PE CHAMP

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PART FOUR

Now that we have examined the circuitry of the CHAMP main board, and the details of its interface with the control panel and keyboard, we are in a position to move into the construction phase. This month we will consider the assembly of the main board, the design and construction of the power supply module, and the assembly of the plinth which supports the main board, and houses the power supply module.

STRIPBOARD LAYOUT

The CHAMP main board consists of a piece of 0·1in matrix Veroboard measuring 304·6 × 165mm (12 × 6·5in). This is an unusually large size for Veroboard, and if you intend to build CHAMP PROG it may be wise to buy two sheets at the same time, because of course CHAMP PROG uses the same type of board.

The board layout and the required track breaks are shown in Fig. 4.1 and Table 4.1. Before working on the board we would recommend chamfering the edges where they slide into the self adhesive card guides, because these guides grip very firmly and this can hamper board removal later.

As far as possible, the Veroboard component geography is similar to the circuit layout of Fig. 2.3, and although there are some differences, constructors should have no difficulty in finding their way around. Notice in particular that the program memory data and address buses, and the four bit m.p.u. bus are each represented by parallel runs of Veroboard copper track. This arrangement is costly in board space, but is more than made up for by the added convenience when wiring up and trouble shooting, and it provides a layout which can be related to the circuit diagram very easily.

SOCKETS

On the prototype board all i.c.s were mounted using Soldercon socket strips. This technique is strongly recommended for three reasons:

(a) Sockets are essential in MOS systems because of the damage which can occur if an LSI chip ever has to be removed.

(b) Soldercon pins are the cheapest way of providing sockets.

(c) Soldercon pins have the advantage that wiring up can take place *between* the i.c. pins instead of *just outside* the i.c. pins, as would be necessary with "raft" type sockets. This is a big help when using 0·6in wide chips, and allows maximum use of available board space.

The *disadvantage* of Soldercon pins is that they are not much good when repeated insertions or withdrawals of the chip is necessary.

This is not a problem with the CHAMP integrated circuits, but the interfacing sockets (SK1–8) certainly will get well used, and consequently conventional low profile 16-way d.i.l. sockets should be used in these positions. It is also possible that constructors of CHAMP PROG will find themselves regularly swopping 4702A chips around on the CHAMP board, and in this case 24-way low profile sockets could be substituted in the IC18 and IC19 positions, although this has not yet been found necessary on the prototype.

You may have noticed that the prototype board sports an extra 28-way Soldercon i.c. socket in the top right-hand corner. This was installed in the prototype to allow

TABLE 4.1.

Track cut positions to be made on CHAMP Veroboard

Row	Positions
5	BN–BF, BB–AV, AR–AJ, T
6	AD–W
9	BN–BE, BB–AU, AR–AJ, T, R–H
11	AD–W
14	BN–BF, BB–AV, AR–AJ
15	V–H
18	BN–AS, AE–AB, D, E
19	AR–AJ, AA–X
20	W
23	V–H
24	BP–AT
29	BP–BD, V–H
31	BA–AT, Y
35	P–H
36	BC–AT
38	P–H
39	BC
40	BB–AT, BD
41	BC
43	R–H
45	BD–AT, AH, AF
46	V, T
48	R–H
49	BA–AT
53	R–H
55	BE–AT
57	X–H
61	BE–AT
66	X–H
67	BE–AT
69	AA–U, R–H
72	AA–H
73	BD–AT
76	AA–H, AB
78	BD–AT
81	R–H
82	AA–T
83	BD–AT
86	AA–T, R–H
87	S
88	BD–AT
91	AA–U, S–H
93	BD–AT
94	F, E, D
95	AA–L
96	K, J, H
98	BD–AT
100	H, D,
101	AA–L, E
103	BD–AT
105	H, D,
108	BD–AT, E
109	AA, U
111	BP–BF, T–N
112	AB–U, M–D
115	BN–BF, AS–AJ
116	BP, AB–U, N–D

