Project 146

The 'Mainsmaster'

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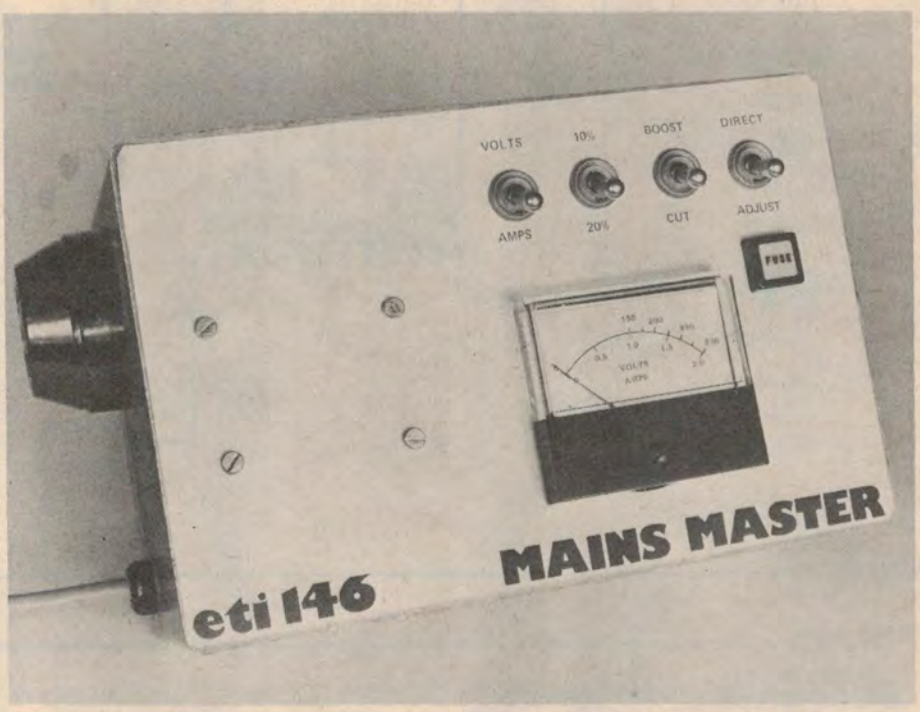
An essential piece of equipment for the keen experimenter's workshop, service bench or test lab.

WHEN TESTING an item of newly-developed mains-operated equipment, or servicing a unit of commercial manufacture, the need often arises where the circuit's response to variations in mains voltage has to be examined. The performance of regulated power supplies is a typical case in point.

The traditional method is to use a "variac". This is a type of continuously variable autotransformer – constructed somewhat like an enormous wirewound potentiometer. A large dial moves a contact over the single winding – the output being taken between the contact and one end of the winding. The main drawback of the variac, for most hobbyists, experimenters – even servicemen, is cost. Secondly, it may do more than is necessary for most people's applications.



Boost or buck

The simple and inexpensive, solution is to connect a suitable step-down transformer as an autotransformer with switching arranged to 'boost' or 'buck' the mains voltage by a small, fixed percentage. This will do the same job as a variac, but over a limited range, and allows scope for a few useful additions – such as monitoring the load voltage and current.

Thus, we have the 'Mainsmaster'.

This project uses a very common stepdown transformer having a 25-0-25 volt secondary. This is switched in series with the output socket so that, when the whole secondary is connected *in phase* with the mains, it will *add* 50 volts increasing the output by about 20%. When only *half* the secondary is connected in phase, the output voltage will increase by about 10%.

Similarly, when the whole secondary is connected *out of phase* with the mains, the output will *decrease* by 20%; with *half* the secondary connected out of phase the output will decrease 10%.

As the transformer secondary is rated at 2A, loads up to about 500 W may be run from the Mainsmaster.

To monitor the output voltage and current a series of resistors and diodes provide rectification and voltage and current scaling for a commonly available 1 mA meter movement. A new scale has been provided, marked with the appropriate voltage and current scales.

