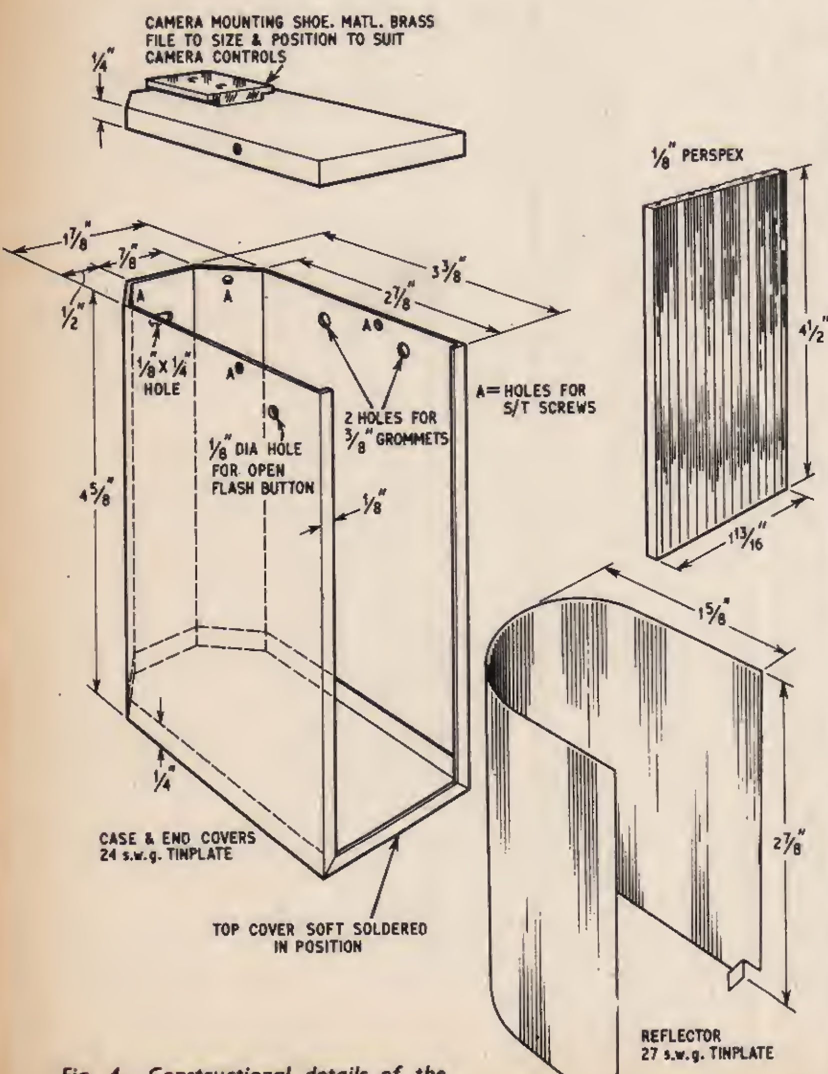


Fig. 4. Constructional details of the case, reflector, and lens

COMPONENTS . . .

Resistors
- R1 20kΩ 6W wirewound
- R2 680kΩ ¼W carbon
- R3 330kΩ ¼W carbon
- R4 470kΩ ¼W carbon

Capacitors
- C1 200 + 200 + 100μF elect. 350V (Radiospares) All sections wired in parallel
- C2 0·1μF paper 350V

Tubes
- V1 Miniature neon indicators
- V2 Flash tube type NU201 (Welmec)

Diodes
- D1–4 Silicon rectifiers type 1S113 400 p.i.v. 400 mA (Texas)

Transformers
- T1 Pulse transformer (see text)
- T2 Midget mains transformer 125–0–125V 50mA (Radiospares)

Plugs and socket
- PL1 & SK1 3-pin D.I.N. pattern (Radiospares)
- PLM Mains plug 3-pin 13A with FS1 1A fuse

Miscellaneous
- Camera sync. lead to suit camera
- 3-core mains cable
- 2-core mains cable (for power connection)
- Sheet metal for boxes and reflector (see text)
- Reeded Perspex (see text)

All the components are readily available through electronic components specialists. The flash tube is available from either Ferranti Ltd., Gem Mill, Chadderton, Oldham, Lancashire, or Welmec Corporation Limited, 27 Chancery Lane, London, W.C.2. If the constructor prefers to use a proprietary pulse transformer, a rather bulky item can be obtained from Ferranti.

