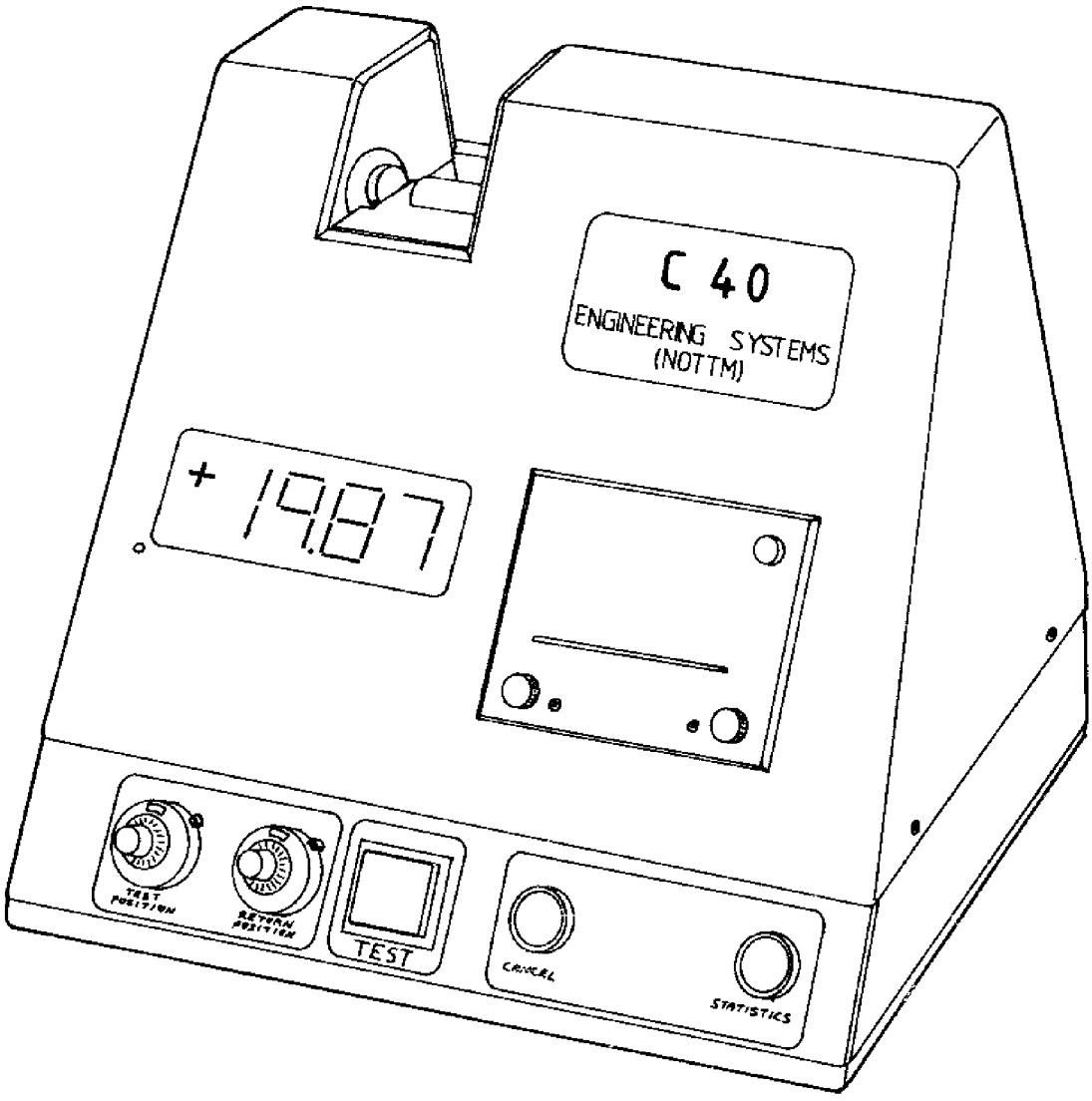
HANDBOOK

C40
TABLET HARDNESS TESTER



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Diagrams and Figures

1. The Machine

1.1 Specification (standard machine)

Maximum load	40 kg
Minimum detectable fracture load	0.2 kg
Resolution	0.01 kg
Readout	0.56" Digital display in kg. with fracture detect and hold (Optional printer)
Analogue output	Voltages proportional to load and displacement
Testing speed	1/8 to 31⅜ mm/min. in ⅛ increments
Fast forward and return speed	50 mm/min
Maximum Tablet diameter	30 mm
Calibration	Weights or internal electronic calibration
Power requirements	220-240V, 50 Hz, 1 amp Selection by or 110-120V, 60 Hz, 2 amp internal switch
Machine dimensions	Height 225 mm, Width 240 mm, Depth 235 mm
Machine weight	9 kg

1.2 Operating mode

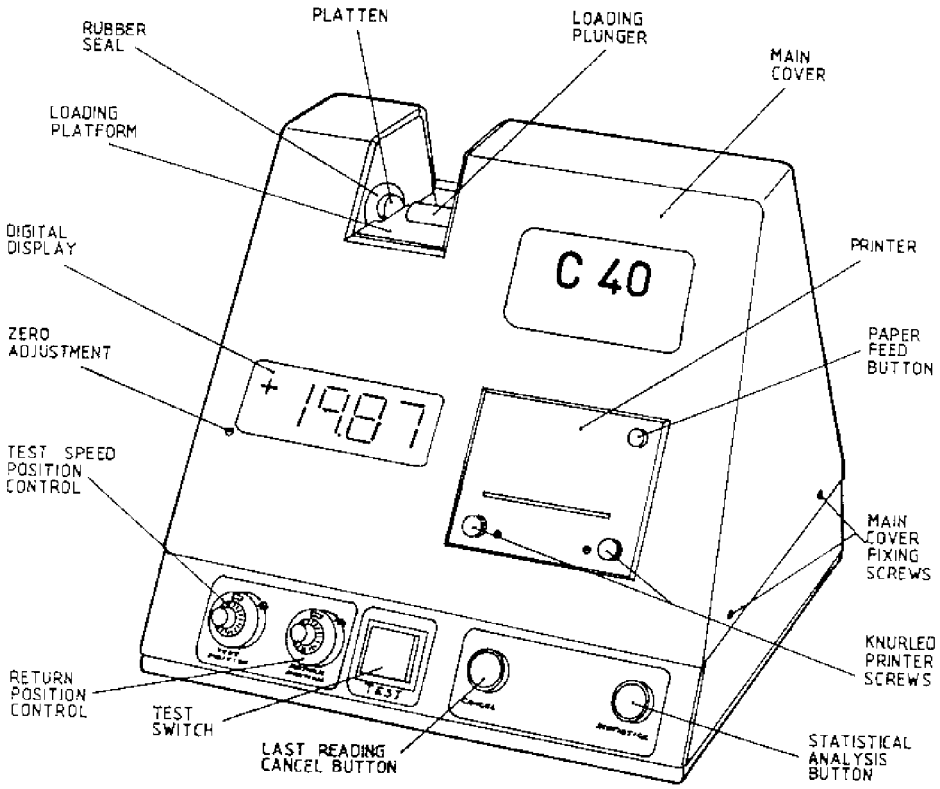
The machine was designed for the compression testing of pharmaceutical tablets, but can also be used for compression testing other small objects e.g. crystals, sweets etc.

In the C40 designation, C denotes compression and 40 is the capacity in kg of the machine fitted with the standard load cell.

1.3 Alternative load ranges

A range of two additional load cells is available for use up to a maximum load of 100 kg, with a sensitivity of 100 g; or a maximum load of 5 kg with a sensitivity of 1 g.

C 40 OPERATING ILLUSTRATION



REAR PANEL

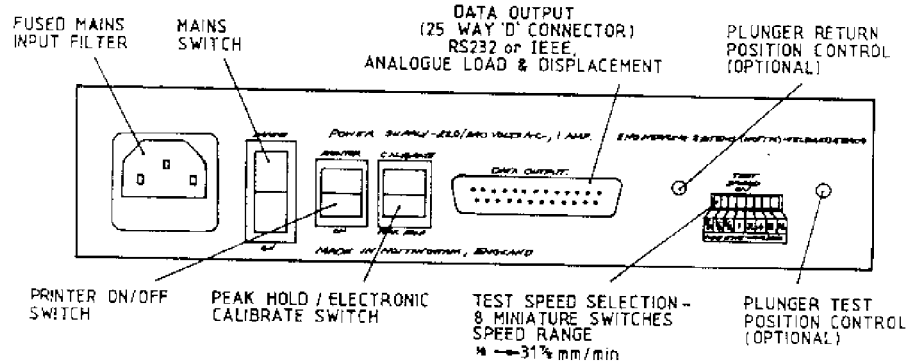


Figure 2

2. Power supply and fuses

2.1 Power connection

The standard machine can be used on 220-240 V, 50 Hz or 110-120 V, 60 Hz power supply. An internal Mains Voltage Setting switch (see figure 5) is set, before leaving the manufacturer, according to the country of destination. The set voltage is indicated on the lower rear back panel. If required the voltage supply can be changed by moving the switch, in which case the above indicated voltage, on the rear panel, should be erased and/or changed and the appropriate fuse inserted.