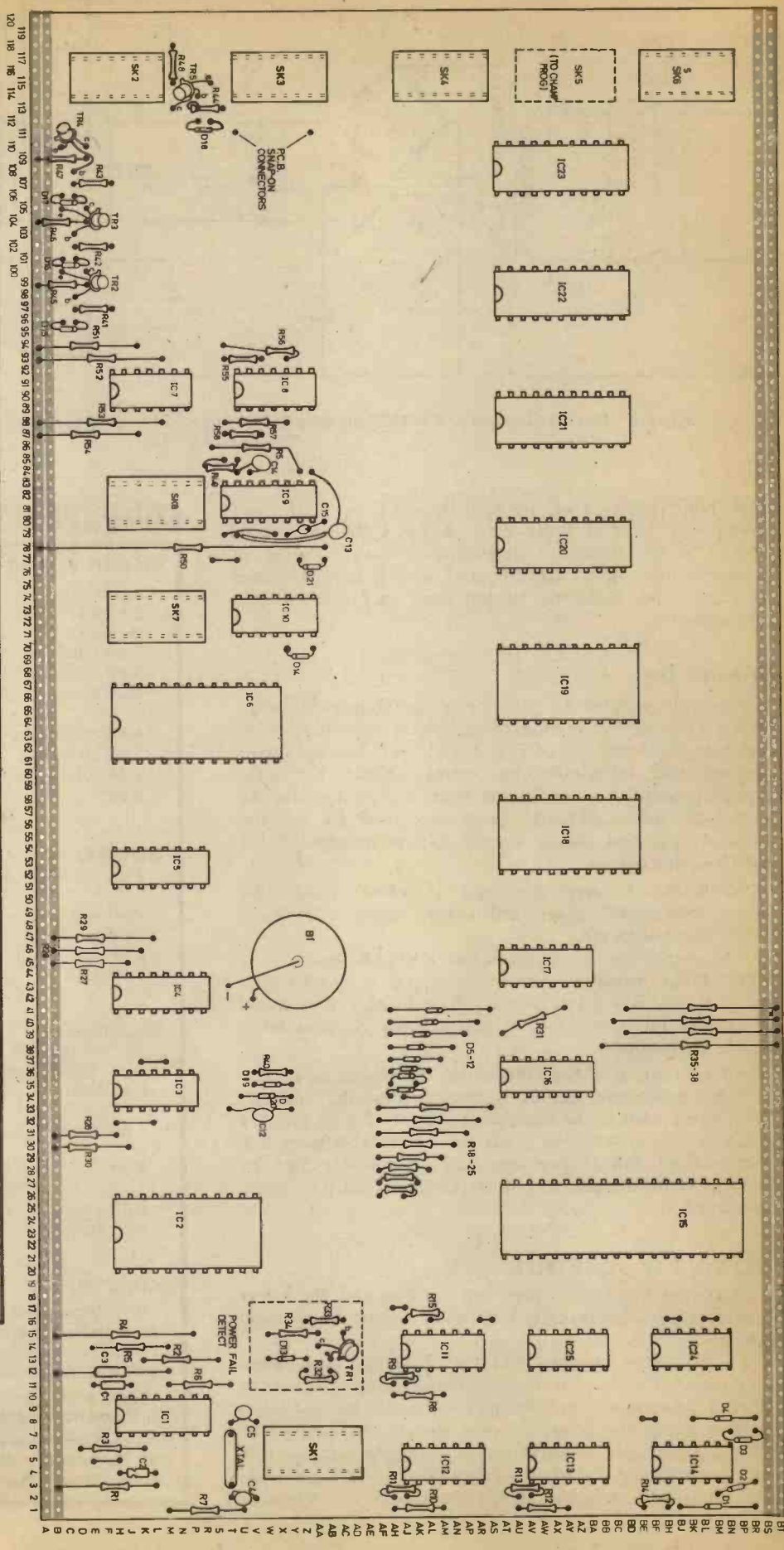


Fig. 4.1. Basic CHAMP board layout. Wiring details of CHAMP complexity cannot be superimposed on this diagram and so for full assembly of this board reference to Fig. 2.3 should be made

