A DIMMER FOR FLUORESCENT LIGHTS

This 700VA dimmer ensures smooth and almost flicker-free control of fluorescent lighting

Although not recommended it *is* possible to dim fluorescent lights over a limited range using a dimmer that has been designed for incandescent lighting control.

But it is very probable that there will be severe flickering at low light levels.

Although this flickering can be reduced by various techniques, it is primarily caused by asymmetrical current flow in the tube, i.e. current in one half cycle is greater than current in the other half cycle, and unlike the 100 Hz flicker that is present at all times, asymmetry introduces a 50 Hz component that the eye can follow.

The most commonly used method of light dimming today is phase control, (described in detail in our article A Practical Guide to Triacs – May 1972).

In this method the effective power input to the lamp is adjusted by varying the proportion of each half-cycle of the mains wave-form that is supplied to the load.

Most domestic dimmers sold today use this operating principle and have a circuit basically similar to that shown in Fig. 1.

This circuit will control fluorescent loads fairly well providing the triggering diode is selected for symmetrical operation, but triggering diodes are not generally sold this way and 10% asymmetry is not uncommon. What this means is that the diode will trigger on one half-cycle at say, 32 Volts and on the next half-cycle at 29.5 Volts. And so at low light levels the diode may trigger the Triac only on alternate half-cycles. This causes flicker.

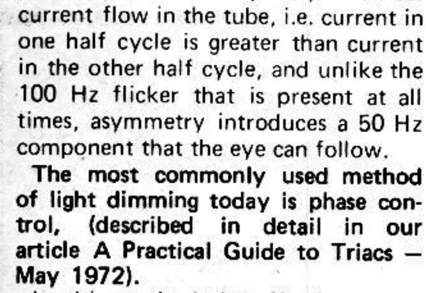


Fig. 1. Many commercially available light dimmers use circuits similar to this.

The same asymmetrical operation will also occur with incandescent loads, but due to the thermal inertia of the filament, the visual effect is much less noticeable.

The dimmer shown in this project overcomes the problem of asymmetry. It provides as nearly as possible an ideal and symmetrical waveform for fluorescent tubes.

Some flickering may still occur at very low light levels because the fluorescent tubes themselves may not be perfectly symmetrical. (The only way to achieve totally flicker-free operation is to use a variable frequency supply. The cost of this method would be enormous).

The maximum loading that can be placed on the dimmer is 700VA. Table 1 shows how the VA rating is calculated. It is also possible to use a combination of both fluorescent tubes and incandescent lamps and in this case the VA rating of the incandescent lamp is simply its normal wattage ie. 100 Watts equals 100VA.

CONSTRUCTING THE DIMMER

Construction is fairly simple, but remember that this unit is connected to the main 240 Volt supply and follow our instructions carefully – especially those sections concerning insulation.

The circuit diagram of the complete unit is shown in Fig. 2, and the foil pattern of the printed circuit board in Fig. 3. Metalwork drawings are shown in Fig. 4 and the complete assembly drawing in Fig. 5.

1. Mount the potentiometers on the chassis and cut the shafts to the required length. The minimum adjustment potentiometer should be cut short and slotted so that it may be adjusted with a screwdriver.

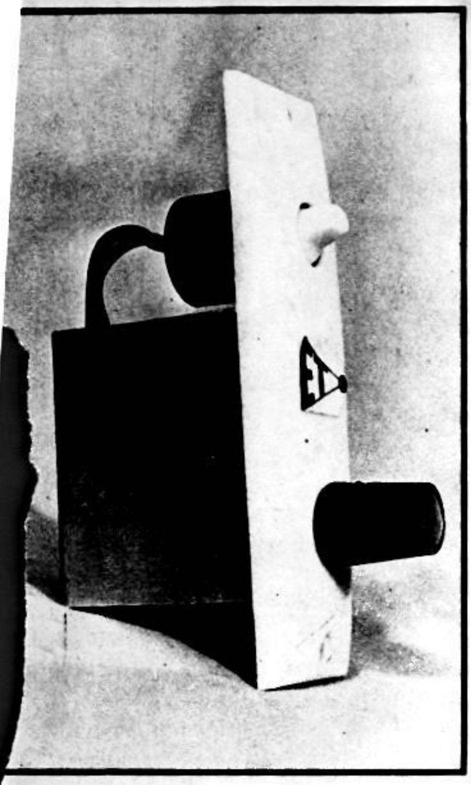
Insulated wires should now be soldered onto the respective terminals of the potentiometers ready for later attachment to the printed circuit board.