For convenience a detachable mains lead is supplied. The cable socket is for connection to the chassis plug in the rear of the machine and the square pin plug fitted with a 3A fuse is for connection to the U.K. mains supply.

CAUTION If moving, servicing or otherwise dismantling the machine, first disconnect the mains plug from the mains supply.

Persons qualified to check for electrical faults (i.e. electronic engineers) with the covers removed and mains connected, should note that AC mains voltage is not directly exposed anywhere throughout the wiring: but must beware of the high DC voltage potential of 60 volts supplied by the + and - 30 volt DC lines (pink and black wires) emitting from the power supply board.

Top cover removal will not give direct access to the + & - 30 volt supply and should be safe when making the internal adjustments described in sections 4 and 5.

2.2 Fuses

A mains fuse is also fitted, underneath the mains connector, situated in the rear panel of the machine and if necessary can be replaced by levering out the fuse holder. Use a 20 mm, anti-surge type fuse, 1A for 220-240V and 2A for 110-120V supplies.

Three fuses are also fitted on the D.C. power supply board, this is located underneath the base plate. To gain access remove the bottom cover (4 fixing screws) and see Fig. 4, (component layout). These fuses are 2 @ 1.6A and 1 @ 2A, each 20 mm, anti-surge types.

3. Operation

The C40 has been designed for simplicity of operation on the factory floor, once set for a particular tablet size, the machine is operated by the load switch situated on the bottom front panel.

Most machines have the position control potentiometers mounted on the front panel, adjacent to the load switch. The controls are 3 turn dial mechanisms. Some machines have been modified by re-siting these potentiometers onto the rear panel so that they are less accessable and more tamper proof.

3.1 Mains Switch

The digital display will illuminate when the rear mounted mains switch is on. If the peak hold switch is on when the machine is first switched on, an arbitrary reading will probably be shown on the digital display, this can be cleared by switching the peak hold switch off and on.

It is recommended that the machine be switched on at least 10 minutes before use to allow the measuring circuitry time to warm up.

3.2 Zero adjustment

This is located in a small hole situated at the bottom left of the digital display. This adjusts the starting point on the digital display which should read zero after the warming up period. If the display does not read zero, set the peak hold/calibrate switch to its central position, insert a trim tool into the hole and turn until the display is zeroed.

3.3 Load switch (yellow)

Situated on the front panel, when pressed this switch electronically latches on and starts the motor which drives the loading plunger. The plunger is driven in the sequence fast forward, test speed, fast return speed, stop. The automatic cut out and return will operate if the maximum load and/or travel is exceeded.

3.4 Loading plunger position controls

Screwdriver adjustments situated on the rear panel, or, 3 turn dials situated on the front panel to the left of the load switch.

3.4.1 Return position

Sets the gap between the jaws when the return cycle has been completed. Turning the knob clockwise increases the gap by approximately 10mm/turn.

3.4.2 Test position

Sets the position at which fast forward speed changes to test speed. Turning the knob clockwise decreases the gap or diameter to be tested at test speed; again 10 mm = 1 turn.

3.5 Statistics operation (if fitted)

3.5.1 Cancel

Pressing the red button situated adjacent and to the right of the load switch cancels the last recorded sample reading.

3.5.2. Statistics

Pressing the green button gives a print out of the statistical data and the time and date. See section 5.2.

3.6 Test speed

Test speed (rear panel) is set by the appropriate combination of switches in the 8 gang switch, the switch setting is additive. Any speed between ½ and 31½ mm/min may be set in ½ mm/min steps.

3.6.1 Test speed range adjustment

Test speed can be checked by using a stopwatch and a rule or a dial indicator to measure the plunger movement in unit time.

If the measured speed does not match the set test speed, adjustment is provided on the speed selector board, see Fig 13.

3.7 Testing

CAUTION:- Some materials may fragment during testing, use the perspex shield, which is fitted to the debris collection tray, to protect the user from flying fragments.

If the gap between the loading faces is not large enough to accommodate the tablet, turn the rear mounted return potentiometer anti-clockwise (1 turn = 1.5 mm) or the front mounted potentiometer clockwise (1 turn = 10 mm). With the peak hold switch set to peak hold, switch the load switch to on and simulate a fracture detect by pressing and releasing the loading jaw, whence the plunger will return to its new position. For convenience turn off the printer (if fitted).

Set the test speed to zero and press the load button, if the plunger moves forward further than the diameter of the tablet to be tested adjust the test position potentiometer (same operation as the return potentiometers described above) more than the required no. of turns to create a large enough tablet gap. Again simulate a fracture detect to allow the plunger to return to its pre-set position. Place the tablet onto the loading platform and press the load button, the plunger should stop short of the tablet. Gradually turn the test position potentiometer until the plunger has moved close to the tablet, switch in the required test speed; the tablet will now be tested, the fracture load displayed and the crosshead returned to its pre-set position ready for testing.

The remains of some tablet formulations may partially adhere to the loading anvils: erroneous results are possible if these deposits are not removed before further testing. A hard toothbrush is ideal, and recommended, for clearing the tablet remains from the loading area into the rear mounted debris collection tray.

When the peak and hold facility is switched on, the digital readout will follow the increasing load but will not fall when the specimen fractures. The maximum load reading is held and printed; or can be manually recorded. If complete failure has not occurred and the test is continued, it is possible that the previous peak reading will be exceeded; the display will then follow and hold the new peak reading. For convenience of operation during a series of tests the peak reading is held when the loading cycle ends and automatically reset to zero when the motor is restarted. Alternatively the peak and hold facility can be reset by switching the peak and hold switch off and on again.

The electronic circuit which holds the peak reading is only stable for a limited period of time and the displayed peak reading may fall 1 digit every 30 seconds after the completion of a test.

4. **Internal Adjustments**

The majority of the internal adjustments are multi-turn potentiometers located on the analogue board and accessible from the front of the display board.

Before removing the outer cover(s) see **CAUTION** under 2.1

To gain access to the internal adjustments the top cover has to be removed. First remove the debris tray. If a printer is fitted, this must be removed otherwise damage, to the printer, will occur. Unscrew the two lower knurled printer screws and carefully ease the printer from its recess, care must be taken not to damage any of the components situated near the top rear of the printer. Pull the printer clear of the top cover and disconnect the flying lead connector. The top cover can now be removed by extracting the four fixing screws (two either side) and lifting the case upwards.

Adjustments, using a trim tool of the 20 turn potentiometers 2, 3, 4, 5 and 6 may be carried out by competent persons. Potentiometer 7 should not be adjusted.

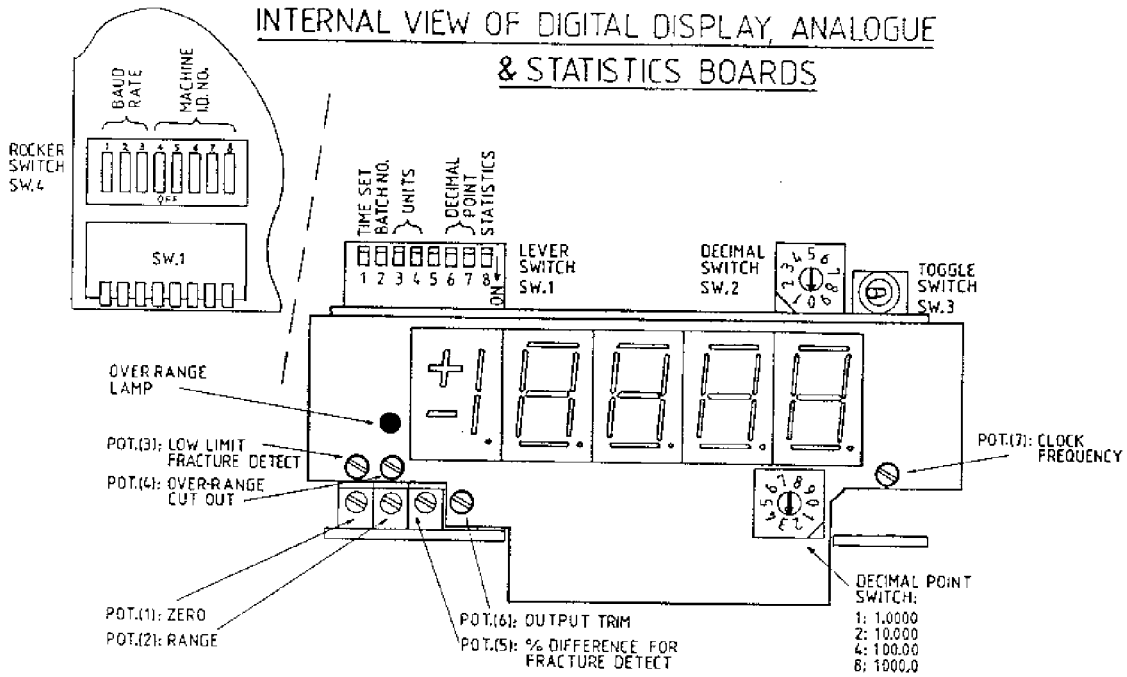


Figure 3.

4.1 **Calibrate (or range), Pot 2.**

Calibration is carried out initially by dead weight loading of the loading anvil.