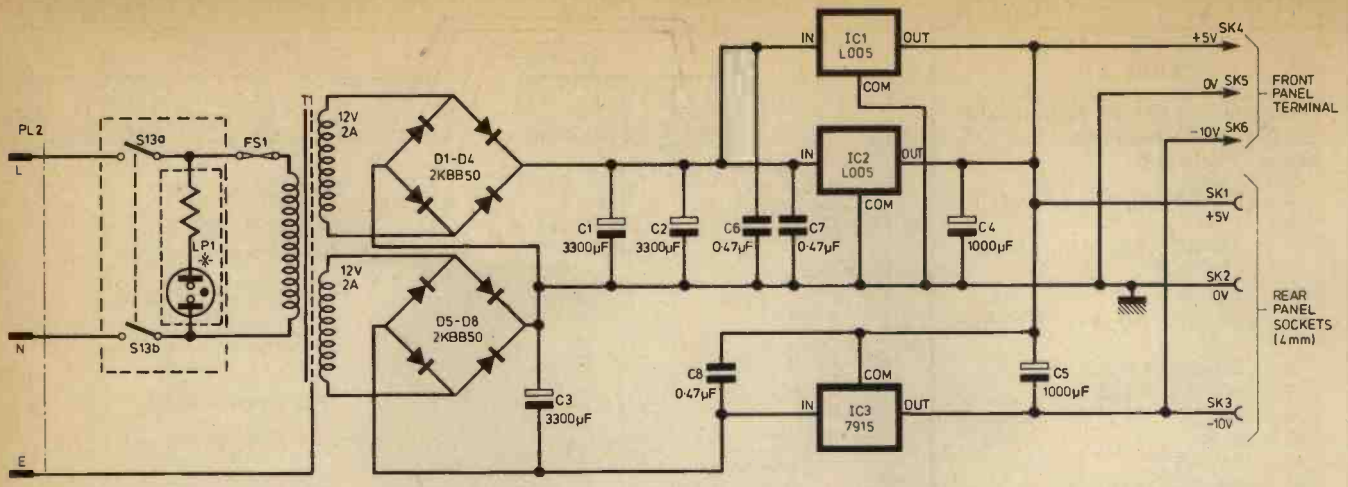


Fig. 4.2. Circuit diagram of CHAMP power supply. Fuse FS1 is only essential if a fused mains plug is not used and should be 2A

the future addition of an 8251 USART or 8253 programmable interval timer chip to the CHAMP board, should it be desirable. With hindsight we consider it unlikely that most constructors would require these facilities, and therefore suggest that this area is left uncommitted.

WIRING UP

It is not possible to produce a comprehensive interwiring diagram for Veroboard circuits of this complexity, but with combined use of Fig. 2.3, Fig. 4.1, and the board photographs, interconnection wiring should be fairly straightforward for the experienced constructor. In the prototype yellow KYNAR wire was used for all the logic wiring, and this is very highly recommended for the following reasons:

(a) Kynar is very fine and therefore avoids the "Spaghetti" effect which can occur with p.v.c. insulated wire.
(b) Despite its small diameter, KYNAR has a very tough insulation which is nevertheless easy to strip.
(c) KYNAR is silver plated which helps you to avoid dry joints and assures you of high integrity interconnections.

The *disadvantage* of KYNAR is that it seems to be difficult to find in amateur suppliers' catalogues at the moment. It is widely used in the electronics industry for its primary purpose of wire-wrapped joints and *is* available from R.S. Components, but if you are unable to secure any, be sure to substitute the very finest single strand p.v.c. wire you can find.

GETTING IT TOGETHER

Once the board has been cut to size and the edges chamfered, track breaks can be made, which conform to Table 4.1.

The Soldercon pins and d.i.l. sockets should be soldered in position first, to provide a reference framework for the discrete components and the interwiring, but the bandolier strip to which the Soldercon pins are attached should be left in place until construction is complete, as this will help prevent any distortion or loss of pins during soldering. The exact order in which the discrete components

COMPONENTS . . .

CHAMP POWER SUPPLY & MAINFRAME

Capacitors

2 off 0·1µF	30V ceramic disc	C9, C10
3 off 0·47µF	Ceramic disc	C6, C7, C8
2 off 100µF	35V tant bead	C11, C12
2 off 1,000µF	25V electrolytic	C4, C5
3 off 3,300µF	25V electrolytic	C1, C2, C3

Semiconductors

2 off L005	Regulator	IC1, IC2
1 off 7915	Regulator (Technomatic)	IC3
2 off	Bridge rectifier 2 Amp (I.R. 2KBB50)	B1, B2

Switches

4 off s.p.d.t.	Doram type sub min	S1, S2, S11, S12
4 off c/o	Doram type min push	S5, S6–S8
2 off n.c.	Doram type min push	S3, S4
2 off n.o.	Doram type min push	S9, S10
1 off d.p.s.t.	Doram type illuminating rocker switch	S13

Miscellaneous

T1	0–12 0–12V, 25VA winding	
PL2	Mains chassis mounting plug	
3 off 4mm	Socket/terminal post	SK4, SK5, SK6
1 off 16-pin	d.i.l. socket (or other connector)	SK7
1 off	Experimenter 300 Breadboard	
8 off 2mm	Sockets	SK8–SK15
3 off 4mm	Sockets	SK1, SK2, SK3

CONSTRUCTOR'S NOTE

The large sheets of Veroboard can be obtained from **A. Marshall (London) Ltd.** A suitable transformer for T1 can be obtained from **Doram**, order code: 66–150–6, or **RS Components**, order code: 207–251.

Card guides for the CHAMP main board may also be obtained from Doram, order code: 68-337-1.

The breadboard (EXP300) is available from **Continental Specialties Corporation (UK) Ltd.**, Spur Road, North Feltham Trading Estate, TW14 0TJ.

