HANDBOOK ©

CT5

½TONNE TESTING MACHINE

For:- TENSION TESTING
COMPRESSION TESTING
and
3 & 4 POINT BEND TESTING

by
ENGINEERING
SYSTEMS (NOTTM)

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1. INTRODUCTION TO THE CT5

1/2 Tonne Desktop Mechanical Strength Testing Machine

The CT5 is a small, vertical loading compression and tension testing machine. The CT5 is ideal for performing other types of mechanical tests on small specimens, such as 3 and 4 point bend tests at loads of up to 500 kg. Optional test rigs and various pillar extensions are available, to enable the testing of larger specimens.

The machine is easy to use, compact, portable and weighs 18kg. A Printer, RS232 and Analogue Outputs are included as standard.

Figure2

The illustration shows some of the options which are available.

3 and 4 point bending rig.

50kg load cell giving a resolution of 0.01kg.

Not shown is the 5kg load cell option which gives a resolution of 1 gram.

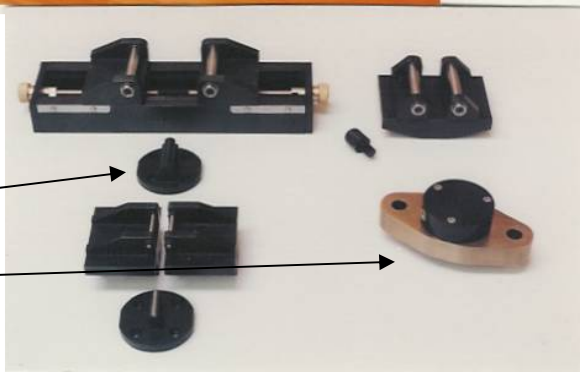


Figure 3

1.1 MACHINE DESCRIPTION

The CT5 is a small vertical loading compression and tension testing machine. The standard load range is 0 to 500 kg and a peak hold facility is built in so that the maximum test load can be captured and held on the digital load display. For more sensitive readings, a 50kg or a 5kg load cell can be fitted. A choice (selected by a 4 way DIL switch on the rear panel) of units i.e. kg, kp, N and lb. and decimal point position is provided.

The test results can be output to any combination of - Printer, RS232 output, or Analogue output of Load and Crosshead movement.

Figure 2 shows the machine set up for compression testing. The operation of the machine is controlled by using the front and side panel controls. The description of these controls is given in sections 2 & 3.

A statistical analysis of batch results can be output.

A wipe clean front panel provides digital outputs of Load & Z position and also Crosshead Speed. Positive action membrane switches control the action of the machine.

The rear panel provides the RS232 & Analogue outputs and also potentiometer adjustment holes for 'fine tuning'.

The load cell is normally mounted on the moving pillars. For special applications, such as conducting tests in an environmental chamber, the load cell can be mounted on the base loading area.

A guard is provided to control any flying test fragments.

A shallow drawer, mounted on the underside of the bottom cover, contains the Handbook and the essential tools for use with the CT5.

1.2 TEST FIXTURES.

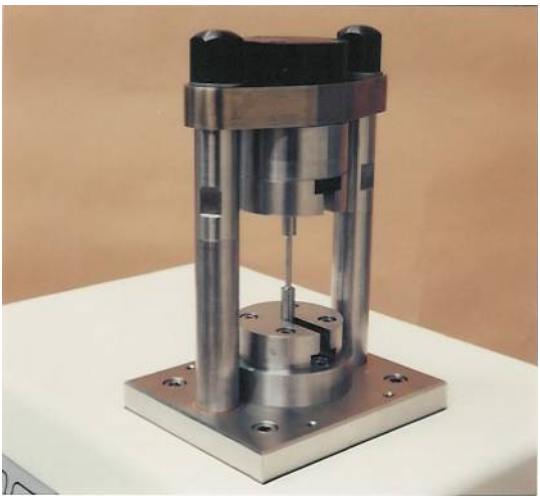
The load cell is normally mounted on the moving pillars and has an o8mm x 1mm fine pitch female thread which is used to connect the various attachments.
The load frame base loading area has various tapped holes to enable the attachment of accessories etc.

1.3 FITTING THE ∅25mm PLATENS

The upper platen screws directly into the load cell and should be lightly tightened using a 22mm or 7/8" A/F spanner. The lower platen is secured to the load frame base using the circular adaptor supplied. First screw the platen to this adaptor and tighten with the above spanner. This assembly is then attached to the base using the two 5mm hexagon screws provided.

1.4 FITTING TENSION TESTING FIXTURES

The fittings will vary depending on the type of tension testing fixtures supplied and fitting instructions will be supplied with the individual fixtures.



Tensile testing using special tensile grips and custom designed specimens. When being used in the tension mode, the rear panel mounted tens/comp switch must be switched to tension. This reverses the polarity of the load cell output and reverses the operation of the crosshead controls.