2. Any 6A or 10A rated triac without built-in diac and with PIV of 400V will do. If you use a triac, such as SC41D, with the case forming the anode, follow the procedure in para 3 to mount the device.

3. Glue a piece of insulating material 0.025" – 0.035" thick and ¾" diameter to the back of the potentiometers.

Before mounting the triac a lead must be soldered onto the top edge (ie nearest the terminals). When doing this, place the triac on a piece of copper or aluminium to act as a heat sink, and use the minimum heat required to make a good joint.

Tube Indicated Wattage	VA Rating
15, 20 or 30	90
40	100
65	180
80	210



Cut a circle of mica ¾" diameter and 0.002" to 0.005" thick. This may be cut out of a T03 washer if required. Glue this mica washer to the side of the chassis, using epoxy glue. Then glue the Triac to the centre of the mica. The epoxy glue should extend completely over the top surface of the mica to prevent the mica splitting. The new 'five minute' epoxy glue is ideal for this purpose.

4. The rf choke (L1) should now be wound following the details shown in Fig. 6. Then wind the pulse transformer as shown in Fig. 7. Care must be taken with the insulation – there is 240 Volts ac between the primary and secondary winding on this transformer.

5. The components can now be soldered onto the printed circuit board. Locate transistor Q2 so that it is about 3/16" off the board and transformer T1 so that it is about 1/8" off the board. Capacitor C1 is mounted flat on top of the diodes. Fig. 8 shows the location of all components.

6. Glue the choke L1 on top of the 50k potentiometer, and connect one lead to the 'cathode' of the Triac (larger of the two terminals).

7. Connect the lead, which is soldered to the case of the triac, and the second lead from the choke to the appropriate places on the printed circuit board.

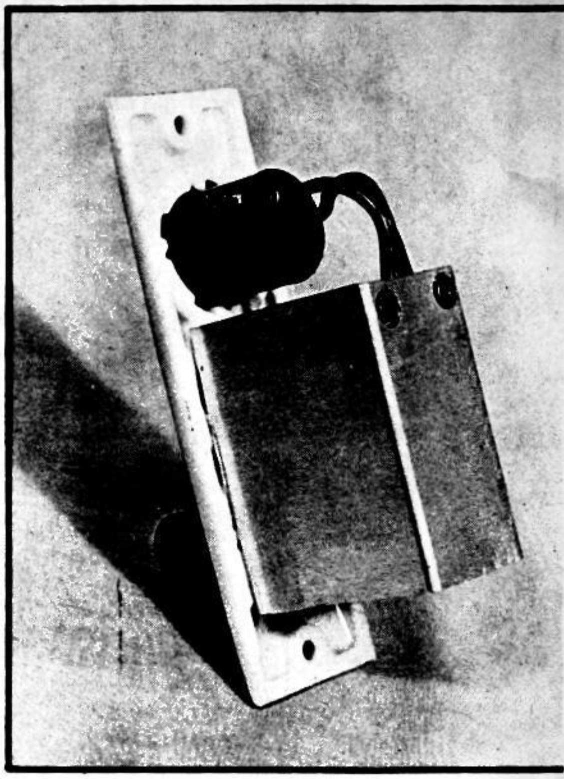
8. The printed circuit board should now be mounted on the chassis using 6BA nuts and bolts and 3/16" insulating spacers. Make sure that the board is reasonably level and is not touching the Triac or the chassis.

9. The leads from the secondary of the pulse transformer should now be twisted together. One lead should be connected to the Triac gate and the second lead connected to the Triac 'cathode'.

