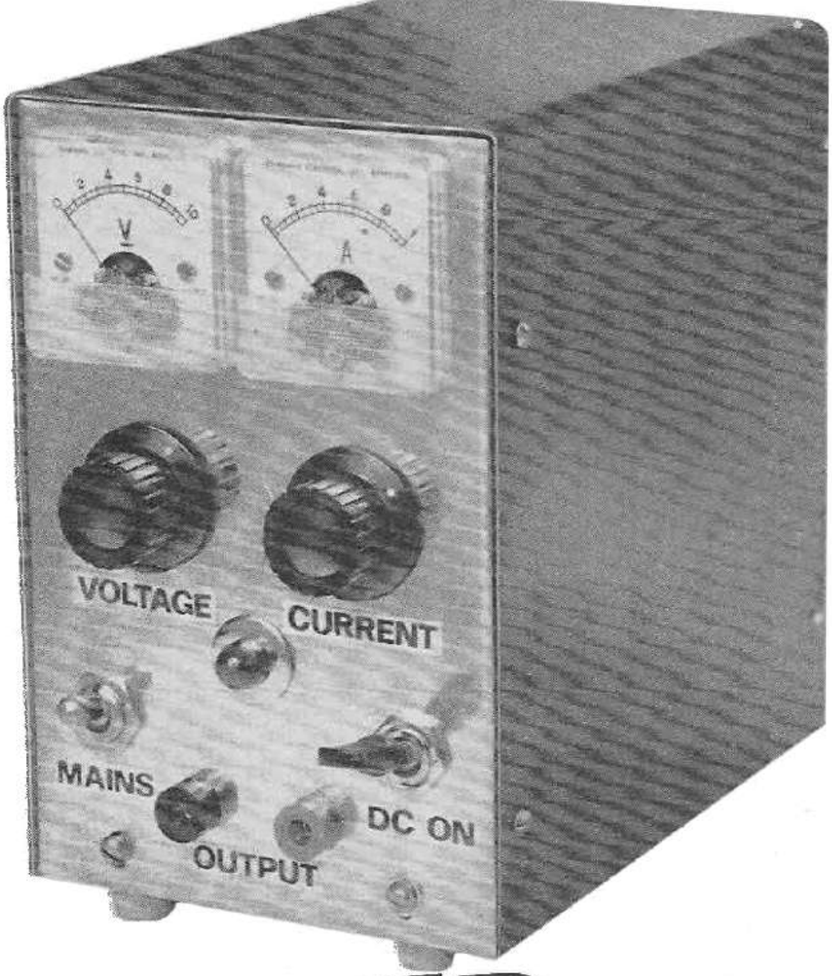
General Purpose



POWER SUPPLY

By F. G. Rayer

THIS power supply will provide up to 20 volts at one amp, so will operate most of the items likely to be used by the electronics enthusiast. These will possibly include radio receivers, amplifiers, and all sorts of experimental and other electronic projects. The power supply can also be used to run model motors or trains within its rating, or for the trickle charging of accumulators, model lighting, or booster charging of dry cells. It can thus be expected to pay for itself in due course.

The same circuit can be adopted with various mains transformers and meters, as will be explained later, and this may allow items to hand, to be brought into service, thereby reducing expense.

The supply is fully adjustable, has excellent regulation, and is automatically protected against overloads or short circuits.

CIRCUIT DESCRIPTION

The full circuit diagram of the Power Supply is shown in Fig. 1. Transformer T1 has a low voltage secondary, and rectification is by the four diodes, D1 to D4. Output from these passes to the reservoir and smoothing capacitor C1. Direct current for the later parts of the circuit is obtained from C1.

Switch S1 is the mains switch, and the neon, LP1 is to show when mains power is on. The transformer fitted is an easily obtained multi-output component, and the rectifiers are connected to the 0V and 19V taps, to give a final output of up to about 20V.

If other transformers are used, the voltage across C1, after rectification, should not exceed 30V. Lower secondary voltages, such as 12V, will naturally reduce the maximum output voltage, but will often be adequate for most equipment. A transformer with two or three 6·3V windings would provide 12·6V or 18·9V with the windings connected in series in correct phase.

The secondary current rating must at least equal the maximum current required, and the circuit is designed for 1A.

REGULATOR

Integrated circuit ICI forms the regulating part of the circuit and is a positive voltage regulator. Negative or inverting feedback is provided by VR1.