4.1.1 **Calibration by dead weight loading**

Switch the Peak Hold/Calibrate switch to its central position. Turn the machine to rest on its left hand side and with the top surface near the edge of a suitable bench. For accurate calibration, the load cell platten should be horizontal. A suitable piece of packing should be inserted under the top edge of the case.

Zero will change due to the change in orientation of load cell weight, re-zero the machine at this stage. Using a suitably shaped hanger (can be supplied by Engineering Systems, part No. ES WH 1Kg.) and set of weights (up to 20 kg) load the machine via the loading anvil. If the applied load is equal to the load indicated on the digital display, the machine is correctly calibrated.

If the calibration is in error, remove the top cover from the machine and repeat the above process adjusting pot 2 (Fig. 3) until the load indicated on the digital display corresponds to the value of the applied weights. Remove the weights, the display should read zero, if in error, re-zero and again load the anvil with weights and re-adjust the range. Repeat this procedure until the display reads correctly with and without the weights. Replace the top cover and re-zero when the machine is in its normal position (i.e. horizontal).

4.1.2 **Electronic calibration**

Switching the peak hold/calibrate switch to the calibrate position connects a high stability resistor into the load cell circuit and gives an apparent load reading on the digital display.

When calibration by dead weight loading has been completed (Weights removed) the calibrate switch should be depressed and the value of the readout noted.

Future calibration can be carried out by using the calibrate switch; the digital readout should correspond to the value of the readout noted above. Calibration using dead weight loading should also be carried out from time to time.

4.1.3 **Decimal Point**

The decimal point position on the digital display is changed by moving the pointer (with a small screwdriver or trim tool) on the lower decimal switch to give the correct decimal point position. Movement of the printer decimal point is described in section 5.3.1.4.

4.2 **Over-range cut out. Pot 4.**

Set the over-range value onto the digital display by switching on the calibrate switch and adjusting the zero potentiometer until the correct over-range value is displayed. Adjust pot 4. so that the small over-range lamp, situated to the left of the digital display, just illuminates. Release the calibrate switch and re-zero.

4.3 **Output trim, Pot. 6**

This adjusts the load cell analogue output voltage to match that shown on the digital display. This should be checked before attempting any further adjustments. A voltmeter, set to read 10 volts DC maximum, should be connected to the load cell analogue output, Pins No. 1 and 9, low and high respectively on the 25 way 'D' type connector situated at the rear. (An adaptor, to give 4mm output sockets, is available from Engineering Systems. Part No. ES ADPT.) Zero if necessary (described in 3.2), set the Peak hold/Calibrate switch to calibrate, the digital display on the C40 should read the same as the reading shown on the voltmeter. If, in error, turn pot 6. until the readings match.

4.4 **Low limit fracture detect suppression, Pot 3.**
(see also section 4.6)

The % fracture detect facility will not operate satisfactorily at very small loads i.e. a fracture would always be detected at zero load and the machine would fail to start. The low limit cutout presets a load below which the motor will not be stopped if an apparent fracture is detected. False fractures may be detected if the setting is too low and some experimentation may be necessary to determine a satisfactory level for the minimum setting. A suggested setting for the standard 40 kg machine is 0.30 kg.

Checking the low limit setting. With the peak hold switch on, press the load on switch. Apply, by hand, a small load, i.e. 0.10 kg to the loading anvil and allow the load to return to zero. Repeat this procedure a number of times, gradually increasing the load until the motor stops. The low limit load will be displayed on the digital display.

Adjusting the low limit setting. Turning pot. (3) clockwise decreases the minimum load.

4.5 **% Difference for fracture detect Pot 5.**
(see also section 4.6)

Fracture is detected and the crosshead motor is stopped when the instantaneous load measured by the loading anvil falls below a preset % of the maximum load (i.e. the peak held load) attained during testing. The fracture detect pot 5. can be adjusted to give any fracture detect % up to 100%. (Typically 60%-70%).

Checking the % setting. Connect a digital voltmeter set to read up to 10 volts D.C., into the load cell output terminals, as described in 4.3.

With the peak hold switch on, press the load on switch: slowly depress the loading anvil by hand to obtain a reading of say 2 kg, gradually release the pressure on the anvil until the motor stops. At this point (and without further releasing the load on the lower platten) note the reading displayed on the external digital voltmeter. Comparison of the peak held load and the digital voltmeter readings gives the % fracture detect setting.

Note: some practice may be required before consistent percentages are obtained.

Adjusting the % setting. Turning pot 5. clockwise decreases the % setting.

4.6 Further consideration of the % fracture detect and low limit settings.
(see also section 4.4 and 4.5)

The following graph shows the relationship between Low Limit load, % Fracture Detect, Peak Hold load, Test Load, Load Cell Load and Fracture point during a typical test. (Time is proportional to test speed.)

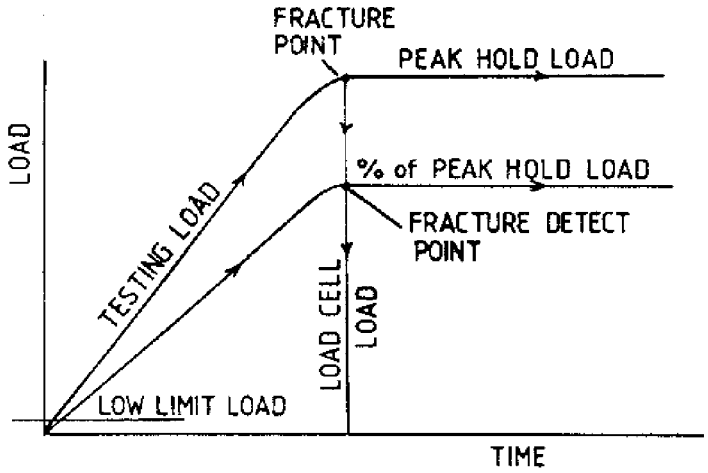


Figure 4

On loading the peak held load follows the load cell load up to the point of fracture, at this point the load cell load drops to zero (unless the test object is spongy or crumbly) and the peak held load remains constant. Fracture is detected by the electronic circuitry when the load cell load crosses the % peak hold load line (or setting). The usual % setting for this 'line' is 60-70% but the material properties of some test objects may demand a revised setting before meaningfull test results can be obtained.

Soft crumbly objects may require a lower % setting because the testing load may drop momentarally (causing a fracture detect) during loading, due to localised surface crumbling prior to the object fracturing or substantially failing. Some experimentation will be required to obtain a satisfactory % setting for these 'difficult' materials. A fracture may not be detected at all if too low a % setting is used, the test object may just be gradually crushed into a powder. Different platten geometries i.e. convex, may have to be considered.

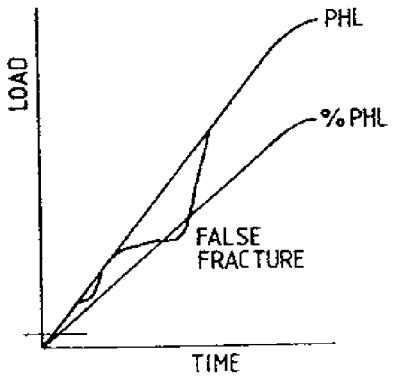


Figure 5

Hard objects in compression may fracture but leave ½ of the fractured test object in the test position between the loading plattens. If the % setting is too low a fracture will not be detected. If the setting is too high, small departures of the load cell load from the peak held load (especially at the start of a test, see 4.4) will give a fracture detect and the test will be halted.

5. Printer (if fitted)

The printer automatically prints the tablet hardness at fracture, as indicated on the digital display. A tablet identification number precedes each hardness reading. The maximum identification count is 99. If the statistics pack is not fitted, before testing a new batch of tablets set the printer to start counting at 1., by interrupting the power supply to the machine, i.e. switch the mains supply off and on again. See below.

IMPORTANT Wait at least 10 seconds before switching the mains ON after switching OFF otherwise the microprocessor controlled printer may receive erroneous signals and incorrect operation and irreparable damage to the printer mechanism may result.

The printer ON/OFF switch inhibits the printer from printing but will not re-set the identification count and the drive electronics will continue counting when receiving fracture detect signals even with this switch OFF.

5.1 Changing the paper roll and cartridge ribbon (Fig. 6)

Before removing or replacing the printer, the mains supply must be switched OFF otherwise the printer electronics may be damaged. Remove the printer with care, as described in section 4.

The printer mechanism is the EPSON M150 unit, spare paper rolls and spare ribbon cartridges should be available worldwide. If in difficulty contact Engineering Systems.

5.1.1 Paper loading

Use only 44.5 mm wood free, high quality paper; maximum diameter 50 mm, internal diameter 13 mm.

IMPORTANT NOTICE:

Take care that paper changing is not carried out in areas subject to static. Touching the connector contacts, etc. of the printer under very adverse conditions could cause damage to it.

Turn printer over and remove paper pivot bar (2) by unscrewing a third knurled thumbscrew (taking care not to lose nylon washer) and withdrawing paper pivot bar. Remove any old paper, tube and discard.