10. Connect the leads from the potentiometers to their respective locations on the printed circuit board.

11. Insert two short lengths of 23/0076 240 Volt insulated wire through the slot in the chassis and solder one end of each to the appropriate solder lands on the printed circuit board.

12. Place a piece of insulating material over the back of the printed circuit board and fit the cover temporarily in position. When doing this make sure that no bare wires can touch any metal. The dimmer is now ready for testing.



PARTS LIST
FLUORESCENT DIMMER

- **C1 – capacitor 0.033 uF, 630V**
- **C2 – capacitor 0.047 uF, 100 or 160V**
- **D1-D4 diodes 1N4004**
- **D5 – diode 1N 914**
- **ZD1 – zener diode BZY 88 C30 or 1N972B**
- **Q1 – Triac type SC41D**
- **Q2 – programmable unijunction transistor type 2N6027**
- **RV1 – miniature potentiometer 50k linear**
- **RV2 – miniature potentiometer 2 Megohm**
- **L1 – choke (see text) wound on ferrite plate 7/8" long x 19mm x 3.8mm**
- **T1 – pulse transformer (see text) wound on Neosid core type 0.159 x 0.375/2 x B6/F14**
- **R1 – resistor 120k, ½Watt, 5%**
- **R2 – resistor 22k, ½Watt, 5%**

One on/off switch plate with switch mechanism and one spare terminal. Insulation material 0.025" – 0.035" thick, mica sheet, 6BA x ½" bolts and nuts, 3/16" spacers, insulated control knob, wire, epoxy glue etc. Metal work, printed circuit board ET 011.

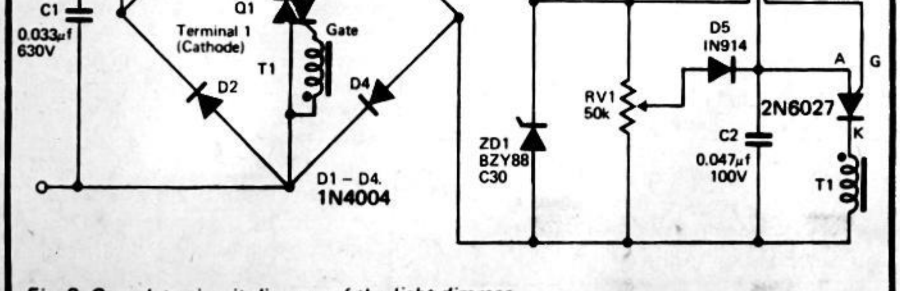


Fig. 2. Complete circuit diagram of the light dimmer.

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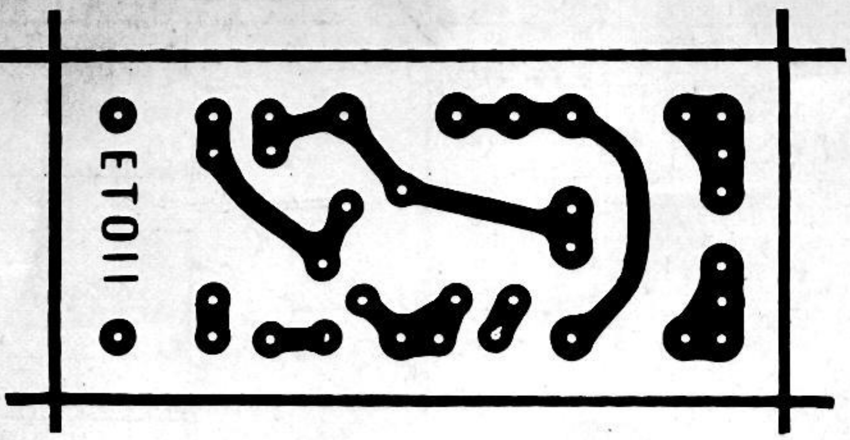
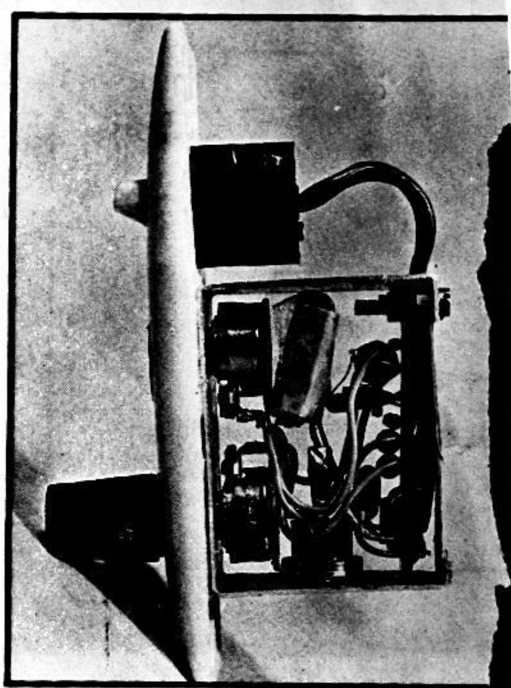