Standard, inexpensive, mains-rated toggle switches are used to arrange the boost and cut, meter switching and switching of the output direct to the mains.

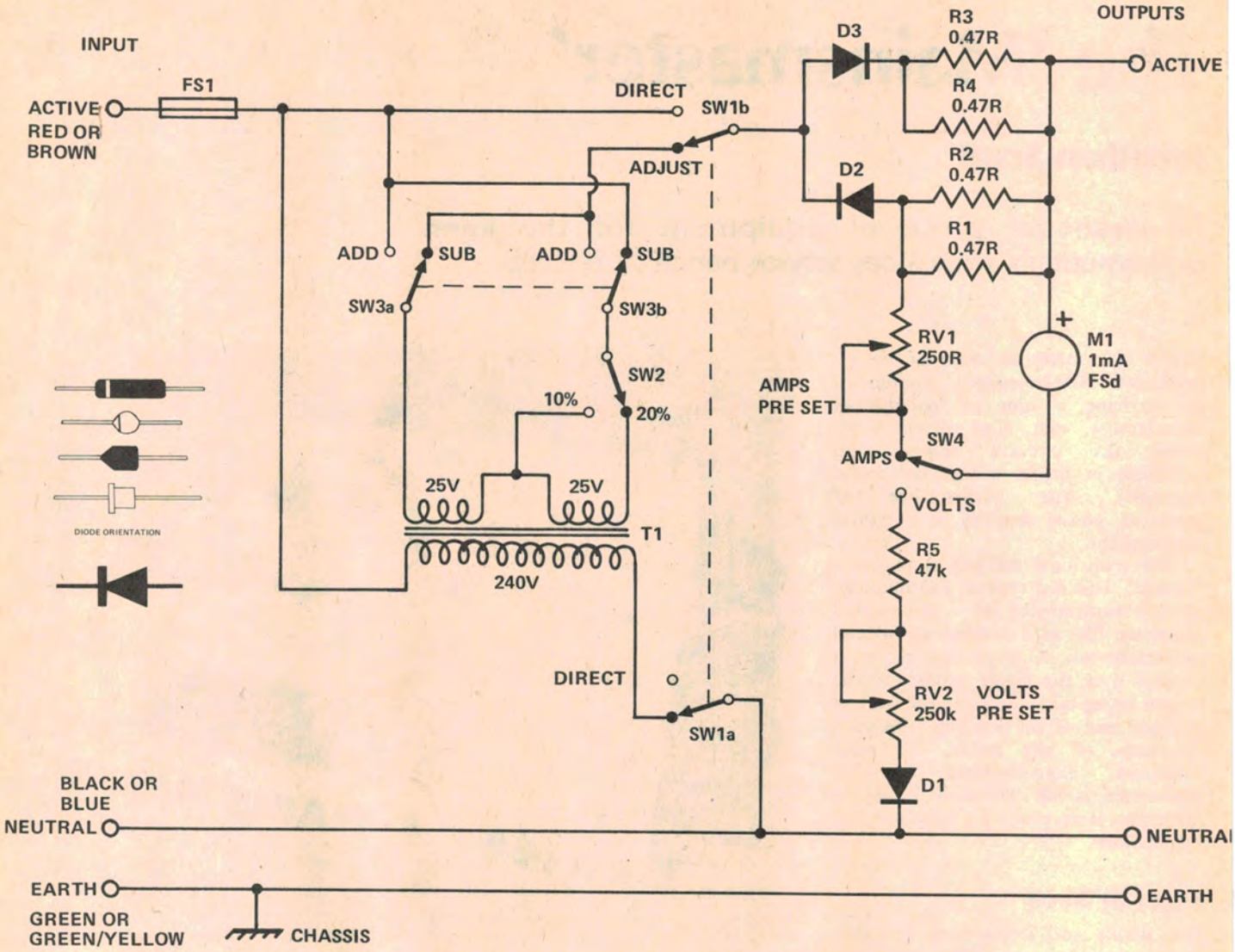
Construction

Since the whole circuit is at active mains potential we recommend that the three-pin plug be fitted last of all!