Prepare a fresh roll of paper by cutting a shallow "arrow head" at its start. Place roll in paper holder region and insert paper pivot through centre, as shown in Fig. 6. Fasten paper pivot with knurled thumbscrew and nylon washer (finger tight only). Straighten first 20 mm paper over paper guide (3) and insert into printer, correctly centred. Push in as far as it will go.

5.1.2 **Ribbon cartridge replacement**

After approx. 10 paper rolls have been used, the ribbon cartridge will need replacement. Remove the printer from the C40 as described above but it is not necessary to remove paper.

Unscrew two pozidrive screws (4) and washers on printer front panel. Remove panel exposing printer mechanism, the ribbon cartridge (5) will now be clearly visible. Taking note of ribbon and paper arrangement, depress cartridge where indicated. Cartridge will tip up and may then be removed and discarded. Insert replacement cartridge, tensioning ribbon if necessary by turning knurled wheel on cartridge in direction indicated. Replace front panel.

Switch ON and depress FEED button (1) when printer will start to feed paper. Check that paper emerges correctly from aperture. The unit is now ready for use.

PAPER AND RIBBON REPLACEMENT

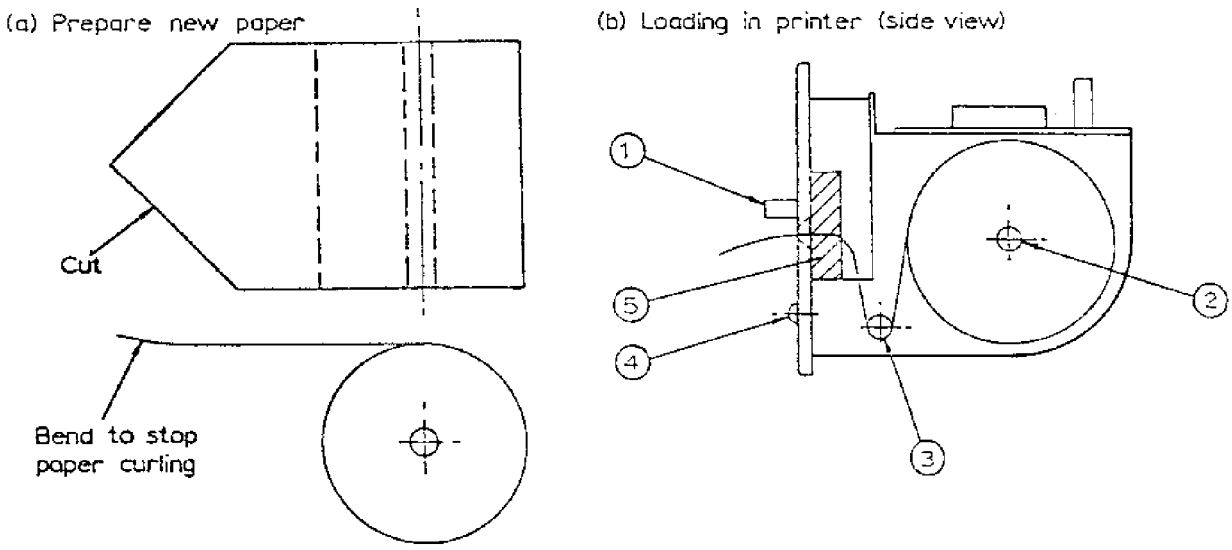


Figure 6

5.2 Description of the statistical package

This optional addition to the C40/CT40 range of testing machines enables the integral printer to automatically print statistical information from batches of tests in an easy to read form which includes the Date and Time.
A typical printout is:-

```
BATCH NO.

.

MACHINE NO. 15
MON 02-03-1987
TIME  14:30
MEAN     = 03.07
STD.DEV  = 00.65
MAXIMUM  = 04.12
MINIMUM  = 01.98
UNITS:KILOGRAMME

   07  03.02
   06  02.87
   05  03.42
   CANCEL 05
   05  00.03
   04  02.84
   03  04.12
   02  01.98
   01  03.26
```

Batch No. A reminder for the operator to write the BATCH NO. on the print out. This print out can be inhibited.
Machine No. - a useful identification facility where there are a number of testing machines within a factory. Can be set to print any number up to 31, a zero setting inhibits the Machine No. printout.
Date and Time - an internal battery with a life of approx. 10 years enables the internal clock to continue to update the date and time when the machine is switched off. A time change facility is provided; in the event of BST or time drift over a period, the time can be reset.
Statistics printout etc. is enabled by the operator pressing a button (membrane switch) located on the front of the machine, this button is not easy to press accidentally.
Units can be changed to read either:- NEWTONS, KILOGRAMME, KILO POND or STRONG COBB. The calibration must also be changed to suit.
Sample data is printed automatically, preceded by an identification No., when a fracture is detected by the machine.
Cancel The last reading can be cancelled, the next reading takes the No. of the cancelled reading.
Data can be output via. the RS232 output socket located at the rear of the machine. The option exists to output (at the end of the day) the day's data readings to a suitable hand held, data capture type computer.

5.3 Operating instructions for the statistical package

When the machine is delivered the package is ready for use without any adjustment. However, various options and adjustments are incorporated into the statistics board. This board is located just above the digital display (see Fig. 3) and before any adjustments can be made the top cover has to be removed (see section 4). Figure 3 shows the position of the adjusting switches which are designated the following no's and names:-

SW1. 8 way lever switch (left hand side)
SW2. Decimal switch (right of centre)
SW3. Biased toggle switch (right hand side)
SW4. 8 way rocker switch (not visible but immediately to the rear of switch 1)

The adjustments which can be carried out are:-

Resetting the clock	SW1, SW2, SW3
Batch No.	SW1
Units.	SW1
Decimal point position.	SW1
Statistics and clock disable.	SW1
Baud Rate.	SW4
Machine identification.	SW4

5.3.1 Lever Switch No.1

This lever switch is clearly visible and positioned just above the + sign on the digital display.
The levers are UP for OFF, and DOWN for ON.

5.3.1.1 Time set enable

Position 1. ON, (down) enables the clock time to be reset or changed.

5.3.1.2 Batch no.

Position 2. ON, gives a print of Batch no. and two line feeds at the start of a new batch.

5.3.1.3 Units

The units are selected using positions 3 and 4

Pos. 3	Pos. 4	Units
0	0	Kilogramme
0 (UP)	1 (DOWN)	Newton
1	0	Kilopond
1	1	Strong Cobb

Note :- the switch setting only changes the print out, the machine has to be re-calibrated to match the print out. See section 4.1

5.3.1.4 Decimal point position

This is set by positions no 6 and 7 and only changes the decimal point position on the printer print-out. The D.P. position on the digital display is changed using the lower decimal point decimal switch, Fig 3., see section 4.1.3.

Pos. 6	Pos. 7	Decimal point position
0	0	0000.
0	1	000.0
1	0	00.00
1	1	0.000

5.3.1.5 Statistics and clock disable

Position 8 disables the statistics, i.e. to enable the statistics package to work, the switch must be down (ON). If the statistics are disabled, the printout is reset to zero by switching the mains switch OFF, then ON.

IMPORTANT - leave an interval of 10 seconds before re-switching ON.

5.3.2 **Rocker Switch No.4**

This rocker switch is situated behind the lever switch (5.3.1) and can be accessed when the display and statistics boards are removed from their housing. The switches can also be reached with a small bent rod; if changes are to be made using this method the machine should be switched off, as the changed switch position will not be recognised until the machine is initilised by switching on, from the off position.
OFF, on this switch, is with the rocker down at the front.

5.3.2.1 **Baud Rate**

If required the Baud rate is variable from 75 to 9600 Baud; but, if the baud rate is changed, the printer baud rate also has to be changed. The printer is limited to 4 baud rates :- 300, 600, 1200 or 2400. The printer baud rate change is by soldered connections on the printer connector, refer to the printer manual (supplied separately) for details.
The baud rate is changed on the statistics board by setting switch positions 1, 2 and 3 on rocker switch no.4.

Pos.1	Pos.2	Pos.3	Baud Rate
0	0	0	75
0	0	1	150
0	1	0	300
0	1	1	600
1	0	0	1200
1	0	1	2400
1	1	0	4800
1	1	1	9600

The printer is set to work at 2400 baud, therefore for normal operation positions 1, 2 and 3 on rocker switch 4 should be set to ON, OFF, ON respectively.

5.3.2.2 **Machine identification number**

Machine identification numbers between 1 and 31 can be selected using positions 4 - 8 of rocker switch no.4. If all these switches are set to zero then MACHINE NO. is omitted.

Pos.4	Pos.5	Pos.6	Pos.7	Pos.8	Machine no.
0	0	0	0	1	1
0	0	0	1	0	2
1	1	1	1	0	30
1	1	1	1	1	31

5.3.3 Setting and resetting the clock

After the top cover (main box) has been removed reconnect the printer so that the printer rests on the bench top just in front of the machine
IMPORTANT NOTE - The machine must *always* be switched OFF when the printer is either being connected OR disconnected. Damage to the printer may result if this precaution is not observed.
When position 1, switch 1, is ON, (down) the clock can be reset.
This switch must be switched OFF (up) for normal operation.
The clock does not update the time whilst in the reset mode, resetting position 1 (to OFF) on the lever switch re-starts the clock.
When the above switch is ON the clock can be reset using Decimal switch (SW3) and Toggle switch (SW2) which are both situated above the least significant digit (right hand display digit).