POWER SUPPLIES

The flash gun requires a power supply of 300 volts d.c. and a peak charging current of 15 mA. It is essential that the correct polarity is observed otherwise the electrolytic storage capacitor will be permanently damaged.

Many commercial outfits use miniature components built into the body of the flash gun. Whilst these may be satisfactory for the average user it is felt that it is probably cheaper to buy the normal flash bulbs rather than batteries for the electronic flash. The larger rated units use a separate power unit, many of which can be used as portable equipment and recharged from the mains.

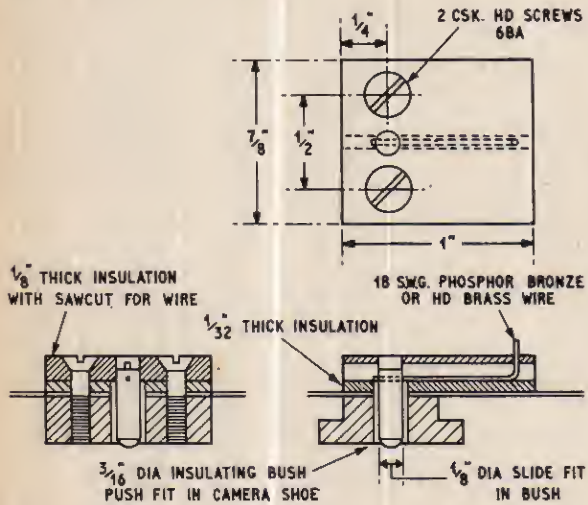


Fig. 5. Synchronising contact mounted in the camera shoe

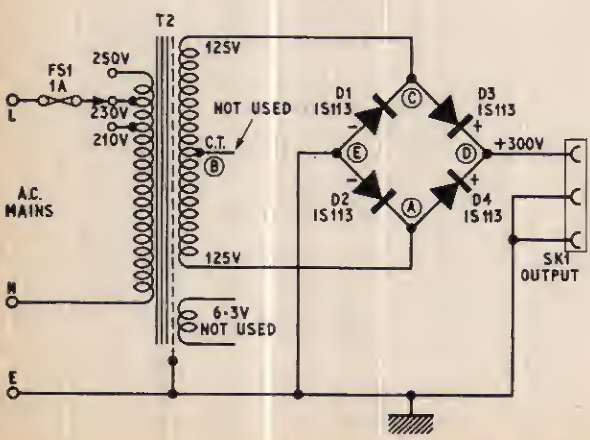


Fig. 6. Suggested circuit for a mains power supply unit

It was considered that the constructor may have his own special requirements and it should be possible to meet these from the following by using whichever method or combination of methods is most suitable..

MAINS POWER UNIT

Where the flash gun is only going to be used indoors a mains unit eliminates the need for batteries and gives consistant results. A double wound transformer is used to isolate the unit from the mains. This can be either a 250V secondary winding type or an h.t. supply transformer 125–0–125V. In addition to the 125–0–125V h.t. secondary there may be a 6·3V secondary winding but this is not necessary. The 6·3V connecting leads between the coil and tag panel can be cut off close to the coil so that there is no danger of short circuits.

The tags may then be used for mounting the silicon rectifiers and making the d.c. connection to the flash gun through a non-reversible socket. The centre-tap on the h.t. secondary is not used. The bridge rectifier connected across the whole of the secondary gives an output of 350V when the flash gun capacitor is fully charged. The circuit diagram is shown in Fig. 6, the mains lead being permanently connected to the unit and terminated with a 13A flat pin plug fused at 1A.

The unit is fully enclosed for safety in a metal box which is earthed through the mains plug. The box is made from two pieces of 22 s.w.g. mild steel bent and drilled as shown in Fig. 8.