Figure 4

1.5 3 & 4 POINT BEND TESTING

The picture opposite shows 3 point bend testing using o8mm rollers for the lower contact points. The ∅8mm roller blocks can be replaced by the ∅3mm roller blocks. The minimum spacing between rollers is 6.5mm using the ∅3mm rollers. A two point roller contact upper adaptor provides the facility for 4 point bending.

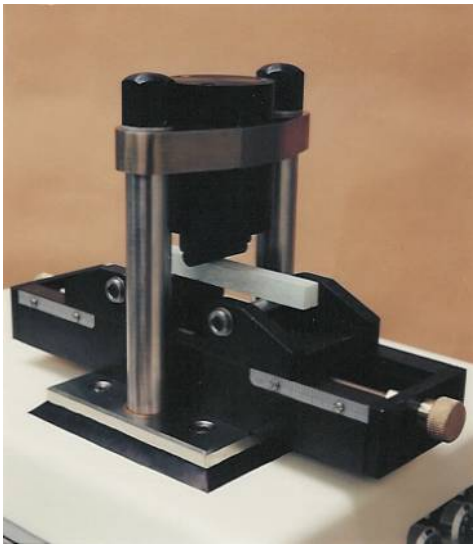


Figure 5

1.6 FITTING THE 3-4 POINT BEND RIG

The upper 3 point bend roller contact is fitted to the load cell using the adaptor provided. Making sure that the 2, ∅mm dowel holes are square to the pillar axis, screw the adaptor onto the load cell using the o8mm hexagon screw provided. The roller contact can then be screwed onto the adaptor using the four o4mm screws provided.

The upper 4 point bend rig ball contact is screwed directly into the load cell and the two point adaptor allowed to rest on top of the specimen directly underneath the ball point.

The lower 3 & 4 point bend rig is screwed directly to the load frame base using the four ∅4mm screws provided. Two ∅4mm dowel holes are provided so that the load frame can be positioned squarely onto the machine.

1.7 REMOVAL OF THE CROSSHEAD/LOAD CELL

The Load Cell can be removed by unscrewing, with a 5mm Allen key, the two hexagon shoulder screws situated at the top of the vertical loading pillars. The connecting cable should be unplugged from the rear panel and/or the Load Cell.

1.8 GUARD

The guard assembly (recently redesigned) is mounted onto the load frame base plate and the two 'wings' rotate about separate pivots. The machine is inoperative unless the guard is positioned to within a few degrees of closure. See section 2.4 for a more detailed description on using the guard.

Note:- The guard supplied may not be the most suitable for all situations.

1.9 ADJUSTMENT OF THE GUARD

For setting up purposes the guard inoperative feature can be overridden by removing the guards (pull upwards) and substituting with the guard simulator bar which is supplied with the machine.

2.0 TORQUE LIMITER

A torque limiter has been incorporated into the drive system. The larger gear (72 teeth) is attached to the ball screw drive via. a slipping clutch mechanism which has been set to slip at approx. 600 to 700kg load. In the event of overload, this will prevent the ball screw and the motor gearbox from being damaged. However if either of the 50 or 5kg load cells is installed, these will be damaged by a large overload.

2.1 PILLAR GUARDS

The main pillars and bearings are protected from the ingress of dust, dirt etc. by telescopic guards. The top sleeve can be lifted off when the load cell is removed and the bottom sleeve can be unscrewed by hand.

2. FRONT PANEL CONTROLS & MACHINE OPERATION

The 8 push button membrane switches, situated on the front panel, and the three 10 turn crosshead control knobs which are situated on the right hand end of the machine, control the normal operation of the machine.
Secondary controls and adjustments are situated on the rear panel.

2.1 LOAD DISPLAY. When the standard 500kg load cell is fitted, the maximum load is 500kg and the resolution is 0.1kg. In addition to reading in kg the units of load can be changed (see 3.9) to read in kp or Newtons or Pounds.

2.2 TEST SPEED
This shows the test speed. If the crosshead is stationary pressing the Speed Setting button situated on the front panel shows the present set test speed. Adjustment of the test speed can be carried out when the speed setting button is pressed. The speed can also be adjusted when the load button is pressed and hence the test speed is being displayed.

2.3 Z DISTANCE. The Crosshead has a range of movement of approx. 48mm. The current crosshead position, relative to the range of travel, is shown in mm with about 1 being the bottom position and 49mm being the top position. (see also Crosshead displacement 3.22)