The sequence of setting the clock is :-

Minutes, 10's Minutes;
Hours, 10's Hours (24 hr. clock);
Day (1=Mon, ... 7=Sun);
Date, 10's Date;
Month(1=Jan), 10's Month;
Year, 10's Years.

These are set in order and the minutes can be changed without having to change the hours etc. (but the minutes have to be set before the hours can be set). To change the time; set position 1, switch 1 to ON (down), the printer will now print out the current time and date. Set the decimal switch (SW2) to the units of minutes and switch the toggle switch (SW3) to the left. The printer now prints the new time. If further resetting of time is required, wait until the printer has stopped printing and continue the sequence, setting the decimal switch to the ten's of minutes and repeat switching the toggle switch etc. The clock setting procedure can be terminated at any time by switching position 1 (switch 1) OFF. A continuation will enable the setting of the Hours, Day's etc.

e.g. The clock is to be completely reset to:- 2.30pm, Monday 2nd March 1987
The best way to avoid making a mistake is to write out the numerical data in reverse i.e.

1987	March	2nd	Monday	24hr time	Minutes
87	03	02	1	14	30

The data string is presented to the clock in order, starting with 0, followed by 3 then 4 etc. and toggling each value into the clock after printing has stopped.

If it had only been required to change the minutes; set 0 and 3 (or whatever value of minutes is required) and toggle each into the clock then switch position 1 to OFF (up).

6. Rear Panel Outputs

The 25 way D type connector provides the analogue output of load and displacement and, if fitted, the RS232 compatible output generated by the printer/statistics interface board.

Separate instructions will be supplied if the IEEE-488 interface is fitted.

Analogue load output is given at pins 1 and 9, Low & High respectively

Analogue Displacement is given at pins 1 and 10, Low & High respectively

RS232 compatible out. is given at pins 7 and 2. (7 is ground)
RS232 input, is on pin 3.

The remaining pins on the 25 way connector are not connected.
Correct polarity of externally connected equipment must be observed.

6.1 Analogue Load Output

This is discussed in section 4.3. This output can be used to drive a variety of external recording devices, i.e. pen recorders, A-D converters fitted to P.C's etc. This output is independent of the peak-hold switch, i.e. this output follows the value of load applied to the loading anvil and will fall to zero on completion of a test.

6.2 Analogue Displacement Output

This output is not internally adjustable and a voltage proportional to the position of the plunger is given, within the range 0-12 volts. When the plunger is fully out i.e. minimum jaw gap, 0 volts is given, When fully retracted i.e. approx. 31mm gap, 12 volts is given at pin 10.

6.3 RS232 Data

This is transmitted only when a fracture is detected or the statistics information is being printed. Pin 2 is used for data out and pin 7 is the corresponding ground pin. The data is transmitted in the format:-
1 Start bit, 7 Data bits, 2 Stop bits, at the rate of 2400 bits/sec.
(see section 5.3.2.1). A line feed only (no carriage return) is given at the end of each line.

6.4 Data capture with external equipment

For machines fitted with EPROM 1A, data appears at the RS232 output at the same time that it is printed on the printer, the batch data is removed from the internal memory (RAM) each time the statistics are printed.

Machines fitted with Eprom 1B will store data until the internal RAM is full and then overwright the oldest data. The stored data can be removed by using a hand held computer such as the PSION ORGANISER II. This data can then be passed on to a mainframe or personal computer for storage and/or further manipulation.

Statistical Process Control (SPC) can also be carried out by the hand held computer if it is left permanently connected to the C40

7. Changing the Load Cell and Rubber Seal

Tools required:- Medium size Pozidrive screwdriver, Combination pliers, 3 mm and 5mm Hexagon Keys.

Remove the top cover as described in section 4.

With reference to COMPONENT PARTS (Fig. 7) disconnect the Potentiometer, Motor, Load Cell and Ground plugs.

While supporting the Load Frame by hand, unscrew the four load Frame Mounting Screws (3mm Hex. Key) and lift the complete Load frame assembly upwards and clear of the remaining machine.

Remove the Load Plate Fixing Screws (5mm Hex. Key) and slide the Load Plate away from the assembly.

Unscrew the Loading Anvil by loosening with pliers, then unscrewing by hand.

Unscrew the two Load Cell Fixing Screws (5mm Hex. key) and remove the load cell taking care not to damage the Rubber Seal.

If the Rubber Seal is damaged, pick out the remains with a dental probe or similar, and replace.

When replacing the Load Cell care is again required not to damage the Rubber Seal. Before finally tightening the Load Cell Retaining Screws check for centrality relative to the rubber seal i.e. the rubber seal should not look distorted, if necessary adjust the position of the Load Cell (within the fixing screw hole clearance) before finally tightening the screws.

Assemble the remaining parts in the reverse order remembering to connect all 3 plugs.

Calibrate as described in section 4.1.1 and set the over-range cut out value (section 4.2) to match the maximum load rating of the new Load Cell. If necessary change the position of the decimal point on both the Digital Display and Printer, see Figure 3.

7.1 Plunger Felt Seal replacement

This felt seal stops grit etc. entering the plunger operating mechanism and should be changed every 2-3 years depending on usage. The seals are located behind the Felt Seal Housing Plate which can be removed when the Load Plate (see above) has been removed.

8. COMPONENT PARTS

The following component layout (Fig. 7) and circuit diagrams (Figs. 10 - 13) show only the major parts. Small items such as individual screws etc. are not listed.

8.1 ELECTRONIC BOARDS FITTED

There are 7 boards fitted to the C40 machines, these boards are identified by a name and number. The name is self explanatry, the number is composed as follows:-

ESB stands for Engineering Systems Board
The NO. eg. 16, is the numerical order of the original Engineering Systems Board design.
The LETTER, eg, A, is the current update mark.
The Numbers, eg. 8506 give the date on which the board was designed or last updated. i.e. Week 6, 1985

Speed & Position Control	ESB 16A 8506
Motor Control	ESB 14D 8708
Power Supply	ESB 17A 8704
Analogue	ESB 6F 8724C
Digital Display	ESB 6e 8429
Connector for ESB 6F to ESB 22	ESB 23 8709
Statistics + RS232 & Printer	ESB 22 8704 Issue C

In addition there is an EPROM situated on ESB 22

EPROM	ESE 1A 8709

The torroidal transformer which is is fitted is designed and manufactured to Engineering Systems specifications. Torroidal transformers are more efficient, smaller and most important, give less electromagnetic interference than a conventional transformer. The penalty is a higher unit cost.

Torroidal Transformer	3A792P

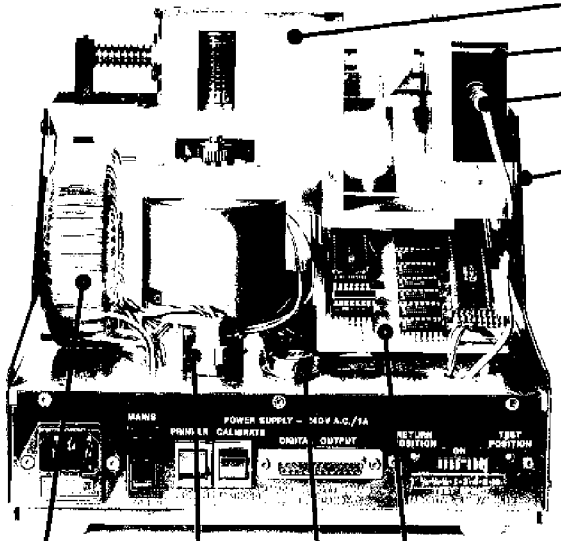
8.2 SERIAL NUMBER

The serial no. is to be found on the top side of the base plate underneath the printer cavity. This number should be quoted in any correspondence regarding the machine.

Serial No. .....