Suppose for a moment that the power supply is set to give an output of, say, 10 volts. In this state the series pass transistor, TR1, is biased sufficiently on for this voltage to appear at the output.

This is accomplished by means of the potential divide network consisting of R2, VR1 and R3, the wiper of the voltage control being fed back to the inverting input of ICI (pin 6).

If a load is now connected across the output, the immediate action is for the voltage on VR1 wiper to reduce. This decrease in

SPECIFICATION

Voltage: Fully variable from 0 to 20 volts.

Current: Fully variable and current limited. Up to one amp maximum.

Meters: Two front panel meters indicating voltage and current supplied to the load.

Fully protected against inadvertent short circuits and overloads for an indefinite time.

voltage causes ICI to increase its output to TR1 causing it to conduct more heavily, and restore the potential at VR1 wiper to its original value to maintain a 10 volt output at the emitter of TR1.

When the load is removed, the voltage fed back to pin 6 increases. In turn the i.c. output reduces causing TR1 to conduct less until the voltage on VR1 wiper is restored.

In practice this "pulling" and "pushing" happens very fast, faster than it does to explain it, with the result that the final output maintains a very stable level—the "ripple", the variation between the "pull" and "push", being within a few millivolts.

CURRENT LIMITING

Current limiting is achieved by VR2 which can limit the current from a maximum of one amp to as low as 50mA. Thus even a short circuit on the output can cause no damage to the power supply.

The output is finally taken to the output terminals via S2, which allows complete isolation of the load from the supply. Capacitor C4 filters any noise induced on the supply lines.

Although not shown on the circuit, a series combination of a resistor and light emitting diode can be connected across the output to give an indication that the d.c. supply is on.

The power supply is fully metered, ME1 measuring the d.c. voltage at the output, and ME2 the current taken by the load. Those used were SEW type MR38P which are seldom seen nowadays in suppliers catalogues, but should be available from old stock. It should be noted that the metal work for the power supply was dimensioned using these types of meters, if other types, either smaller or larger are used then the sizes must be varied accordingly.

METERS

Ideally the meters should read 0 to 20 volts f.s.d. for ME1, and 0 to 1 amp for ME2. These can be purchased correctly scaled, but it is more likely that constructors will already have meters to hand, and these can be used instead. The voltmeter, MEI could be a milliameter with a series resistor, R4.

This resistor can have a value of one kilohm per volt for a 1mA meter; which means a resistance of 20 kilohms for the meter to read 20 volts, or 200 ohms per volt for a 5mA meter, which is four kilohms to read 20 volts. The formula for calculating this "multiplier" resistor is simply:

$$R_{MULTIPLIER} = \frac{\text{Voltage to be measured}}{\text{Current rating of meter}} \text{ (Kilohms)}$$

For the current meter ME2, a direct reading meter can be used. If however a meter of greater sensitivity than one amp f.s.d. is used it can be shunted with resistance wire.

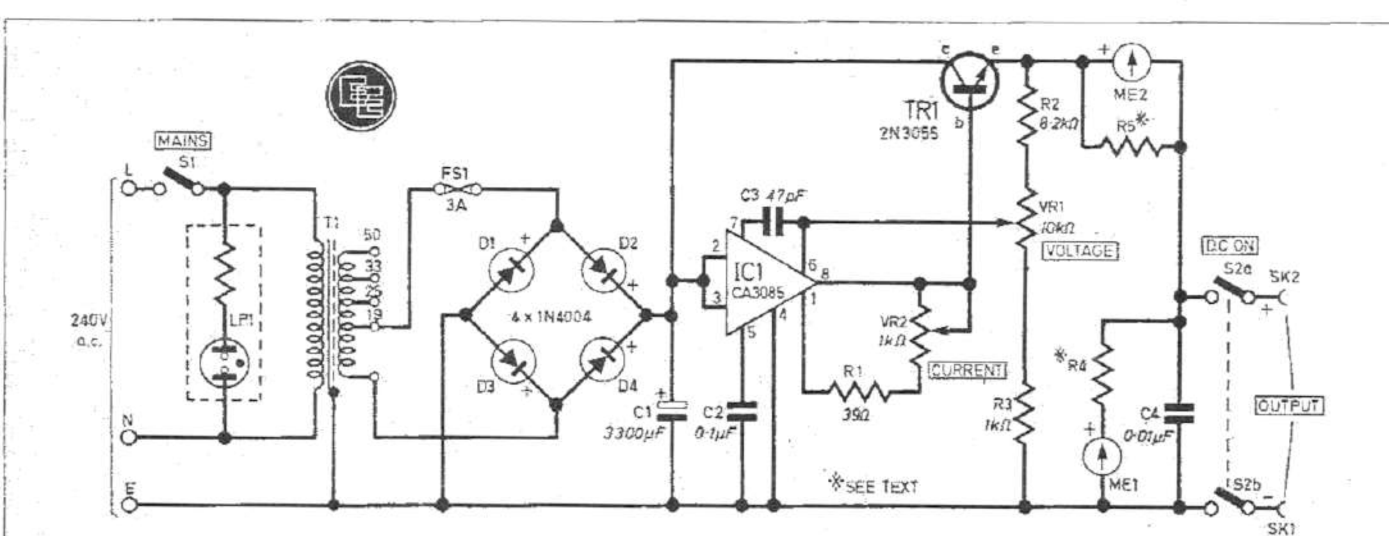
The value of this resistor is calculated from the following equation:

$$R_{SHUNT} = \frac{I_m}{I - I_m} \times R_m \text{ (Ohms)}$$

Where I_m = Current rating of meter, I = Maximum current to be measured, and R_m = Resistance of meter.

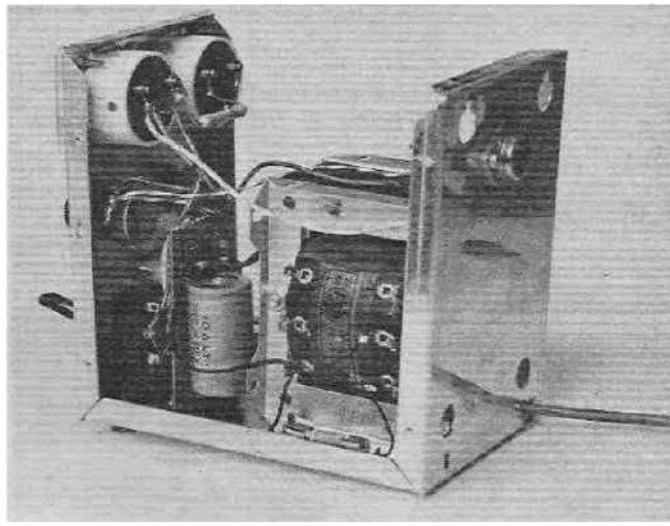
As the value of the shunt may be rather small, and quite possibly will be difficult to measure an alternative is to find the shunt by trial and error. To do this connect a 500mA load, such as a six watt 12 volt bulb and a test meter set to read one amp in series across the output. Solder a short length of resistance wire across the meter terminals.

Fig. 1. Complete circuit diagram of the General Purpose Power Supply.



Adjust VR1 from a low voltage until the test meter reads 500mA. If ME2 reads too high, shorten the resistance wire. If it reads too low, lengthen the wire to increase the resistance. With a few trials ME2 can be made to read correctly.

Switch off the mains each time the shunt is being changed.



The main chassis frame members. The power transistor TR1 is seen mounted on the rear panel. The circuit board is mounted vertically close to the output switch S2. It would be a good idea to insert a piece of plastic or polythene sheet between S2 and the circuit board to avoid any possibilities of "short circuits . The cover for the unit is simply a "U" shape which is fitted over and fixed with self tapping screws.

CONSTRUCTION starts here

CASE DETAILS

An attractive and inexpensive case can be made from three 152×100mm flanged Universal Chassis members for the front, bottom and back. These are held together with 4BA mounting hardware as supplied with these parts.

A cover is necessary to protect the user and power supply. This can be made from a piece of sheet metal of 22 s.w.g. or similar. The overall size is 408×152mm and is finally bent into a "U" shape. This is relatively easy if the metal is not too stout and if gripped firmly when bending. It is fixed to the main chassis using self tapping screws which screw into the flanges on the Universal Chassis members.

CIRCUIT BOARD

The diagram in Fig.2 shows the stripboard layout for the rectifier part and regulator part of the circuit. Make all the breaks shown not forgetting those which isolate the metal mounting bracket and then wire the diodes followed by the resistor and capacitors. The i.c. is left to last. Be extra careful with the i.c. as many of the leads are splayed out more than normal, and if forced can break away from the body. A socket cannot be used here for this reason.