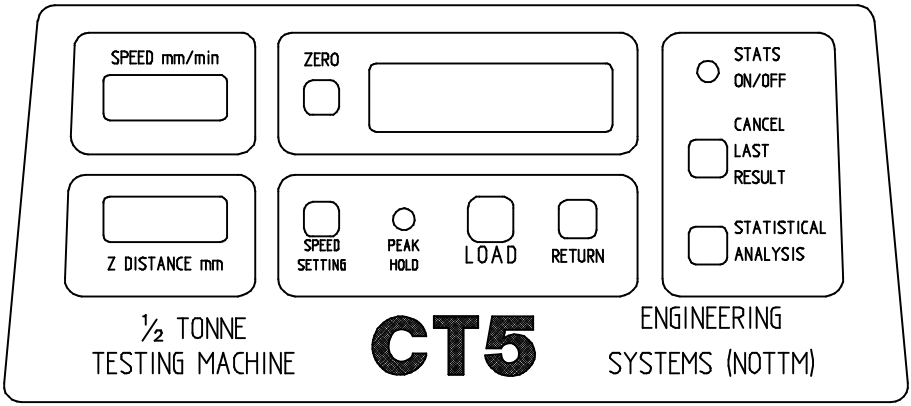


Figure 6

2.4 LOAD SWITCH & GUARD (red)

The CT5 is started by pressing the LOAD button. The 2 wings of the guard must be closed to within a few degrees otherwise pressing the LOAD button will not start the machine

When started, the motor drives the crosshead downwards. If the machine is set up to operate in Tension mode (rear panel switch), the crosshead direction will be reversed i.e. moves upwards when started.

If the guards are opened during testing, the machine will stop and automatically reverse the crosshead direction.

Also, the machine incorporates a fracture detect facility which automatically stops the motor when the specimen has fractured. The automatic cut out will also operate if the maximum load or the maximum allowable travel is exceeded.

For setting up the machine or for performing individual tests it may be necessary to dispense with the guard (see section 1.9). However, it should be noted that this may contravene local safety regulations, if used in this manner.

2.5 RETURN SWITCH (green)

When the return switch is illuminated the crosshead is returning to its preset position. This position is determined by the position of the RETURN POSITION control knob situated on the right hand side panel. The crosshead is automatically returned to this position when either a fracture, overrange, or overtravel is detected. The crosshead can also be returned during loading or, to a new higher preset position, at any time by pressing the return switch.

Note:- The crosshead will not return unless the RETURN POSITION KNOB is set to a 'higher' value than the current crosshead position.

2.6 PEAK HOLD SWITCH (yellow)

When the machine is first switched on, the peak hold is off and the digital read-out follows the load cell output for both increasing and decreasing load. If a test is commenced by pressing the LOAD button, the peak hold is automatically switched on and the digital read-out will follow the increasing load but will not fall when the specimen fractures. (If complete failure of the test specimen 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) The maximum load reading is held and can be recorded. When a new test cycle is started, the peak hold is briefly and automatically switched OFF then ON, to reset the load reading to zero. See Appendix 1 for a further discussion regarding fracture detect parameters.

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

2.7 ZERO SWITCH (green)
Pressing this switch disables the peak hold and zero's the Load Display. When the machine is first switched on the load display is automatically zeroed.

2.8 SPEED SETTING (green)
When pressed the preset test speed (see 2.2 & 3.16) is displayed.

2.9 STATS ON/OFF. (red)
Pressing this button enables (red LED on) or disables the statistical analysis. If on, the results (up to 99) are stored in the machine's memory and are used in the statistics calculation when the STATISTICAL ANALYSIS button (see below) is pressed. When OFF, the results are not stored and no test No. is printed when the latest test result is printed out. When the CT5 is switched on, the button assumes the same setting as when last switched off.
If the machine is switched off, the stored results are not then accessible when the machine is next switched on as the counter is automatically reset to zero.

2.10 CANCEL LAST RESULT. (yellow)
Pressing this button cancels the last result. The cancelled No. is then used for the next tablet to be tested. The button can only be used to cancel the immediately previous result.

2.11 STATISTICAL ANALYSIS. (green)
When the correct batch size is reached and the STATISTICAL ANALYSIS button is pressed, the statistical data is printed out on the printer. This data is also sent to the rear RS232 output; the counter is also zeroed. The maximum batch size is 99. If the batch size reaches 99, the statistical data is automatically printed out and the counter reset to zero.

The Standard Deviation (STD.DEV.) is calculated by using the 'SAMPLE STANDARD DEVIATION' calculation. A typical printout is shown below and includes the Time and Date.

No. 1 10.4 kg
No. 2 16.3 kg
No. 3 18.2 kg
CANCEL 3
No. 3 14.3 kg
No. 4 18.6 kg

BATCH Size. = 4
MINIMUM = 10.4 kg
MAXIMUM = 18.6 kg
STD.DEV. = 3.4
MEAN = 14.9 kg
TIME 13.57
FRIDAY 20-05-1999

The printout shows that reading No. 3 was manually cancelled. The result is overwritten by the next result, which is then called No.3.

To change the Time & Date, see Appendix 3

As normal, when statistics are required the STATISTICS button is pressed and released. However, if this button is held down for a few seconds, (until printing of the data commences) **an abridged version of all the test results is printed**, prior to the printing of the statistical data.