COMPONENT PARTS

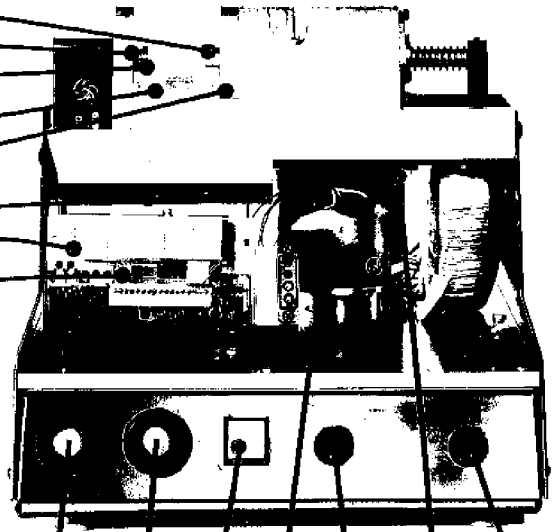
REAR VIEW



Load Frame
Load Cell
Load Cell Plug
Load Frame Mounting Screws
Loading Plate Fixing Screws
Digital Display (ESB6e 8429) and Analogue board ESB 6F 8724C

Potentiometer & Motor Plugs
Printer interface & RS232 Board (ESB 22 8704)
Toroidal Transformer (3A792P)
Motor Amplifier PA 73

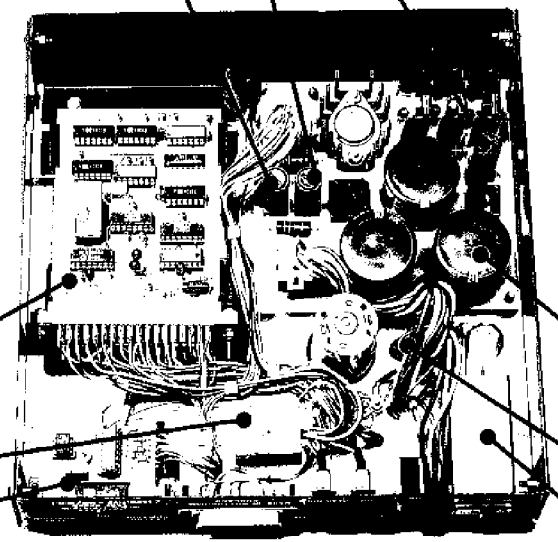
FRONT VIEW



Plunger
Rubber Seal
Loading Anvil
Loading Plate
Felt Seal
Housing Plate
Over-range lamp

Test Position
Load Switch
Cancel Button
Statistics Button
Return Position
Drive Motor & Tacho Unit
Linear Potentiometer

Fuses, 20 mm Anti-surge
1.6A 1.6A 2.5A



Motor Control board (ESB 14D 8704)
Motor amplifier socket (ESB 18)
Speed and Position Control board (ESB16a 8506
Power Supply board (ESB 17a 8704)
Mains Voltage Setting Switch (operate from top)
Mains Plug, Fuse and Filter unit

BOTTOM VIEW

Figure 7

9. **Maintenance and repair**

Routine maintenance is unnecessary except for care of the load frame gearing and motor gearing, these should be inspected after a period (2 years, depending on usage) and lightly re-greased if necessary. Suggested grease:- ROCOL MTS 1000. If faults cannot be easily traced, contact Engineering Systems.

Important:- If the rubber seal behind the loading anvil is damaged it must be replaced promptly, as tablet chippings etc. can fall into the load cell; this may upset the load cell mechanism and cause erroneous results.

Warning:- Only qualified personnel should be allowed to check for faults if any of the outer casing has been removed and the mains supply is connected. (See **CAUTION** under 2.1)

9.1 **FAULTS/SYMPTOMS/CURES etc.**

Simple faults such as - 'nothing happens when the machine is switched on' can usually be cured by anyone who knows how to change a fuse. However the ability to cure the more subtle or elusive faults requires some understanding of how the machine works. The following diagram shows how the CT40/C40 operates :-

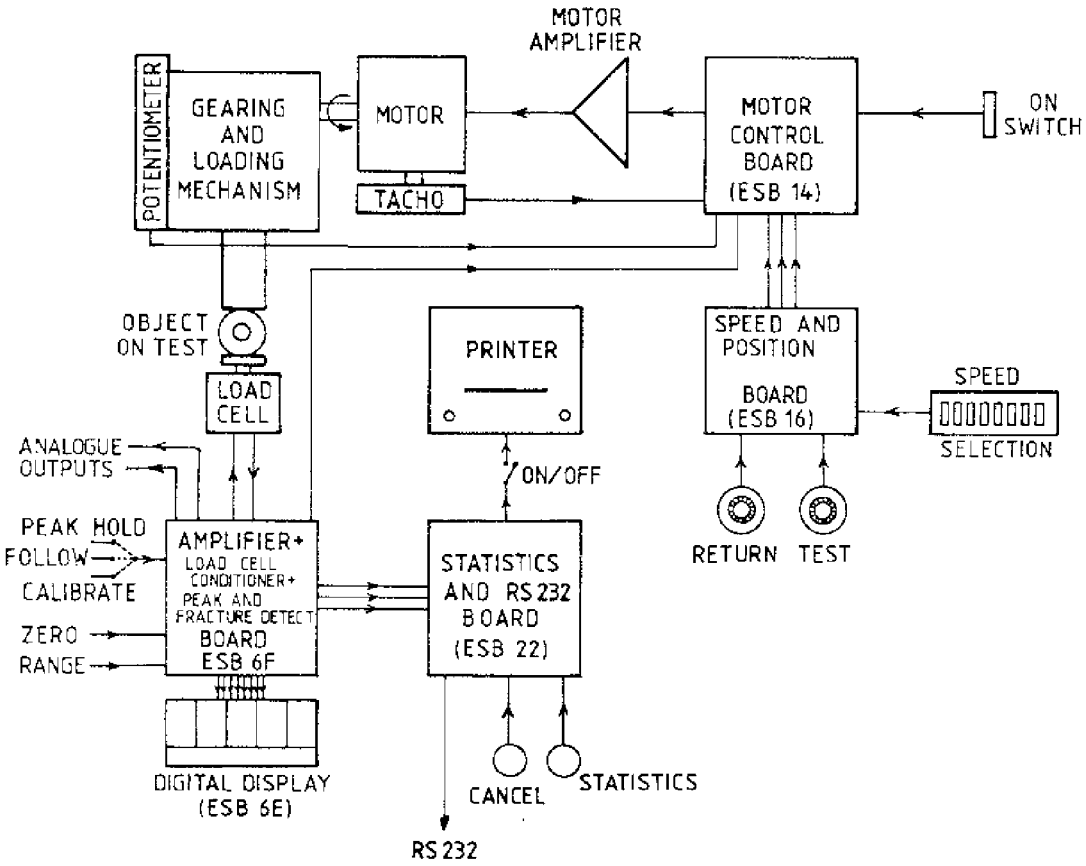


Figure 8

This self explanatry diagram is drawn in 'an anti-clockwise direction of operation', starting with the RETURN, TEST, SPEED & ON controls and ending in the centre with the PRINTER.

The preceding picture is not quite the whole story as low voltage D.C. POWER has to be supplied to the various components and boards. The following diagram completes the picture.

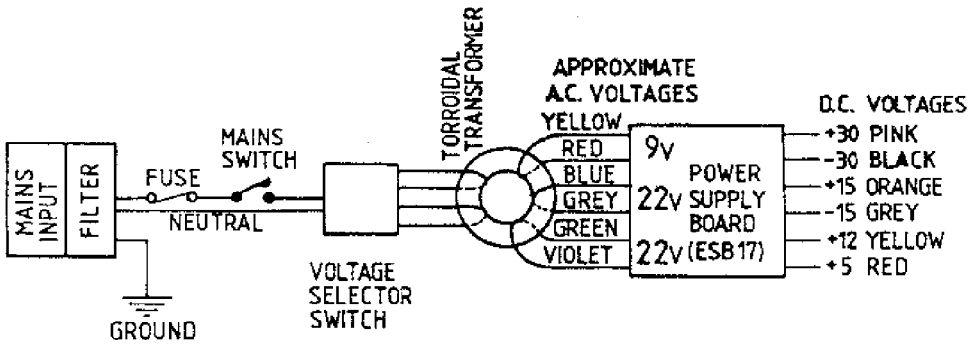


Figure 9

This diagram reads left to right, and shows how the mains input voltage is FILTERED, FUSED, TRANSFORMED and finally CONVERTED into the required D.C. VOLTAGES.

Once the preceding information has been understood fault finding can begin - The machine is MODULAR i.e. built of larger easily replaceable units onto which the many smaller components are mounted. There are approx 8 easily replaceable main modules which are fitted above and below the BASEPLATE to which the wiring loom and other fixed (but replaceable) items are attached. There are basically two types of faults which can occur - MECHANICAL or ELECTRICAL.

The main replaceable modules are :-

MECHANICAL	Gearing & Loading mechanism, including the sub-modules, Motor + tacho, Load Cell, Linear Positioning Potentiometer.
ELECTRICAL	Torroidal Transformer.
ELECTRONIC	Power Supply board, Amplifier + Digital Display boards, Statistics + RS232 board, Speed and Position board, Motor Control board, Printer.

9.1.1 **FIRST STEPS IN FAULT FINDING**

Think logically about the nature of the fault - is it likely to be electrical or mechanical? Faults can usually be isolated into small areas. Perseverance is necessary when tracing INTERMITTANT faults

9.1.2 **ELECTRICAL & ELECTRONIC FAULTS** - It is important to realise that one does not need to be an expert in electronics to cure 'modular electronic faults'. In fact one does not need to know anything at all about electronics to be able to change a board and cure an electronic fault. However fault finding is not always plain sailing and to cure those subtle faults an awareness of electronics will be needed.

Personal STATIC DISCHARGE can damage some of the electronic circuitry and care should be observed when handling the electronic boards. Ideally static free areas should be used, but in practise this is not always possible. Minimum handling, of the edges only, of the boards should help to overcome the static discharge problem.

9.1.3 **GENERAL FAULTS**

FUSES - Check fuses as described in section 2 of the handbook.