Unless you are competent to do so, it would be wise not to deviate from our design in any detail.

Construction is relatively simple, with only the meter, diodes and transformer needing to be connected a particular way around. All switches need to be 240 V rated. We used DPDT switches for SW1-SW4 though only two need to be DPDT rather than SPDT. This was because we could not readily locate 240 V AC switches of identical appearance in both DPDT and SPDT. It is advisable to use the pc board shown as it forms a solid, reliable mount for the trimpots.

A number of sensible construction practices should also be included. Firstly, use a proper cord clamp for the mains cord. Earth the transformer and front panel. (Our transformer is bolted to the front panel and both earthed). ▶



It is advisable to use a robust box, an all-metal diecast one being the best, though expensive. Use proper 240 V AC rated hookup wire (known as 23 x .0076).

After the interconnections have been completed according to the diagram the calibration of voltage and current ranges remains. Do not attempt to adjust the trimpots with the unit plugged in. These should be adjusted in small steps, each adjustment being made with the unit disconnected. The meter should be set to agree with a multimeter or reference instrument measuring across a purely resistive load, such as 200-300 watts worth of incandescent lamps. Remember that the unit is only rated to 2 A, so only 500 W can be drawn continuously. The fuse will limit the output current to 3 A. ●

MAINS WIRING

Constructors should keep in mind a number of simple rules when doing any 240 Vac mains wiring.

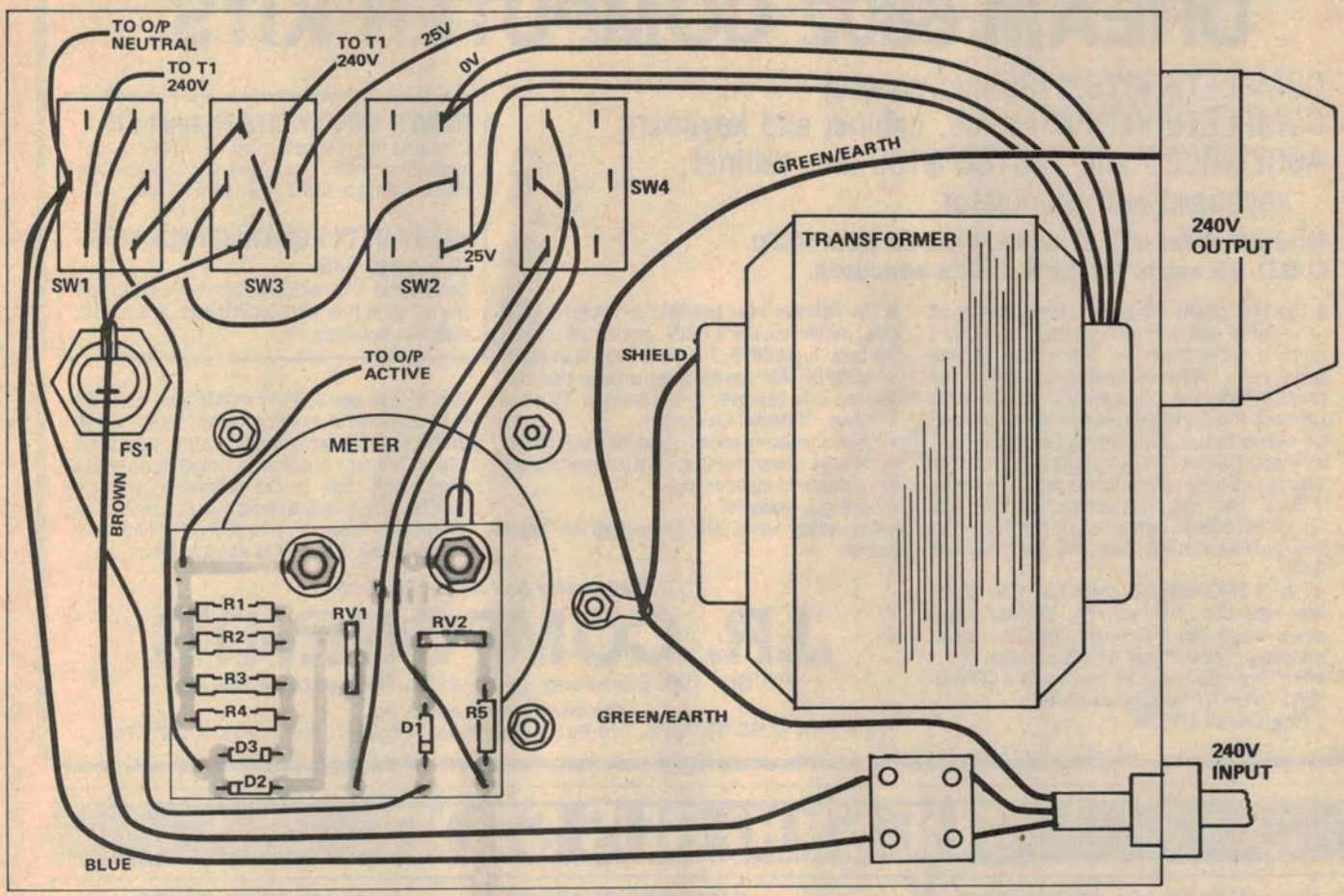
Firstly, the input cord should be standard, approved three-core flex. Not "figure-eight" flex. It should be secured to the case of the equipment with either a clamp-type grommet or passed through a standard rubber grommet and secured inside the equipment by a proper cable clamp. Knotting the cable is not good enough – and dangerous.