Note: The sample standard deviation σ_{n-1} is defined as

$$\sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n-1}}$$

Where: n=sample size & x=test result(s)

2.12 CROSSHEAD CONTROL KNOBS

These knobs are situated on the right hand end of the machine. The crosshead is driven in the sequence:- fast down (or up in tension mode), test speed and fast return speed.

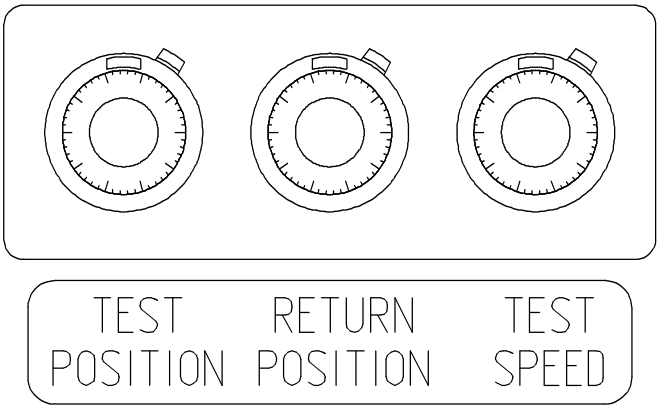


Figure 7

2.13 CROSSHEAD TEST POSITION CONTROL KNOB

This knob sets the position at which the 'fast forward' (down or up depending on test mode) speed changes into the test speed. So that tests are completed without wasting much time, this should be set so that the platen/roller etc. comes to within a small distance (say 1/2 mm) of the test piece at the end of the fast forward speed. If the platen/roller etc. comes into contact with any object during its 'fast forward' motion, the crosshead will stop and be returned to its preset return position.

The maximum travel is approx. 48 mm, therefore one complete turn of the ten turn dial mechanism will vary the distance setting by approximately 5 mm.

2.14 CROSSHEAD RETURN POSITION CONTROL KNOB

The 10 turn dial mechanism sets the amount of returned distance between the specimen and the crosshead when the return cycle has been completed. *For a return to occur, the RETURN POSITION KNOB must be set to a larger value than the position at which fracture occurred. If the RETURN POSITION is set to a value which is less than the fracture position, then no return will occur.*

2.15 MACHINE OPERATION in COMPRESSION or 3 POINT BENDING

If the 'daylight' between the platens is not large enough to accommodate the specimen, turn the return position potentiometer to a larger value (1 turn is approx. 5 mm) and press the return button. The crosshead will now return to its new higher position.

With the test object positioned on the lower platen or bend rig, set the test speed to its lowest setting and gradually decrease the test position dial until the platen has moved close to the test object. Press the return button and dial in the required test speed. Now set the RETURN POSITION KNOB to show a value slightly larger than that shown on the TEST POSITION dial. Ensure that PEAK HOLD is set to hold (red light ON in peak hold button window). The specimen is now ready for testing. Press the load button; testing will commence with the sequence:- fast down, test speed, detection of fracture, crosshead return to preset position, printout of the test result (if printer is switched ON).

An additional safety feature is incorporated :- the test will be aborted and the crosshead returned if the load cell detects more than a small load during the fast down sequence.

2.16 TENSION TESTING

When tension testing, it is essential that the crosshead does not return until the specimen remains have been removed as a return will subject the elongated specimen remains to a compressive load. The RETURN POSITION KNOB must be adjusted at the beginning of each tensile test,

1. To set the starting position
2. To set the return position so that the broken specimen is not damaged by a fast return.

A more detailed description will be supplied with the individual tension test equipment.

3. REAR PANEL SECONDARY CONTROLS

3.1 REAR PANEL SECONDARY CONTROLS, INPUTS, OUTPUTS & ADJUSTMENTS.

Situated on the REAR PANEL are:-

Mains input combination plug, Filter & Fuseholder, Analogue & Digital (RS232) outputs, Calibration & Printer switches, Calibration potentiometers.

The Rear Panel looks like this:-

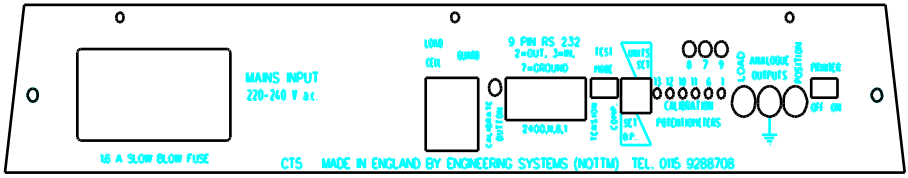


Figure 8

The following is a detailed discussion of the rear panel controls and adjustments.

3.2 MAINS INPUT

This comprises a combination mains filter, IEC plug, rocker switch and captive fuse drawer. An IEC/MAINS connector lead is supplied with the machine and should be fitted with a 5A slow blow(T) fuse. See section 5. for further details.