Fig. 3. Foil pattern of the printed circuit board. Note that this is shown here exactly twice full size.



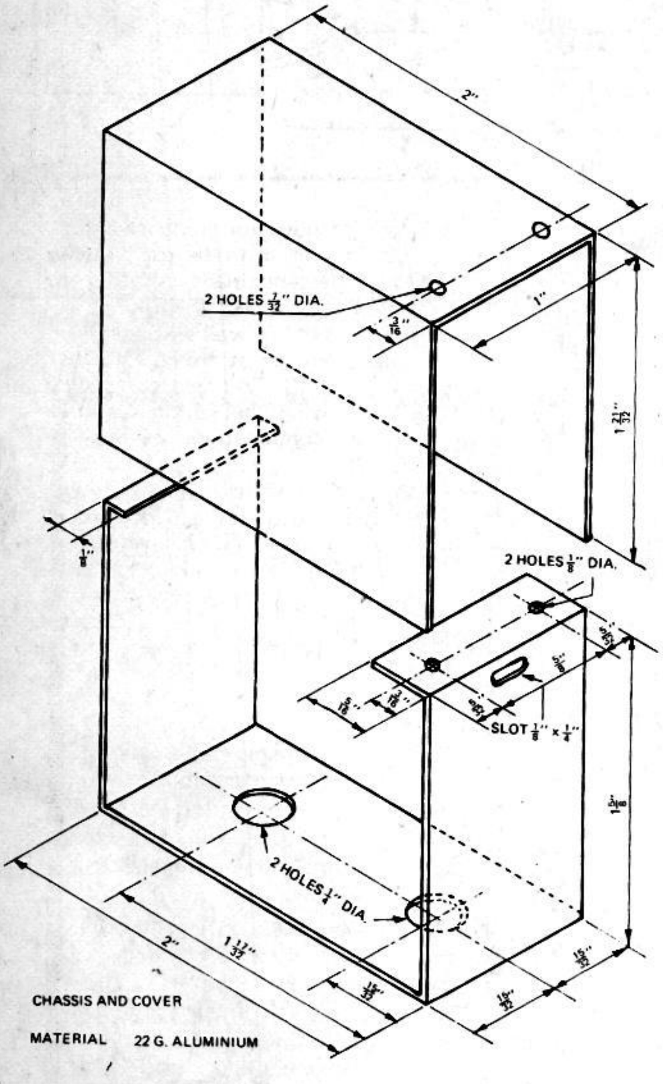
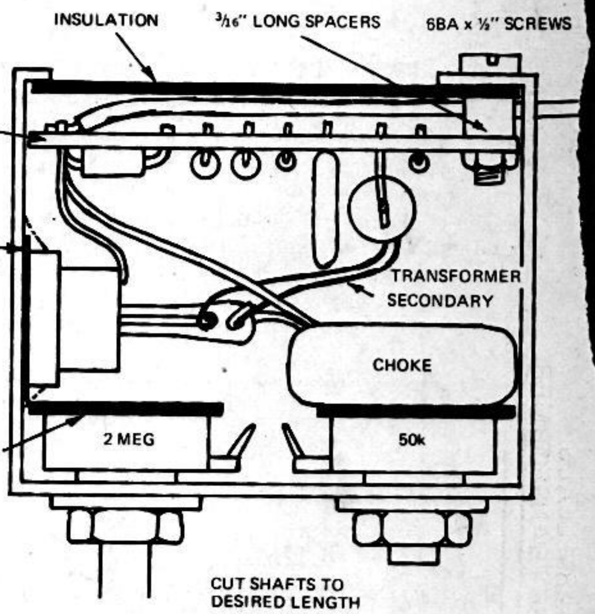