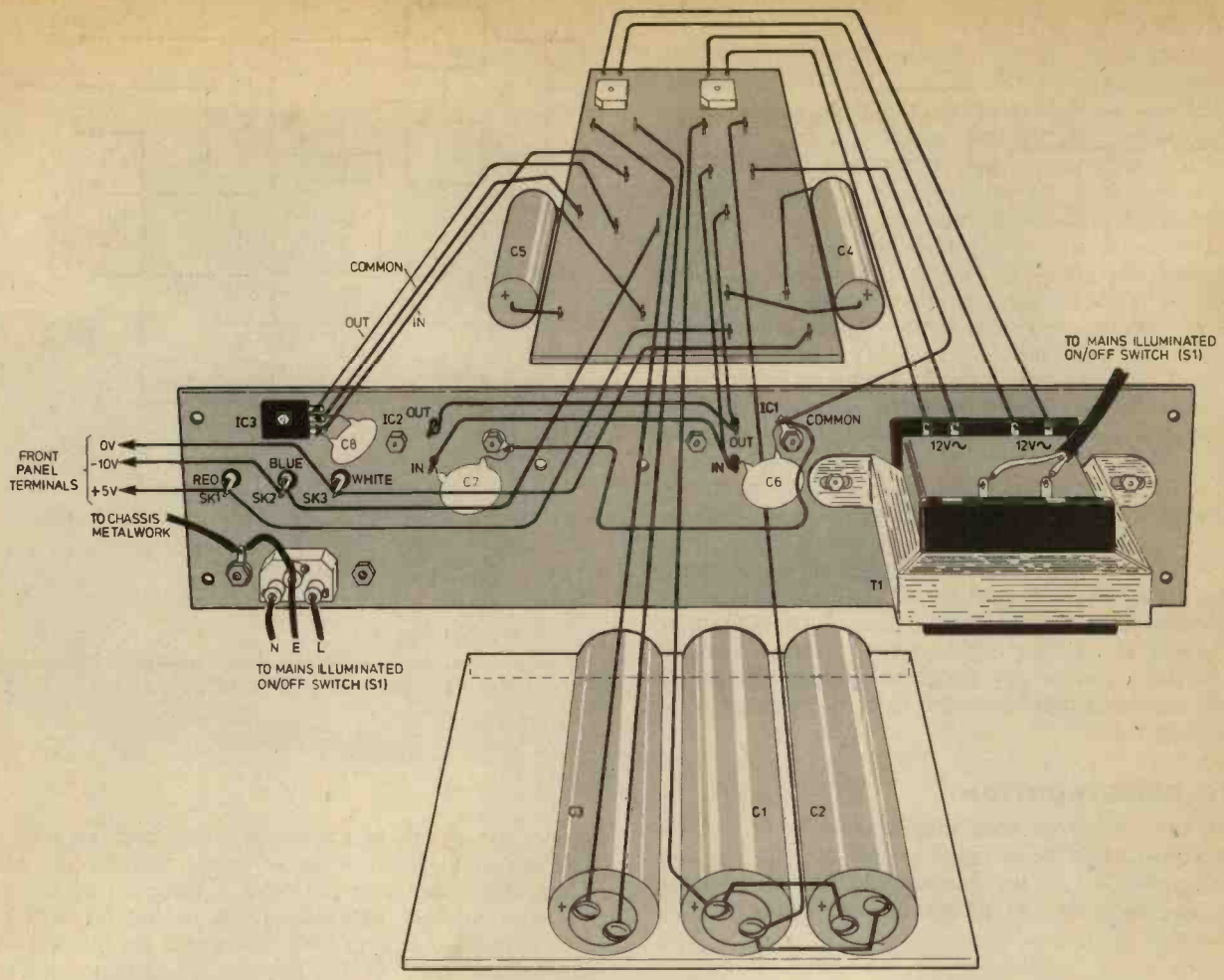


Fig. 4.3. Exploded view and wiring layout of CHAMP power supply. The p.c.b. and the large electrolytic support plate are both mounted on the CHAMP back-plate

and the interwiring are added, is best left to individual preference, but of course, the MOS chips should *not* be plugged into their places until construction is complete, to prevent accidental damage. The last component to be mounted should be the DEAC stack, and in fact it might be wise to add this only after the circuit has been checked with power applied.

The power connections to the board are made via three wander plug terminated flying leads, and these are made with p.v.c. insulated flexible wire soldered to terminal pins inserted in the CHAMP board power bus tracks. Terminal pins are also used to provide the keyboard power, and two are situated adjacent to SK3 for this purpose, wired to +5V and 0V respectively.

The 16-way interconnection jumpers from SK7 to SK8, and from SK1 to the front panel socket can ideally be made up using ribbon cable, and 16-way plugs of the penetrating "no solder" variety such as those made by T & B Ansley, which was the method used in the prototype. The main problem with these components is availability; putting them together was found to be easy even without the special tools made for the purpose, and much more convenient than making soldered connections. An alternative to the ribbon cable system is to use d.i.l. "header plugs" with soldered multiway cable, a more tedious but perfectly sound solution.