The mains input voltage is normally set to 220-240 V a.c. This can be changed to 110-120 V a.c. by removing the outer casing (see section 8.1) and switching the VOLTAGE SELECTOR SWITCH which is situated on the top side, rear of the baseplate. When this has been done and the outer covers replaced, the 1.6A SLOW BLOW(T) mains fuse which is normally fitted should be changed to a 2.5A SLOW BLOW(T) fuse. A 110-120 V a.c. label (obtainable from ENGINEERING SYSTEMS) should be fitted over the existing 220-240 V a.c. printing.

3.3 CROSSHEAD

The crosshead connector is for the Load Cell operation.

3.4 CALIBRATE BUTTON

When pressed a 'calibration reading' is displayed on the load display. See section 6.4 (Electronic Calibration) for further details.

3.5 DIGITAL RS232 DATA INPUT/OUTPUT

The 9 way 'D' type female connector provides the RS232 output which is transmitted only when a fracture is detected. Data appears at the RS232 output at the same time that it is printed on the printer.

Whilst the RS232 output is exactly the same format as the printer output, provision has been made internally so that the RS232 and printer outputs can be different. Customised outputs are available to suit individual requirements. Contact Engineering Systems for details.

The data is transmitted in the format:-

2400 bits/sec, No parity, 8 Data bits, 1 Stop bit.

The CT5 is configured as a TERMINAL device and is fitted with a female 9 way 'D' connector.

RS232 output, is transmitted from the CT5 on pin 2.

RS232 input, is on pin 3.

Pin 7 is GROUND.

Correct polarity of externally connected equipment must be observed.

The remaining pins on the 9 way connector are not connected.

3.6 DUST COVER

A dust cover plate is fitted over the remaining potentiometers and also the Test Mode switch, the Units & D.P. setting switches, the Printer ON/OFF switch and the Analogue Outputs. This cover could be discarded if the CT5 is not being used in a dusty environment and frequent adjustments of the settings are required.

3.7 TEST MODE

This switch sets the machine to work either in compression or tension.
When in compression, the test sequence is:- Fast down, Test speed, Fracture detect, Fast return (if the Return Position Pot is correctly set), Print out.
In tension the sequence is:- Fast up, Test speed, Fracture detect etc.

3.8 UNITS and DECIMAL POINT

Both the units and the position of the decimal point can be changed by altering the position of the switch elements of the 4 Way DIL Switch. Changing either units or D.P. position or both, changes the output format for both the Digital Load Display and the Printer Output.

The units and decimal point can only be changed when the counter is zero. This is because the statistics routine cannot process mixed units.

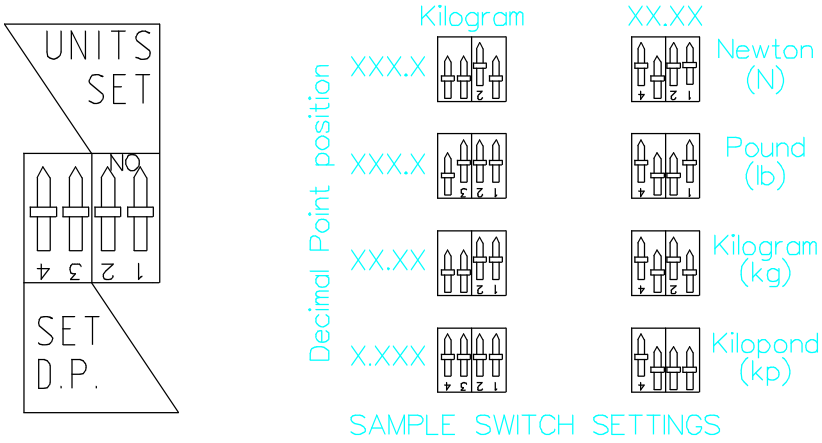


Figure 9

3.9 UNITS CHANGE

Switches 1 & 2 change the units displayed. The digital display shows the correct output for the units chosen. i.e. an internal multiplication takes place when the units are changed. The decimal point is positioned in the same relative position when the units kp or kg or lb. are displayed. When N is selected the D.P. is automatically shifted one place to the right.

3.10 DECIMAL POINT

If the load cell capacity is changed from say 500kg to 50kg, the D.P. needs to be shifted one place to the left. Switches 3 & 4 change the D.P. position. This should be changed to give the correct position for the load cell which is currently installed.

3.11 CALIBRATION POTENTIOMETERS (8 off)

These adjustments are made by adjustment of the 20 turn potentiometers located on the rear panel. A small insulated trim tool is supplied for the potentiometer adjustments. The small end is used for adjustment of pots 6,10,11,12 & 13 and the large end is used for pots 7,8 & 9.