Fig. 4. Details of metalwork.

Fig. 5. How the unit is assembled.



TESTING

If a Megger is available, check the insulation by twisting together the two leads from the dimmer and testing between these two leads and the metal chassis. (Fig. 9). A reading of several Megohms should be obtained.

If a Megger is not available then check by using the circuit shown in Fig. 10. The lights should not glow at all – if they do then there is an insulation breakdown within the dimmer. If an isolating transformer is not available the same test can be made by connecting the mains directly to the dimmer via a 15 Watt bulb as shown in Fig. 11.

If the test must be done without using an isolating transformer, place the dimmer on a thick dry newspaper and take extreme care not to touch either the dimmer or the leads whilst power is connected to the circuit.

Having completed the insulation test, connect the dimmer to an incandescent bulb as shown in Fig. 12. Turn both potentiometers fully anticlockwise and switch on the power to the dimmer. The light should not be on, now turn up the minimum adjustment potentiometer until the light just glows. The main potentiometer should now control brilliance up to the maximum level.

If flickering is evident, switch off and reverse the connections from the pulse transformer to the Triac.

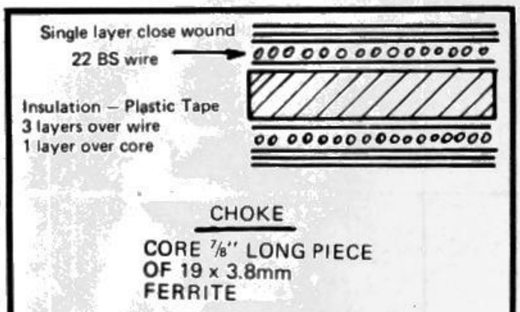


Fig. 6. How to wind the choke.

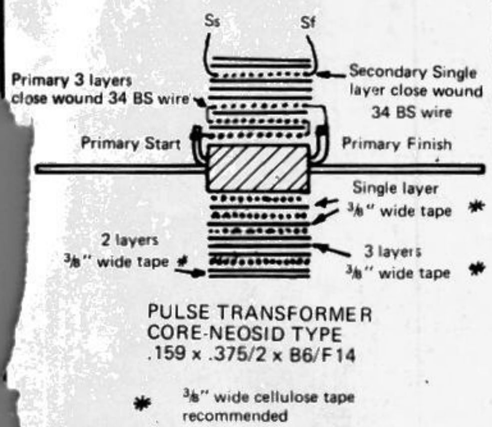


Fig. 7. Details of the pulse transformer – follow the construction exactly as shown.