POWER SUPPLY CIRCUIT

The CHAMP power supply is designed to provide sufficient current to power the main board, the CHAMP-PROG board, and any reasonable combination of interface circuitry on the breadboard socket. The specification therefore calls for a +5V supply at 1A, and a −10V supply at 750mA. In practice these current specifications have been comfortably exceeded.

The circuit of the power supply module is shown in Fig. 4.2, and as can be seen, the design is fairly conventional, using fixed voltage regulators to set the output potential and provide the necessary high quality regulation. The positive supply uses two L005 devices in parallel to meet the current requirement, but there is no reason why LM309Ks should not be substituted directly if available. The LM309K will also provide a higher current capability if this should be necessary, although to take full advantage of this, the bridge rectifier would have to be changed to a 4 amp unit to prevent overheating.

A negative regulator from the 79' series i.c.s is used to provide −10V but since −10V units are not available, a 15V device (the 7915), is used with its common terminal referenced not to zero volts, but to the +5V output from the L005s.

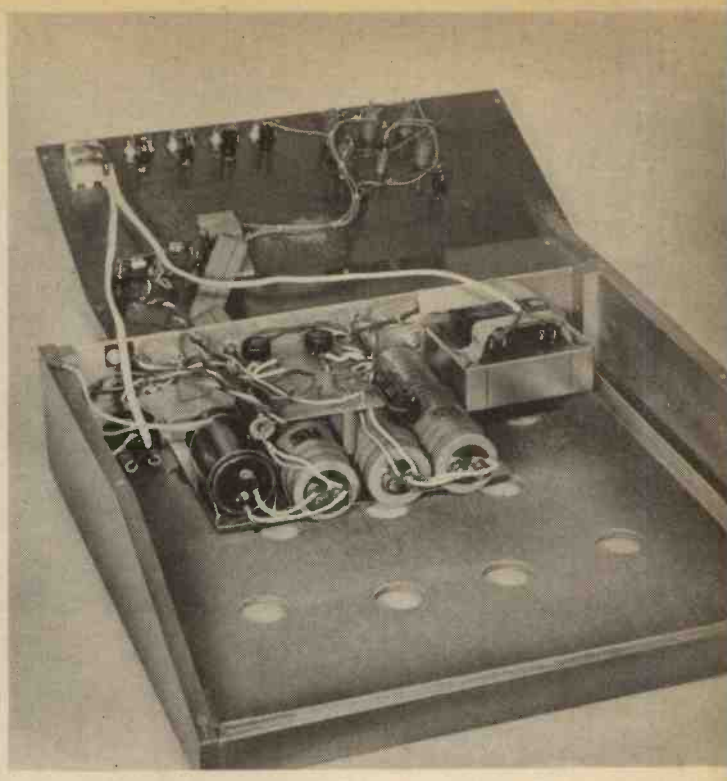
This configuration works well with no compromise of the short circuit protection provided in the regulator.

POWER SUPPLY LAYOUT

The power supply is built as a module which can be tested independently of the other CHAMP components, and which can be removed easily from the plinth as and when necessary. The module uses the aluminium back panel of the plinth as its main structural component and also as a heat sink for the regulators and transformer. The large electrolytic smoothing capacitors are supported by an aluminium tray which rests on the bottom panel of the plinth for stability, and for the sake of neatness, some of the circuit interconnections are provided by a printed circuit board which mounts on a bracket also attached to the back panel.

Figure 4.3 shows the overall arrangement and the connections required, and this should be compared with the photograph of the unit assembled in the plinth. The printed circuit board layout is shown in Fig. 4.4, although 0·15in matrix Veroboard or even pin-board could be used instead if p.c.b. making is not your area of interest.

The only thing to remember when wiring up the unit, is that wire of sufficient diameter to handle the currents involved should be used, and that all terminals conducting mains voltage should be properly insulated. It is of course *essential* that all exterior metalwork be connected to the mains earth to prevent any danger of electric shock, and CHAMP should always be used with a 13 amp plug fitted with a 2 amp fuse.



PLINTH CONSTRUCTION

The plinth design has been simplified as far as possible so that construction is straightforward, but as you can see, the appearance of the finished unit is very pleasing to the eye. Materials and dimensions are given in Figs. 4.5 and 4.6.