The function of each calibration potentiometer is:-
6.) % Difference for fracture detect
7.) Low Limit Fracture Detect suppression
8.) Overrange Cut-out
9.) Digital Load Display Output Range
10.) Load Analogue Output Range
11.) Load Analogue Output Zero
12.) Test Speed Range Adjustment
13.) Z Position Range

3.12 % DIFFERENCE FOR FRACTURE DETECT (POT 6)

Fracture is detected and the crosshead motor is stopped when the instantaneous load measured by the load cell falls below a preset % of the maximum load (i.e. the peak held load) attained during testing. The fracture detect pot (6) can be adjusted to give any fracture detect % up to 100% (Typically 60%-70%).
See Appendix 1 for a further discussion and adjustment details

3.13 LOW LIMIT FRACTURE DETECT SUPPRESSION (POT 7)

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 cut-out 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 is 3kg for the 500kg load cell and 0.30kg for the 50kg load cell.
Checking the low limit setting. With the peak hold switch on, press the load on switch. Apply, by hand, a small load, i.e. 2kg, to the load cell 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.
ALTERNATIVE SETTING METHOD:-
Alternatively, with the bottom cover removed, set Pot7 (Low Limit) to give approx. 30mV on TP5 (situated on the Main Circuit Board).

Adjusting the low limit setting. Turning Pot. 7 clockwise decreases the minimum load.

3.14 OVERRANGE CUT-OUT (POT 8)

Remove the bottom cover.
For the 500kg load cell set to 490kg. (4805 N) with the formula CUTOUT = (490 x R)/C
For the 50kg load cell set to 49kg. (480.5 N) with the formula CUTOUT = (49 x R)/C
Where C= Load reading when Calibrate switch is pressed.
and R= corresponding reading on TP8 (situated on the Main Circuit Board) measured with a voltmeter.
Set the calculated CUTOUT voltage onto TP6 by adjusting Pot8. Note :- the calibration button must not be pressed at this stage.
Turning Pot 8 clockwise increases the voltage on TP8.

3.15 DIGITAL LOAD DISPLAY OUTPUT RANGE (POT 9)

This adjusts the range of digital output to correspond to the applied load and should only be adjusted when calibrating the machine. See section 6.

The functions of Pots 10 & 11 are described in sections 3.20 & 3.21.

3.16 TEST SPEED RANGE ADJUSTMENT (POT 12)

Remove the bottom cover.
Note :- Machine gearbox ratio for normal speed is 316.9/1 and for double speed is 158.7/1.
Gearbox to ball screw ratio is 72/45 = 1.6
1 turn of ball screw = 2.5mm crosshead travel
Set the External Test Position Pot to its maximum position and press the Load On button, set the external TEST SPEED pot so that the gearbox gear (smaller, with 45 teeth) rotates 10 times in 1 minute. Now adjust Pot12 (Speed Range) so that the SPEED display shows 15.6 mm/min. A clockwise rotation of Pot 12 increases the range adjustment.

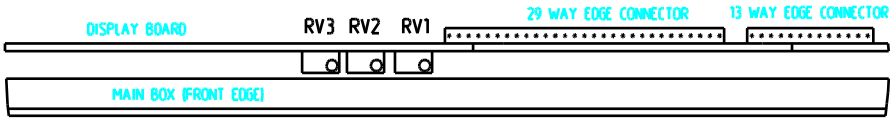


Figure 10

When the Test Speed is ON, and the speed display shows 15.6 mm/min., switch the Test Speed OFF. With the SPEED SETTING switch pressed, adjust RV1 (display board) so that the SPEED display shows 15.6 mm/min.

Pots RV2 (motor zero speed) and RV3 (zero speed setting) are set before the machine leaves the factory and should not require any further adjustment. A clockwise rotation of RV1 increases the speed display.

3.17 Z POSITION RANGE (POT 13)

Set the external Return Position & Test Position Pots to zero and press the Load button, when the machine has stopped measure the distance, in mm, between the crosshead and the load frame top.
Set the external Crosshead Control Return Position Pot to its maximum position (10.0) and measure the new distance between the crosshead and the table top. Set Pot 13 so that the reading shown on the Z distance meter is equal to the range of the crosshead movement i.e. the difference between the two readings. Turning Pot 13 clockwise increases the crosshead display.

3.18 ANALOGUE OUTPUTS

These d.c. voltages are outputted via. 4mm terminals. BLACK is GROUND. YELLOW output is proportional to LOAD. RED output is proportional to CROSSHEAD POSITION.

3.19 LOAD CELL OUTPUT (Yellow terminal)

This output can be used to drive a variety of independent recording devices, i.e. pen recorder, U.V. recorder, etc. It is independent of the setting of the peak-hold switch. i.e. this output follows the value of the load applied to the loading platen. An output of 1 volt/10kg (standard load cell) load is given at these output terminals. It should be noted that the low (Black) output is indirectly connected to the chassis i.e. earthed. Some external equipment may also have the low terminal earthed and care should be taken when using these terminals to ensure that the correct polarity connections are made. The adjustments for this output are described below.

3.20 LOAD ANALOGUE OUTPUT ZERO (POT 11)

Adjustment for the Load cell output zero. Clockwise rotation causes the output to decrease.