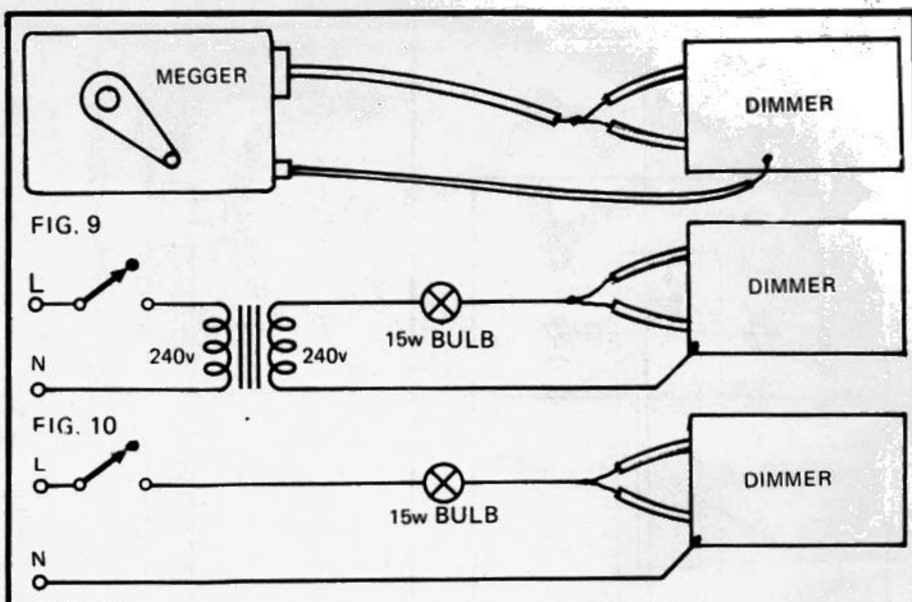


FIG. 9

FIG. 10

FIG. 11

The unit may now be glued to the front plate and the cover glued onto the chassis (use Araldite or other epoxy glue). Connect the two wires from the dimmer to the switch.

INSTALLATION

Any modifications to the house wiring must preferably be carried out by a qualified electrician and the following notes are intended for guidance only:-

If the dimmer is to be used solely with incandescent loads, all that is necessary is to connect the dimmer in place of the existing wall switch.

If fluorescent lamps are to be used, **refer to Fig. 13. This is a composite drawing showing the wiring required for various combinations of fluorescent lamps.**

A single fluorescent lamp would be connected as shown in Fig. 13a. If twin tubes are used then Fig. 13b would be applicable. If both single and twin fittings are to be paralleled then use Figs. 13a and 13b.