The flying leads can be wired either direct or by the use of Veropins. Colour coding of the wires will be an advantage at this stage if for instance, at a later date fault finding is necessary.

FRONT PANEL

Next to be wired can be the front panel. Drilling details for this is shown in Fig.3. Note that the hole sizes depend on whatever type of meter you have. If other larger types are used then obviously a larger front panel, hence a larger overall case needs to be used. It is best therefore to obtain the meters first and make the case accordinly.

It will be easier to dismantle the three sections of the chassis when wiring up the front panel, remembering to leave connecting wires long enough to reach the rest of the circuit. Wiring details for the front panel is shown in the overall diagram of Fig.4.

BOTTOM AND REAR

Whatever type of transformer you have chosen needs to be fixed as near to the back as possible so as to clear the front panel components. The completed circuit board can also be mounted on the bottom panel using the small bracket as detailed in Fig.2. The fuse holder is also mounted at this stage.

The rear panel has only one component mounted on it and this is the power transistor TR1. This needs to be isolated from the chassis, and is accomplished using

COMPONENTS

Resistors
R1 39Ω
R2 8·2kΩ
R3 1kΩ
R4 Meter multiplier (see text)
R5 Meter shunt (see text)
All ¼W carbon ± 5%

Potentiometers
VR1 10kΩ lin. carbon
VR2 1kΩ lin. carbon

Capacitors
C1 3300μF 25V elect.
C2 0·1μF polyester
C3 47pF polystyrene
C4 0·01μF polyester

Semiconductors
TR1 2N3055 silicon *npn*
IC1 CA3085 positive voltage regulator
D1 to D4 1N4004 silicon rectifier

Miscellaneous
LP1 240V mains neon with integral resistor
ME1 0 to 20 volt meter, 60 × 48mm front (see text)
ME2 0 to 1 amp meter, 60 × 48mm front (see text)
S1 s.p.s.t. toggle switch
S2 d.p.d.t. toggle switch
SK1, 2 4mm sockets (1 off red, 1 off black)
FS1 3 amp fuse with chassis mounting holder
T1 240 volt mains transformer, secondary as required rated at 1 amp. Type MT104AT (Home Radio) was used in prototype which had a 19V secondary. (See text)

Stripboard 0·15 inch matrix 10 strips by 20 holes; aluminium 20 × 20mm; Universal Chassis flanged members 152 × 100mm (3 off); 22 s.w.g. sheet metal for cover, bent into a "U" shape, overall dimensions 408 × 152mm; 4BA and 6BA hardware as required; insulating kit for TR1; two small round knobs; four rubber feet; length of mains cable; connecting wire.

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General Purpose POWER SUPPLY

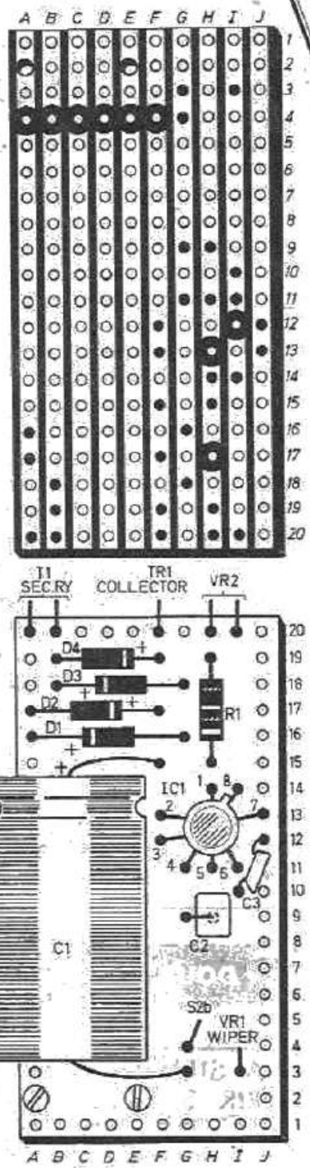


Fig. 2. Wiring details for the component board showing the breaks to make.