3.21 LOAD ANALOGUE OUTPUT RANGE (POT 10)

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 a 10 volt range, should be connected to the load cell output terminals on the rear panel, polarity must be observed. Zero if necessary (described above), push the calibrate switch, the digital display on the CT5 should now read the same as the reading shown on the voltmeter. If in error, turn pot 10 until the readings match. A clockwise rotation causes a decrease in output range.

3.22 CROSSHEAD DISPLACEMENT (Red terminal)

This output is not internally adjustable and an output voltage in the range 0 12 volts is given at these terminals, the low (Black) terminal is earthed and the voltage output is proportional to the position of the crosshead.

3.23 PRINTER ON/OFF SWITCH

When OFF the printer output is disabled.

4. PRINTER

4.1 THE PRINTER automatically prints the peak reading at fracture, as indicated on the digital display.
The printer can be disabled by switching the rear mounted printer ON/OFF switch to OFF.

The printer is fitted with two external vertical bar controls which are situated at the top left hand side of the printer's front cover. The left hand bar is for opening the printer door and the right hand bar is the paper feed switch.

Pressing the paper feed bar whilst the printer is printing may cause printing errors.

4.2 CHANGING THE PAPER ROLL AND CARTRIDGE RIBBON
The printer door is hinged vertically on its right hand side. To open the door, rotate (anti-clockwise) the left hand (of two) vertical catches and the door will swing open to reveal the paper roll and the ink ribbon. To release the print mechanism and ribbon from the front panel, push the door and the chassis horizontally apart.

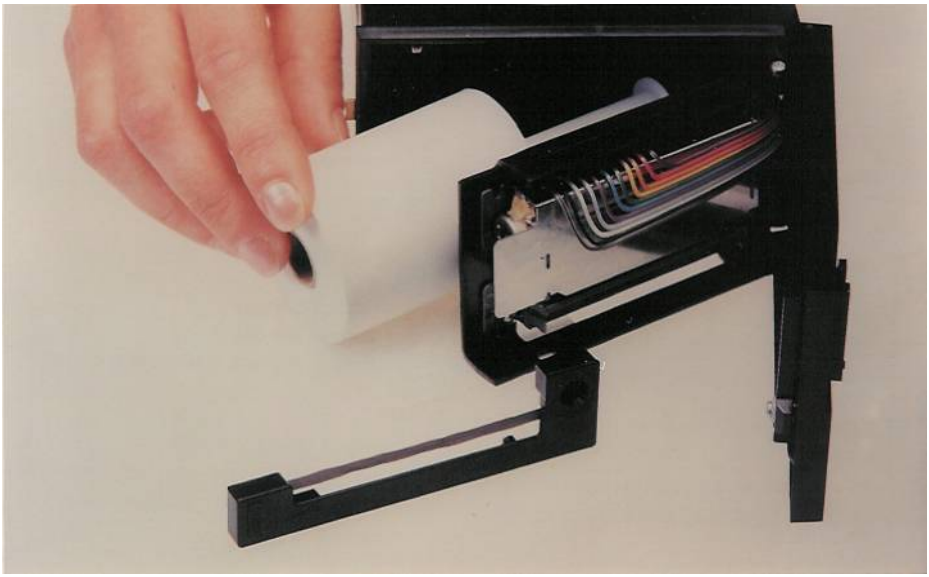


Figure 11

4.3 PAPER ROLL REPLACEMENT

Open the printer door as described above and swing the door open to expose the paper roll.

Remove the old paper roll by pressing the black paper roll retaining button situated at the end of the paper roll spindle. Slide off the old roll and tear off any remaining paper. Pull any remaining paper out from the front of the printer.

Take a new roll of paper and separate the end from the rest of the roll. Remove any damaged or gummed part of the paper and cut the free end into a 'V' shape using scissors or a knife. Sometimes the roll is loosely wound, if so tighten the roll by pulling on the free end of the paper. Also sometimes the paper roll may me slightly too large, if so remove a meter or two of paper from the roll. Put the new roll onto the spindle with the paper unspooling in an anti-clockwise direction when viewed from the outer end. Insert the end of the paper up and into the printer mechanism and press the paper feed actuator rod which is situated inside the top left hand portion of the printer casing. Wait and check that the paper emerges from the front of the printer before releasing the actuator rod and closing the printer door.

Use 57mm wide, 48mm maximum diameter, 13mm internal diameter paper rolls,

The printer mechanism which is used is from the EPSON M160 series. Paper rolls and printer ribbons should be available from local suppliers worldwide.

For U.K. users the recommended suppliers for the paper rolls are:-

Able Systems Ltd. Tel. 01606 48621 and their order code is A160PR.

A consumables pack is available containing 5 rolls of paper and two Epson ribbon cartridges. Order code is A160CBP.

Codes correct, May 1996.