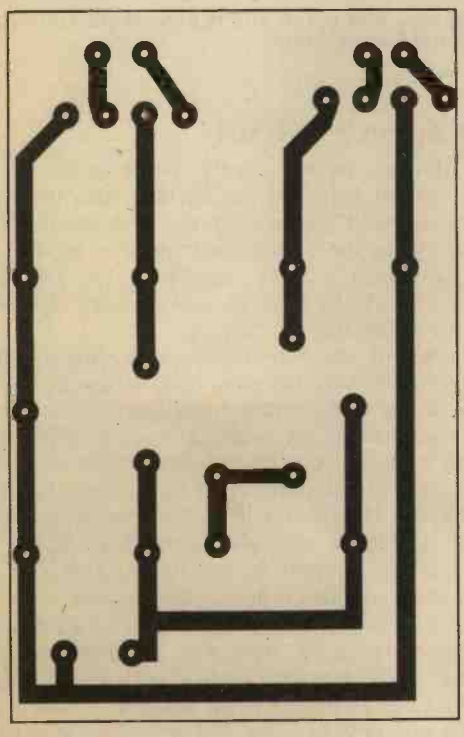
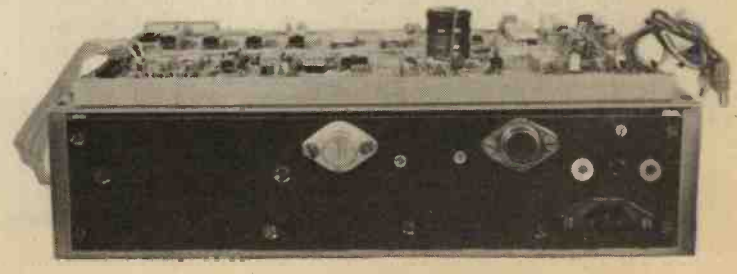


Fig. 4.4. Printed circuit layout of CHAMP power supply, p.c.b.

The first step is to cut the plywood parts to size, and it is important at this stage to ensure that the two plinth side members are identical. This is achieved by clamping the sides together with G clamps, or binding with tape before finally trimming both to size. On the inside bottom edge of the sides, mark a line equivalent to the thickness of the bottom panel, and similarly on the inside rear edge, mark a line equivalent to the thickness of the back panel, and finally, on the front edge draw a line equivalent to the thickness of the front edging strip.

The plywood runners should be cut to fit inside these marks, and then pinned and glued in position with a woodworking adhesive such as Evostick Resin W. If a large illuminated mains on/off rocker switch like the one in the prototype is used, it will probably be necessary to truncate the left-hand plywood runner to provide the necessary clearance for the switch body. The bottom panel, when cut to size, should have a number of air holes drilled in it to allow for convection cooling of the power supply module, whereupon it can be primed and glued to the sides and the front edging strip.

It is a good idea to temporarily attach the aluminium back panel at this stage, so that the plinth is properly aligned while the glue hardens. The aluminium top panel or cover should be carefully cut to size, and all the