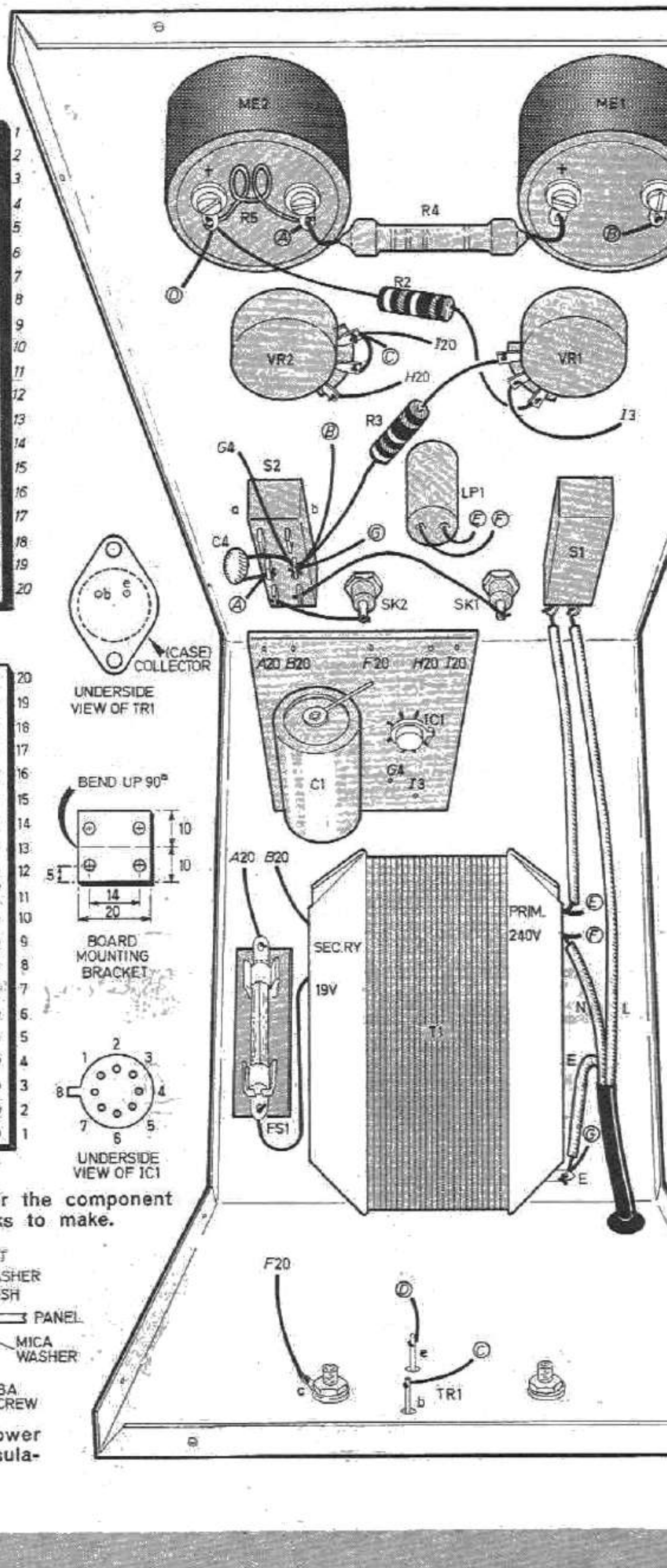
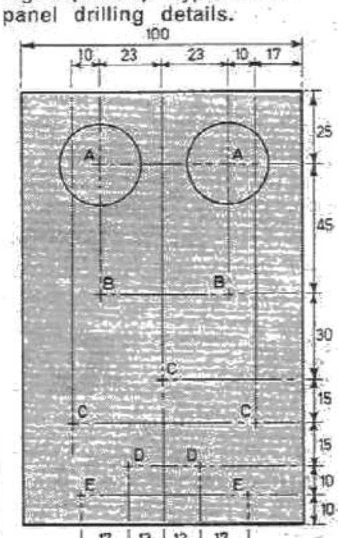


Fig. 4 (Left). Main wiring details for the unit. With the transformer specified there is not a great deal of room on the base, hence the component board should be mounted as near to the front panel as possible without touching the mains switch.

Fig. 3 (Below). Typical front panel drilling details.