The active and neutral wires must be terminated, immediately inside the equipment, to a terminal block. The earth wire must be **longer** *and earthed via a lug under a bolt and nut used for that purpose alone so that, if the clamp fails under any circumstances, the earth lead will be the last to break. If any subsequent wiring passes through a metal partition or chassis it should be sleeved or a small grommet inserted in the chassis hole.*

Do not pass mains wiring over any circuitry within a piece of equipment. Route it around, keeping well clear of components. Use cable ties. Keep mains wiring well separated from low voltage wiring, preferably at opposite ends of the chassis of a piece of equipment. This also reduces the likelihood of hum pickup in sensitive circuits, such as high gain amplifier stages.

Use electricity authority approved transformers (see ETI, September 1979, page 13) and three-pin plugs.

Follow these directions and you should live to enjoy your hobby for many years.



PARTS LIST – ETI 146

Resistors
all ½W 5%
R1-R4 . . . . .0.47R
R5 . . . . . .47k
RV1 . . . . . .250R
RV2 . . . . . .250k

Semiconductors
D1-D3 . . . . .EM4004 or sim.

Switches
SW1, SW3 . . .DPDT 3A, 240 Vac switch
SW2, SW4 . . .SPDT or DPDT 3A 240 Vac switch

Miscellaneous
FS1 . . . . . .3 A (3AG) fuse and fuse holder
T1. . . . . .Ferguson PF3259, 25-0-25V 2 A transformer or similar.
M1 . . . . . .1 mA, 65 mm square panel meter

Diecast box 200 x 125 x 100 mm, 3pin mains panel mount socket, ETI 146 pc board, cable clamp, mains cord and plug, rubber feet.

HOW IT WORKS – ETI 146

The circuit may be divided clearly into two parts: the voltage switching part, and the metering part. The switching part works simply by switching either half or all of the secondary of T1 in series with the mains supply – either in phase to add, or 180° out of phase, to subtract. This is controlled by SW1, SW2 and SW3. SW1b removes the 240 V AC from the transformer when the direct connection is used. The whole circuit (and load) is protected by F1.

The metering part measures volts and amps. Diode D3 rectifies the voltage across the load. R5 and RV2 set the meter range to 300 V AC FSD. R1-R4 with D1-D2 form a (symmetrical) 2 A shunt for the meter which allows it to pick off DC (since the meter sees only the current in R3/R4). RV1 sets the current sensitivity.