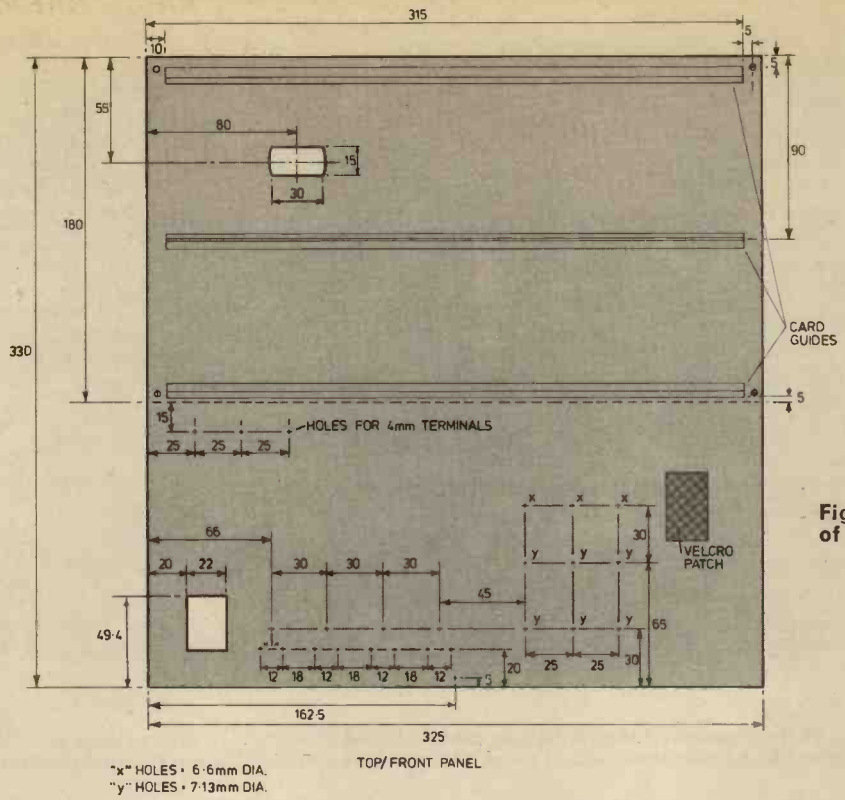


Fig. 4.5. Top/front panel of CHAMP unit

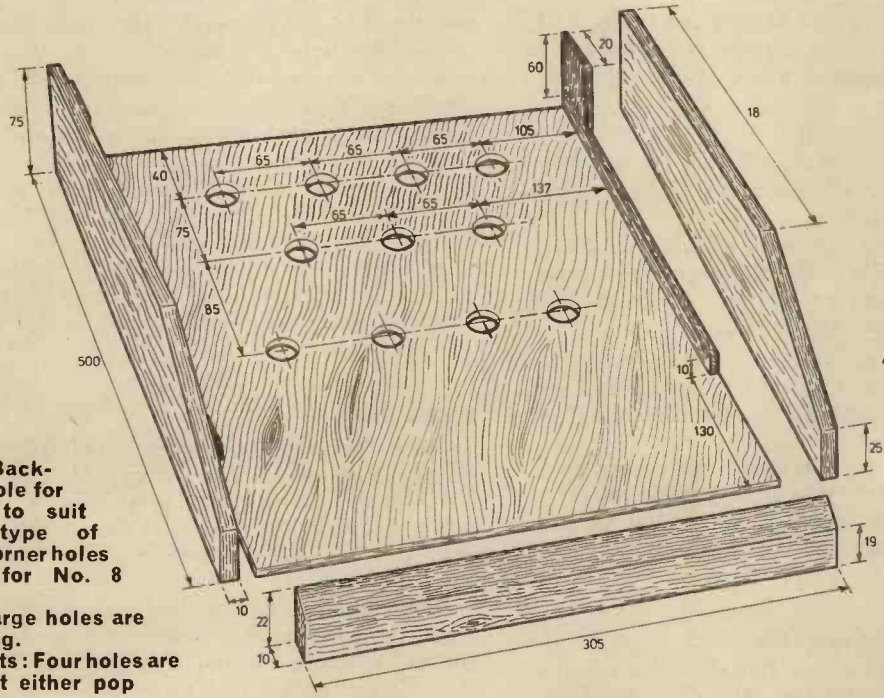
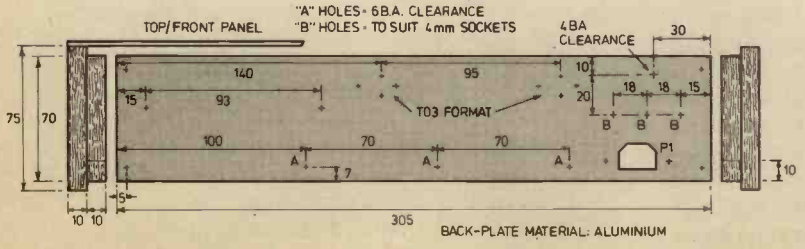
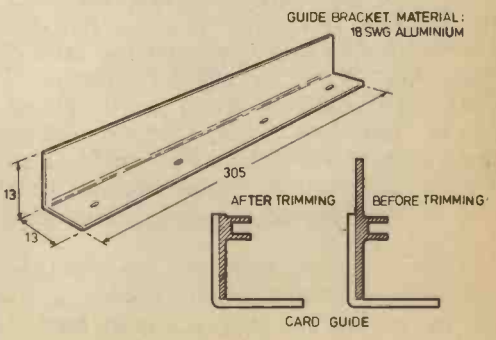


Fig. 4.6. Back-plate: The hole for P1 is cut to suit whichever type of plug used. Corner holes are drilled for No. 8 woodscrews.
Base: The large holes are for air cooling.
Guide brackets: Four holes are drilled to suit either pop rivets or screws