There may be occasions when it is

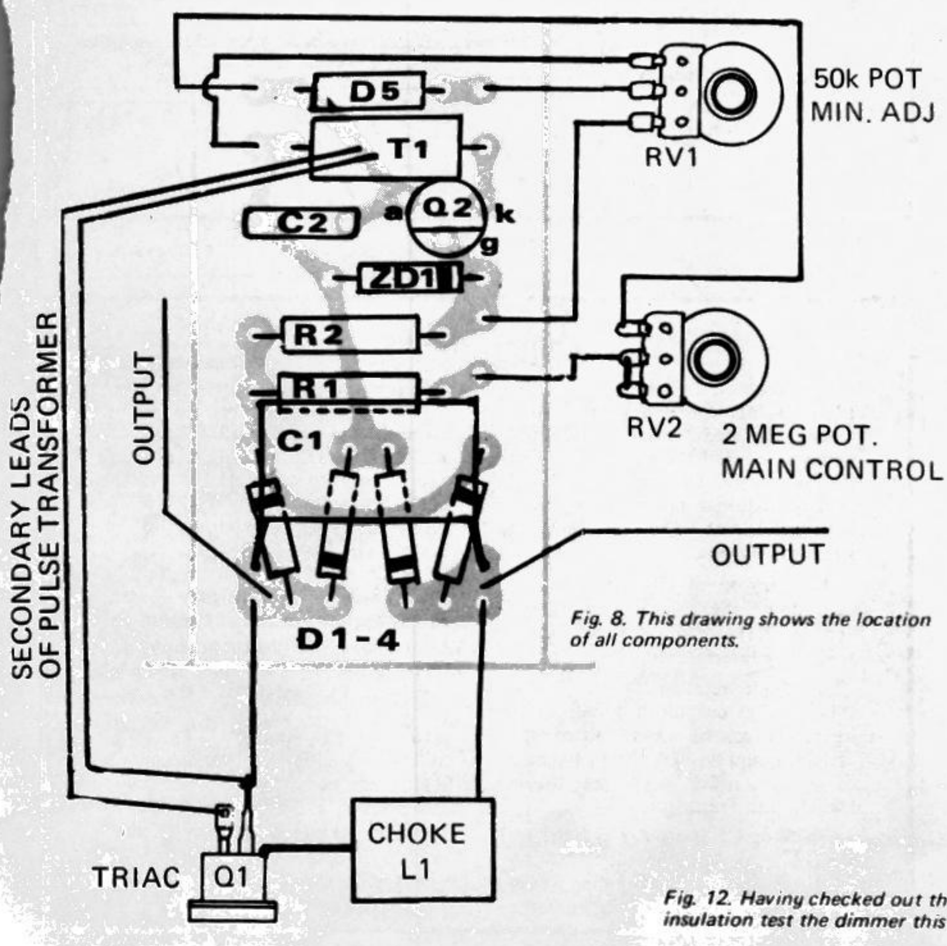


Fig. 8. This drawing shows the location of all components.

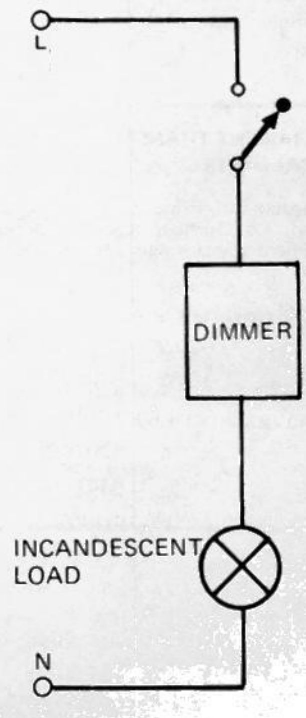


Fig. 12. Having checked out the insulation test the dimmer this way.

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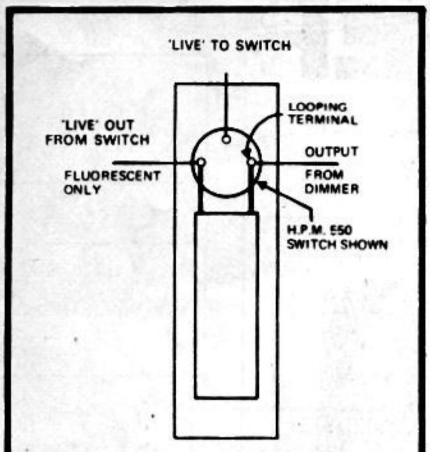
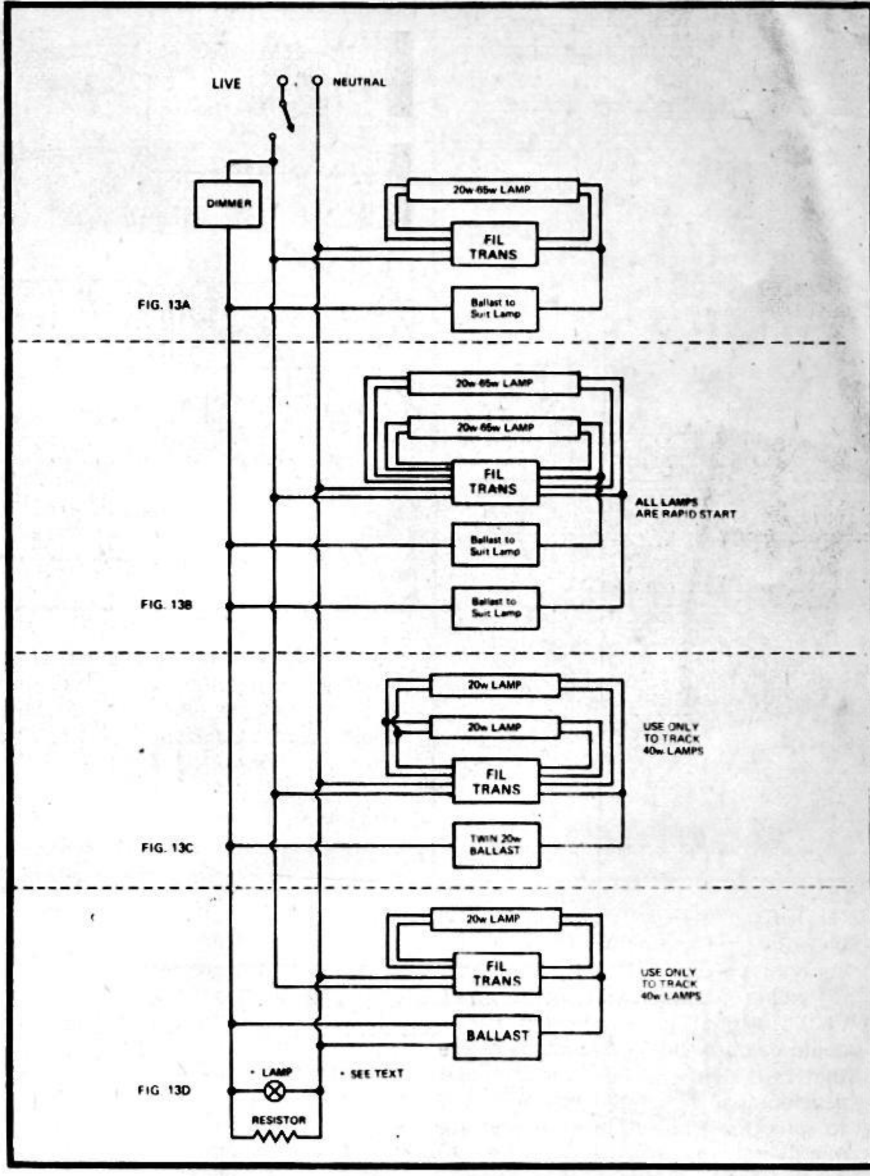