For those who constructed the *DC/AC Inverter* described in the February 1965 issue of PRACTICAL ELECTRONICS this flash gun is useable outdoors by connecting this mains transformer unit to the inverter. The primary current of the inverter is about 1A so a self-contained unit could be built using a small chargeable 12V accumulator. This arrangement, however, is likely to be rather bulky and if a completely portable unit is required it is recommended that the following battery powered unit is constructed.

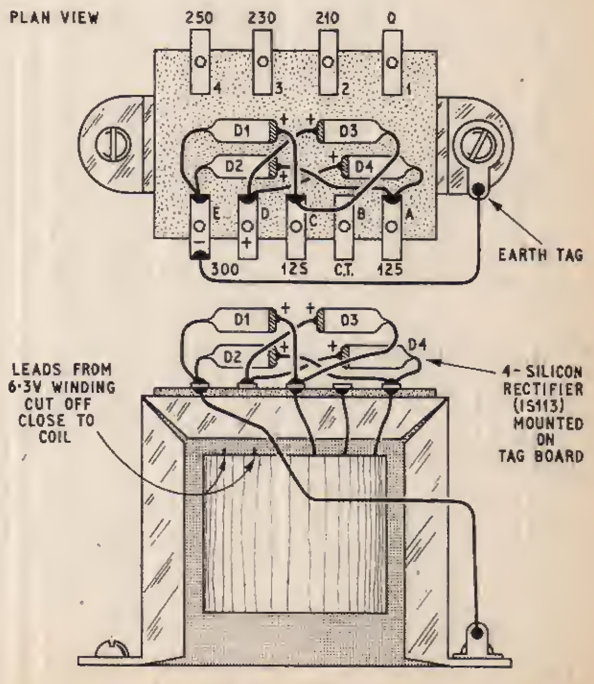


Fig. 7. Assembly of components on the mains transformer

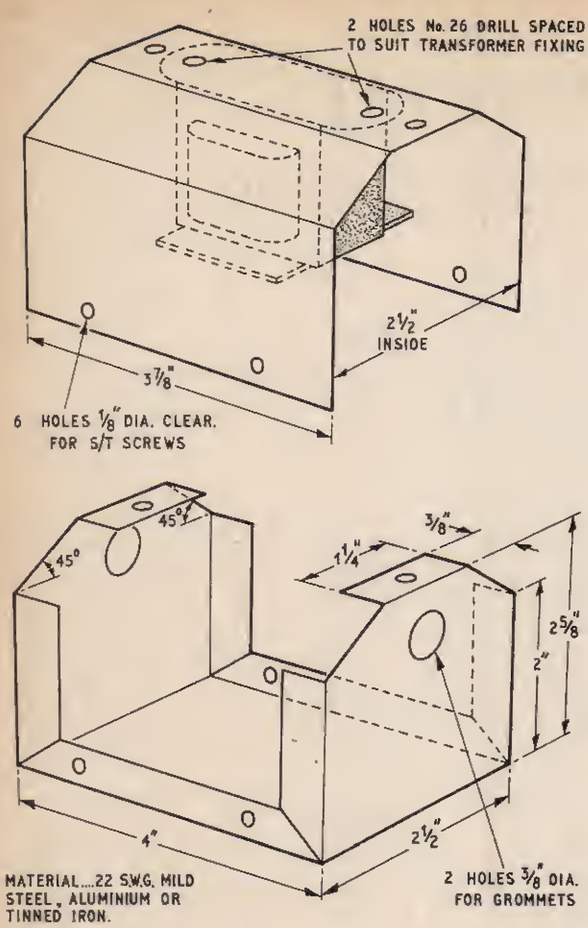


Fig. 8. Constructional details of the power unit case

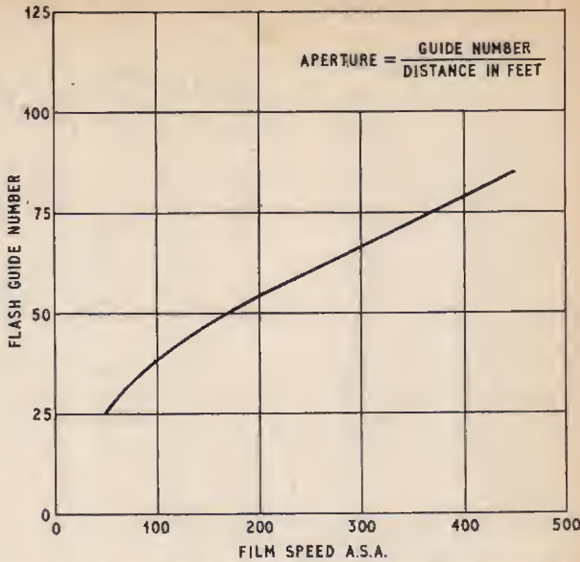
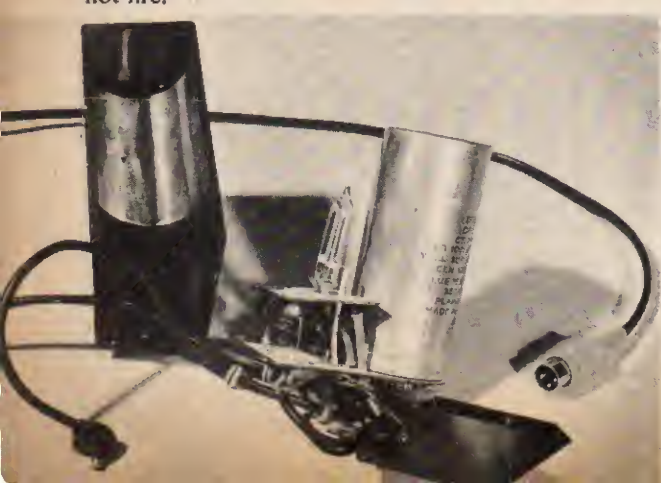


Fig. 9. Graph of flash guide number against film speed for the flash gun

PORTABLE POWER SUPPLY UNITS

The simplest form of portable power supply is the h.t. dry battery. Modern layer type of construction has produced efficient batteries which do not disintegrate and corrode away as easily as the older type of dry leclanché cells.

Small layer type batteries are available which should give something like 1,000 flashes before the end point voltage falls below that required. The neon V1 indicates this; if it does not light up the flash tube may not fire.



Three Ever Ready 90V B126 batteries connected in series will give adequate voltage for a considerable period. For those who require a more compact unit the 300V B1489 can be used, but this will have a shorter life.

A carrying case for these is easily constructed from wood, plastics or sheet metal. The case should be fitted with a non-reversible socket similar to the one used for the mains supply unit.