POWER SUPPLY - Are the correct voltages being supplied to, and being supplied by, the power supply board? A voltmeter will be needed to check this. The wiring diagram gives the A.C. input and D.C. output voltages which should appear on the power supply board. Cure - replace the power supply board or the torroidal transformer

CONNECTIONS - check, visually and by wiggling, that all electrical connections, plugs, sockets and board inter-connections etc. are properly connected. Check also for 'loose' wires and loose soldered connections anywhere and that the M3 nut at the top of the 'EARTH WIRE PILLARS' is tight. Check for loose foreign bodies, especially of metal, which may short out a circuit board. Check for continuity between connecting boards especially where there is a connector fitted between boards.

BOARD CHANGING It may be that an internal supply voltage fault caused the failure, therefore it would be prudent to check all power supply voltages before changing boards.
If it is suspected that a fault lies within a particular board, replace it with a spare board (module). However if a spare is not available and an electronics workshop is available it may be possible to repair boards 'in house'. Otherwise a spare will have to obtained from the manufactures or the machine sent back for repair.

9.1.4 **MECHANICAL FAULTS** are usually more easy to find than electronic faults. Unplug the mains supply and remove the outer cover(s). A close visual inspection quite often reveals the fault which may be minor and easy to cure, or major and disasterous! Check the tightness of all 'nuts & bolts' etc, remove the small top rear gear guard (two posidrive screws) and check the gears for tightness. Now try connecting the mains and pressing the start button listen for and isolate any peculiar noises.

9.1.5 **SPECIFIC FAULTS**

MOTOR will not start - Are the return & test controls in the correct position, i.e. is the test control 'less' than the plunger (or crosshead) position?
Are the speed switches set to non-zero?
Faulty control board.
Faulty speed board.
Faulty motor amplifier.
Faulty Motor

MOTOR starts but no plunger or crosshead movement - Gears slipping.

FUSES blow on switch on, check that anti-surge (slow blow) fuses are being used.

TEST button bulb does not illuminate - replace bulb.

DISPLAY does not light up - check fuses especially the 2A fuse on the power supply board. These fuses must all be of the anti-surge or slow-blow type

DISPLAY will not zero - Check peak hold/calibrate switch is in it mid-position.
Check load cell platten is not obstructed.
Fault with load cell, is there a possibility that the load cell has been overloaded? check for linerarity etc. with the calibrating weights.

DISPLAY flashes '0',s - load cell not plugged in or leads damaged.
Amplifier board fault.

DISPLAY will not settle to a constant value - analogue board faulty.
Load cell or connections faulty.

DISPLAY jumps up a few digits when peak/hold is switched on - incorrect internal adjustment of trimmers on peak hold chip on analogue board.

PRINTER not working correctly, Check that statistics board (above display is, properly mated with the analogue board connector and that the rear, (8 way, 6 wires) connector is connected correctly. Check that the position of the setting switches on lever switch No.1 is correct and have not been inadvertently changed. Replace printer if a spare is available.
Replace statistics board if a spare is available.
If possible check that the RS232 output is working correctly, if this works the fault is unlikely to be on the statistics board as there is only a small amount of extra circuitry on this board to drive the printer.

TIME & DATE incorrect- adjust as described in section 5.3.3. If the clock will not adjust, is it approaching the limit of the internal battery life (10 years)? Cure- renew the 'clock chip' no. DS1216 which is situated on the statistics board underneath the RAM.

NOTE : various internal trim adjustments, on the analogue board, are set before leaving the manufacturers. These settings should never alter - but - if for any reason they change, the operation of the machine will be upset. Section 4 in this handbook gives details of the majority of adjustments which can be made. If malfunction is still suspected, return the analogue board to the manufactures for complete readjustment.

If the sequence of operations in performing or simulating a test is carried out too quickly, apparent faults may occur.

9.2 **Repair**

Instrument Mechanics and/or Electronic Engineers should have no difficulty in replacing any of the major modules, which are all available as spares, and are detailed in the spares price list.

10. **Guarantee**

The guarantee operates for one year from delivery date and covers failure due to defective components, materials, workmanship but not failure due to misuse or accidental damage. Defective components or machines should be returned to the address below where they will be examined and wholly or partially replaced if necessary.

Manufactured in England by :-
Engineering Systems (Nottm)
1 Loach Court,
Radford Bridge Road,
Nottingham. NG8 1NB

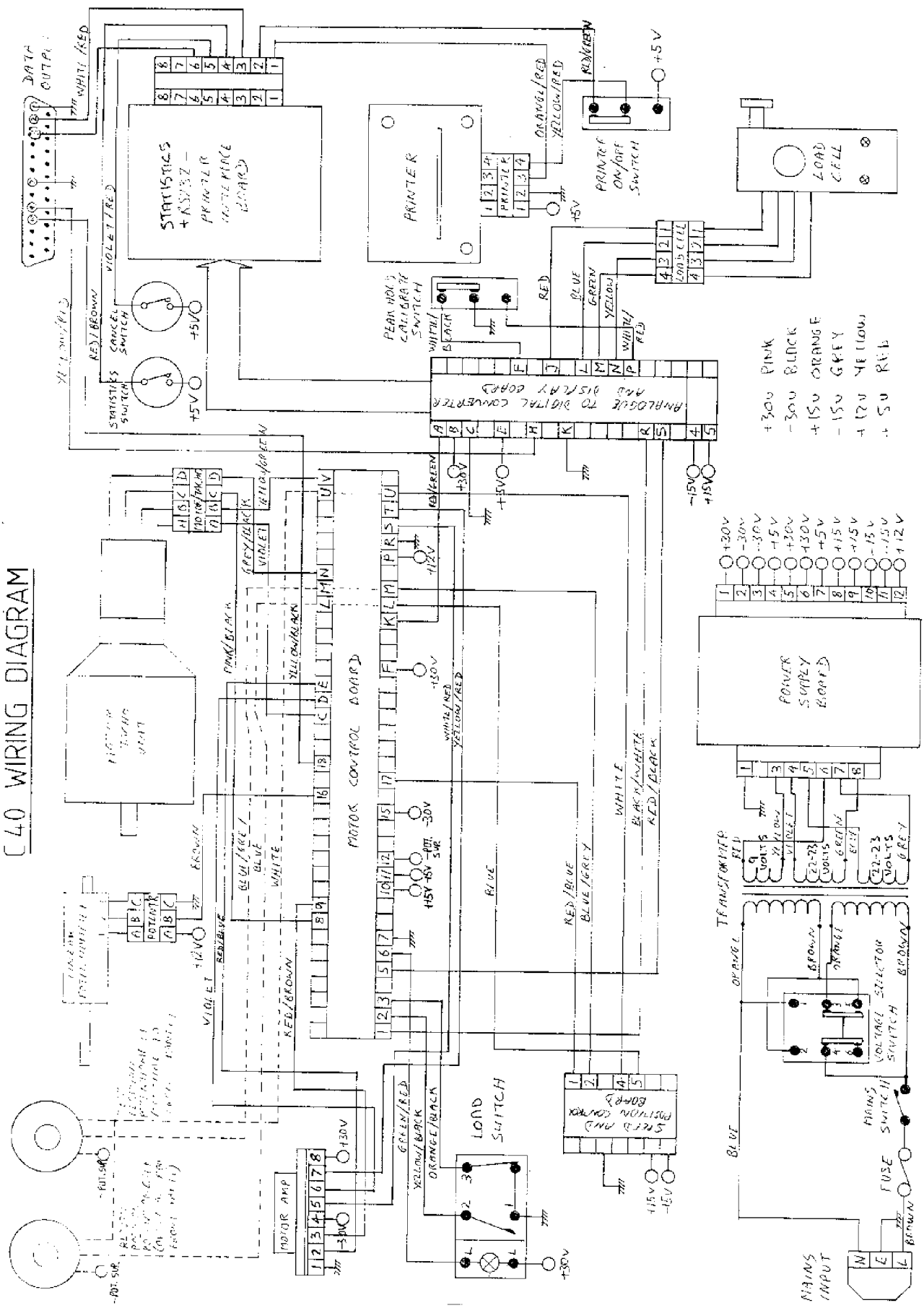

C40 WIRING DIAGRAM
STATISTICS + RS232 - PRINTER MOTHER BOARD
PRINTER
LOAD CELL
ANALOGUE TO DIGITAL CONVERTER AND DISPLAY BOARD
MOTOR CONTROL BOARD
POWER SUPPLY BOARD
LOAD SWITCH
MOTOR AMP
MAINS INPUT
FUSE
MAINS SWITCH
VOLTAGE SWITCH
TRANSFORMER
+30v PINK
-30v BLACK
+15v ORANGE
-15v GREY
+12v YELLOW
+5v RED