Fig 14. This shows how the dimmer is connected to the lamp switch



necessary to parallel a twin 20 Watt fitting and a single 40 Watt fitting – in this case use Figs. 13a and 13c.

No matter what combination of fluorescent tubes are used it will always be necessary to install the resistor (or incandescent bulb) as shown in Fig. 13 and explained in the fluorescent dimming article.

Again, as explained in the fluorescent dimming article, filament transformers must be used. The correct type of transformer for each application is shown in Table 2.

Filament transformers may be ordered through your parts supplier or through an electrical wholesaler. Our experience is that most companies do not hold them in stock but will willingly obtain them against a firm order. ●

FILIAMENT TRANSFORMERS & BALLASTS

Transtar Ltd, Prince Consort Road, Hebburn, Co Durham stock the following filament transformers and ballasts in one can:

Single rapid-start tubes

20W	A20SCR
40W	A40SCR

Twin rapid-start tubes

2x20W	A20TSCR
2x40W	A40TSCR

HOW IT WORKS

The power circuit consists of C1, L1, and Q1. Q1 is a Triac, which when triggered into conduction, remains so until the current through it falls to zero. The Triac is triggered at any required point during each half cycle to give a chopped sine-wave output.

The purpose of C1 and L1 is to slow down the rise time of voltage and current to reduce radio frequency interference.

The diode rectifier bridge (D1 – D4) supplies unsmoothed 240 Volts dc to the control circuit, where R1 and ZD1 supply 30 Volts to the gate of the PUT (Programmable Unijunction Transistor) Q2.

Capacitor C2 is rapidly charged via RV1 and D5 until the voltage set by RV1 is reached. Charging then continues via R2 and RV2. When the voltage across C2 exceeds the gate voltage (nominally 30 Volts) by about half a volt the PUT conducts and discharges C2 into the primary of pulse transformer T1. This causes a pulse of energy to be fed into the gate of the Triac and to trigger it into conduction.

The action of the Triac conducting removes all voltage from the control circuit until the next half cycle of the mains input waveform.

The point in each half cycle at which the PUT (and hence the Triac) is triggered is determined by the setting of RV1 and RV2. The range of the main control potentiometer RV2 may be varied by the preset potentiometer RV1, and so RV1 is used to preset the minimum light level.

This circuit ensures symmetrical firing of each half cycle of the Triac.