USING THE FLASH GUN

The flash gun will provide an intensity of light which is approximately equivalent to a PF1 photoflash bulb at 1/500 second. The graph (Fig. 9) gives an indication of the guide number as obtained with the author's model. It is suggested that a few trial exposures be made as a test because of the variations that can occur due to the reflecting surfaces both in the unit and from the walls of the room in which it is used.

The shutter should be set to a 1/50 second and if the camera is fitted with a choice of synchronisation the "X" position should be selected. If the camera does not have this type of synchronisation then it may not be suitable for electronic flash because the contacts close before the shutter is fully open. As the electronic flash is much faster than the ordinary flash bulb it is over before the shutter is fully open. Your photographic dealer can advise you on this.

As the speed of the flash and the intensity of illumination is fixed the only variable control is the aperture. This is set depending on the distance between subject and flash and increasing the distance requires a large aperture (lower f number). The product of the distance times the f number is known as the guide number and once this has been found for a particular set of conditions the aperture may easily be calculated for other distances for the same film speed.

The flash tube should give about 10,000 flashes which will more than pay for the cost of the tube if ordinary flash bulbs are used. The maximum rate of operation is three per minute and with a 300V supply the charge limiting resistor is chosen so that 20 seconds is required before the capacitor is fully charged ready for the next flash. ★