Figure 10

C40 / CT40 CONTROL BOARD – ESB14D8708

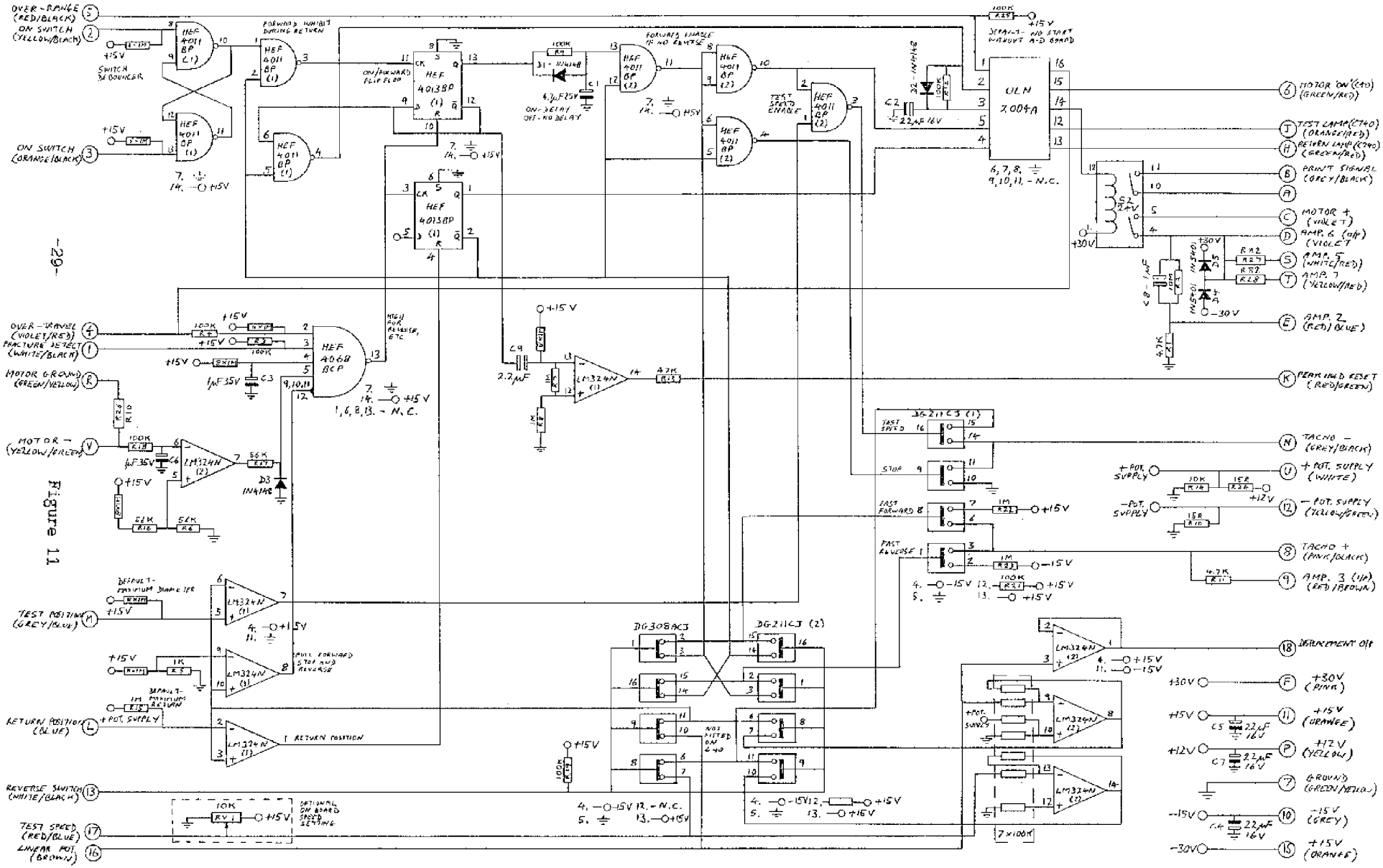


Figure 11

C40 POWER SUPPLY BOARD ESB17A 8Y04

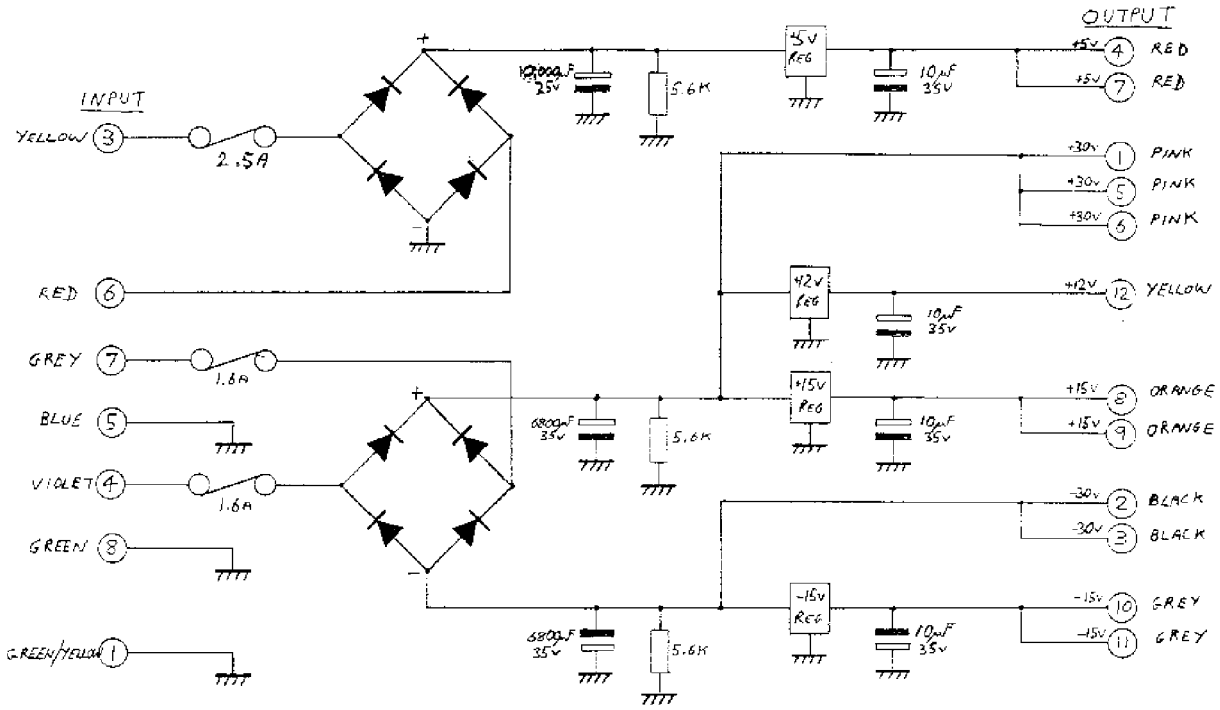


Figure 12

C40 SPEED & POSITION CONTROL BOARD ESB 16a 8Y06

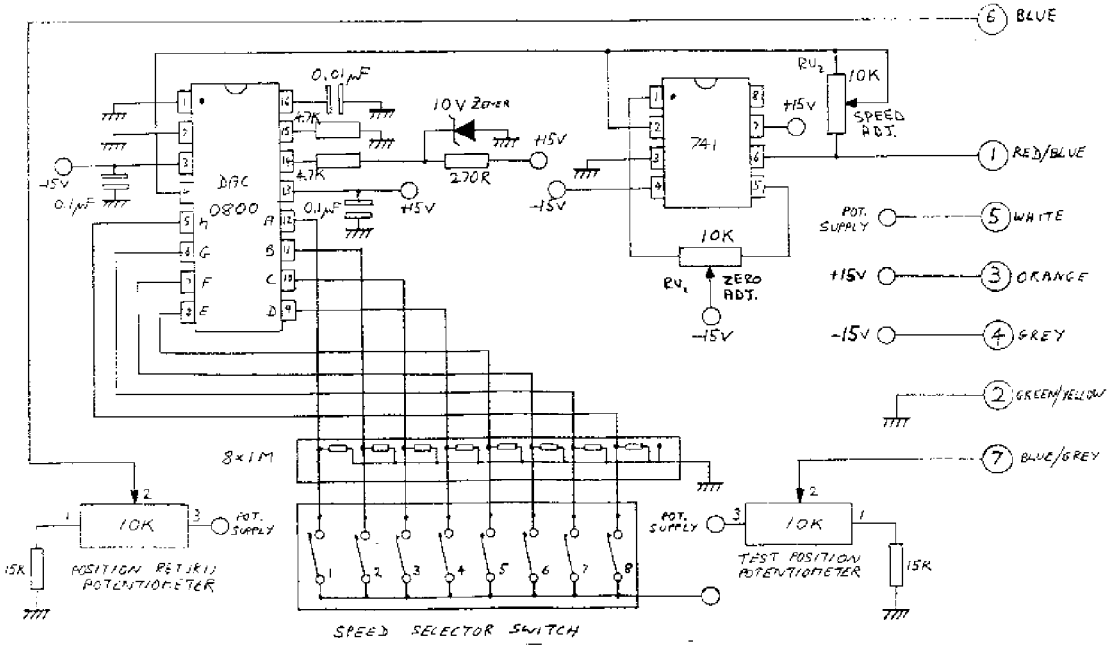


Figure 13

Notes:-

A few minor anomalies exist with the present C40 machine; it is hoped to cure these in future batches.

1. **Noisy operation of the gearing system**

Some of the C40's are noisy when operating at full forward and return speeds, this is not significantly damaging to the drive system and may cure itself after a period of running in. The problem appears to be a very small vertical bounce of the worm when driving, and 'climbing' onto the wheel which drives the plunger.