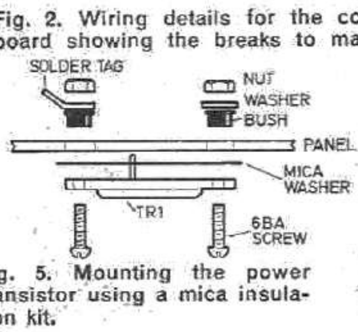
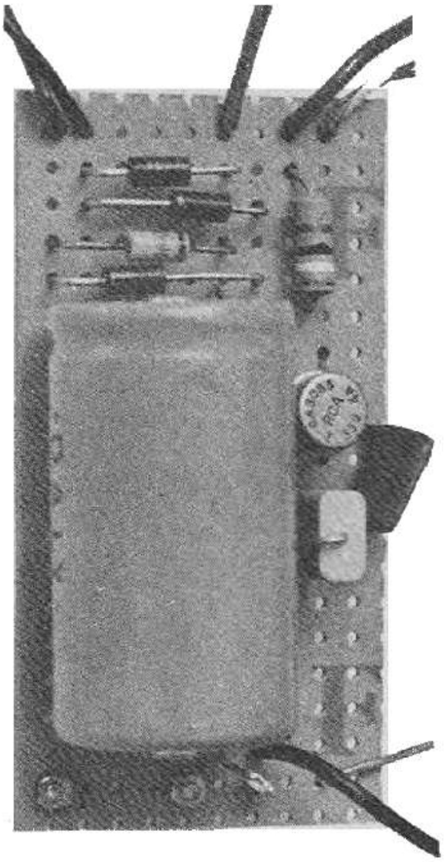


Fig. 5. Mounting the power transistor using a mica insulation kit.



The completed circuit board. Note the small L-shaped mounting bracket.

a mica insulating kit as shown in Fig.5. When mounting the transistor be sure to position it so that it will clear the mains transformer, otherwise a short circuit may occur and cause a great deal of damage.

Four holes each 15mm in diameter are also drilled in the rear panel, two near the top above the transformer, and two at the bottom. The three separate sections can then be bolted together before testing.

IN USE

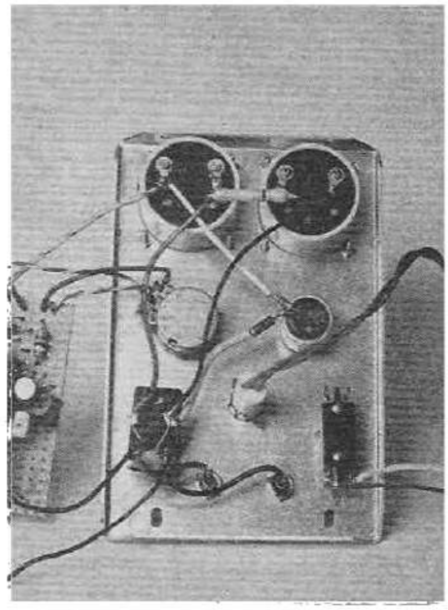
Before switching on, the usual checks should be made to ensure that no errors have crept in. Be extra cautious with this design to look out for short circuits, particularly around the rectifier part of the circuit board and transistor. An ohmeter set to its low resistance range should show no indication at all when connected between the chassis and the case of the transistor. Take time over this test as mistakes at this stage can be very expensive!

If all seems well the mains lead can be plugged in, fit a one amp fuse in the plug, and switch on. The neon should at once light, and depending where the controls are set an indication may be seen on the voltmeter.

Adjusting the VOLTAGE control, VR1 should allow the wanted voltage to be set on the meter. The range obtained on the prototype was just over zero to just over 20 volts. Depending on the transformer used the voltage can be lower or higher.

CURRENT CONTROL

Set the required voltage on the meter and connect the power supply to a load, turn the CURRENT control fully anticlockwise and switch on S2. The voltmeter will still show an indication but the current meter will show zero. Slowly turn the CURRENT control clockwise and note the reading increases also. When further rotation of the control produces no further increase in the reading turn the control back to the point where the reading stopped.



Rear of the front panel showing interwiring between components.

The CURRENT control is now set so that no further increase in the current will take place. The load and power supply in this state are now fully protected. For example if the load goes short circuit the power supply will limit the current thus protecting the load as well as the supply. Under fault conditions such as this the voltage reading will remain the same, but the current will fall to almost zero. There is a slight leakage current on a full short circuit but this can normally be ignored.

Once practice has been gained at using the controls the power supply will become a most useful instrument in the constructors workshop. ⌑

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BY DOUG BAKER