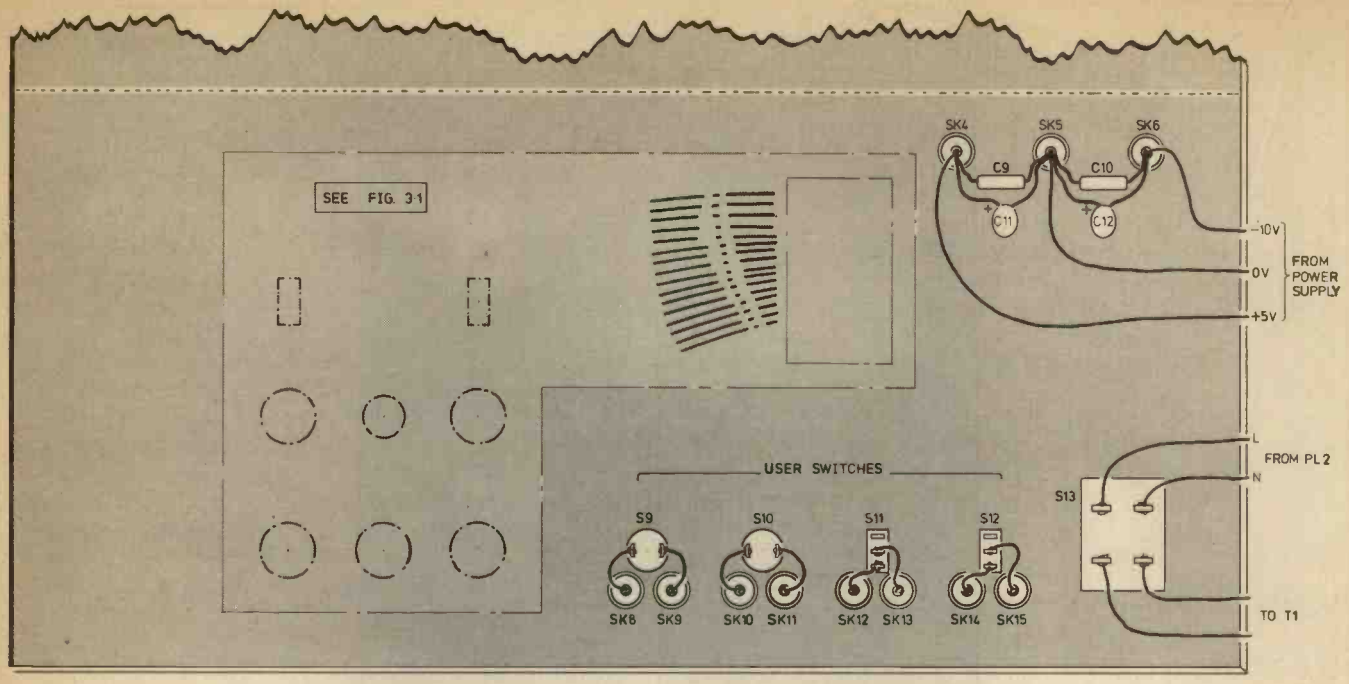


Fig. 4.7. Rear view of front panel wiring. A 16-way connector (d.i.l. socket in the prototype) enables all leads from the CHAMP board to be disconnected at once. Details given match Doram type pushbutton switches

necessary component locating and fixing holes drilled and deburred. The bend in the cover can be produced fairly easily, even without a bending machine, if the following procedure is followed:

(i) Mark the bend line in pencil.
(ii) Clamp the panel to a workbench with the aid of a stout straight edge, with the pencil mark aligned with the straight edge.
(iii) With another stout straight edge press evenly down on the panel, bending it only a few degrees at a time.
(iv) Remove the panel often and check it against the plinth until the desired angle is obtained.

The cover should now be screwed to the plinth and the edges trimmed before the L shaped brackets and card guides are bolted (or pop-riveted) into position (see Fig. 4.6).

It is a good idea to use the CHAMP main board as a jig while finally positioning the card guides prior to fixing, to ensure that the board is not too loose or too tight when assembly is complete.

FINISH

A lot of care was taken over the finish imparted to the CHAMP prototype, and we feel that the results achieved, justify the small amount of extra effort involved. When the "fit" of the plinth components is satisfactory, the cover should be removed and the plywood base given two or three coats of aerosol primer. Allow the primer to dry and sand down to a fine surface between coats. A top coat of a suitable colour can then be applied; in the case of the prototype, a metallic cellulose paint was used, with attractive results.

The cover should be rubbed down all over with wet and dry paper or fine Emery to provide a good "key" for the primer which is applied, and as before, apply two or three coats. A contrasting metallic finish was chosen as the top coat, and several light coats should be applied until a good finish is achieved.

Before the outlines and lettering are applied to the cover, the paint should be allowed at least two days to harden off to prevent damage to the finish. The outlines are first pencilled in with the aid of a soft pencil, then inked over with either drawing ink or a spirit based felt tipped pen. (Do not use a water based ink, or the lines will run when varnish is applied.)

All necessary lettering is applied with Letraset, or a similar dry transfer technique, before the application of a coat of clear polyurethane varnish to give a durable protective finish.

ASSEMBLY

When the plinth is complete, the front panel components can be fitted and wired up as in Fig. 4.7. The use of a 16-pin d.i.l. socket as a termination adds to the modularity of the design, but is not strictly necessary. Terminal pins and soldered connections could be used instead if desired.

The ribbon cable, or loom, from the front panel is taken through the large hole in the cover to appear under the main board, so that it can be unobtrusively mated with the appropriate d.i.l. socket.

The power supply module should be thoroughly tested in isolation before the main board is plugged in, and it is wise to do comprehensive voltage checks on the main board *before* any chips are plugged in. It will not be possible to get CHAMP to run properly at this stage because the keyboard has not been described, and the CHAMP firmware will not be available, but if desired, the clock chip can be plugged in and the clock and reset waveforms checked with an oscilloscope, as can the SYNC pulses emanating from the 4040 CPU chip.

NEXT MONTH: Keyboard design and construction