4.4 RIBBON CARTRIDGE REPLACEMENT

After approx. 5 paper rolls have been used, the ribbon cartridge will need replacement. To expose the Ribbon Cartridge, position the forefinger underneath the outer edge of the door and the thumb on top of the printer mechanism chassis and press in vertically opposite directions until the catch is released and the chassis swings away from the door.
DO NOT FORCE OR PULL THE DOOR AND CHASSIS APART WITHOUT FIRST RELEASING THE CATCH.

When the chassis and the door have been parted the ribbon can be removed by pressing down on the end of the cartridge marked PUSH. Carefully remove the old cartridge and replace with the new one ensuring that the paper lies between the ribbon and the steel printer platen. Check that the ribbon cartridge is correctly seated over the printer ribbon drive shaft and snap the cartridge into place.
Ensure that the ribbon is tight and parallel to the paper and if necessary tighten the ribbon by turning the faceted disc clockwise.

For supply of the printer ribbons the recommended suppliers are:-

Able Systems Ltd. order code is A160IRCP.

Codes correct, May 1996.

5. POWER SUPPLY AND FUSES

5.1 POWER CONNECTION

The standard machine can be used on a 220-240 V, 50 Hz or 110-120 V, 60 Hz power supply. An internal switch (see figure 13, Voltage Selector Switch) is set, before leaving the manufacturers, 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 5A 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 a.c. mains voltage is not directly exposed anywhere throughout the wiring; but must beware of the high d.c. voltage potential of 54 volts supplied by the + 27 and - 27 volt DC lines (pink and black wires) emitting from the Power Supply Board.

5.2 FUSES

A mains fuse is incorporated into the fuse/switch unit which is fitted in the rear panel of the machine. This fuse can be replaced by opening the fuse retaining draw. Use a 1.6A fuse for 220-240V and a 2.5A fuse for 110-120V, both 20 mm, anti-surge (T) or slow blow type fuses.

Five fuses are also fitted near the top of the d.c. power supply board, this is located underneath the main cover and on the upper part of the base plate. To gain access to these fuses refer to 'dismantling procedure' (section 8.1). These fuses are 3 @ 5A and 2 @ 1A, each 20 mm, anti-surge types. The CT5 power supply board is marked with the fuse numbers which are also shown on the CT5 power supply circuit diagram (see later). The values which should be installed are:-

Fuses 1, 4 and 5 - 5A (slow blow or anti-surge)(T)
Fuses 2 and 3 - 1A (slow blow or anti-surge)(T)

6. CALIBRATION PROCEDURE

Before the CT5 is delivered, it is calibrated, with dead weights, to conform with the ASTM standard E4-83a (load Verification of Testing Machines). A calibration certificate accompanies each machine. The unit of weights used are kilogram (kg). The machine's displayed units can be changed to output in kg, kp, lb. or N (see section 3.9). When calibrating either by weights or by proving ring it is essential to use weights which correspond to the displayed units. If the units are subsequently changed (using the rear mounted DIL switch) the displayed output will still be valid for the changed units.
The machine can be calibrated using a proving ring, as shown in the photograph. Extension pieces are required to accommodate the ring, similarly larger objects can be tested using various lengths of extension pieces.
An electronic calibration switch is provided so that a daily calibration check can be made.

6.1 CALIBRATION BY DEAD WEIGHT LOADING

This can be done by ENGINEERING SYSTEMS, using a purpose built rig so that the machine can be tested according to ASTM E4 standards.

6.2 CALIBRATION USING THE PROVING RING

A proving ring is available as an optional extra. This ring is supplied in a polypropylene case and is also supplied with ball ended end mountings, extension pillars and two adaptors for use with the CT5. A calibration certificate is also supplied with the ring.
The photograph shows the CT5 being calibrated, using a Proving Ring.

6.3 CT5 CALIBRATION PROCEDURE

1.) Remove crosshead/Load Cell and fit extension pillars, replace crosshead/Load Cell onto the extensions. See section 1.7

Figure 12

2.) Remove the 2 wing guards by lifting upwards and replace them with the guard simulator bar. This enables the machine to be started without the guards in position.

3.) Remove the load cell platen and screw the concave adaptor piece into the load cell hole.

4.) Remove the bottom platen and screw the concave adaptor piece into the hole, adjust the crosshead position and place the bottom end of the proving ring onto this concave cup. Use the crosshead control knobs and the load button to lower the crosshead until there is JUST a small amount of load applied i.e. so that the proving ring is held in place. The crosshead will need to be in slow test speed (say 4mm/min) before the load cell touches the proving ring.

5.) As soon as the proving ring is held firmly in position under a small amount of load, press the LOAD switch to stop the crosshead moving down.

6.) Press the ZERO switch to zero the load and if the PEAK-HOLD lamp is on, press the PEAK-HOLD switch to turn it off.

7.) Zero the proving ring dial gauge.

8.) Press the TEST switch. The PEAK HOLD lamp will come on. Immediately press the PEAK-HOLD switch to disable the Peak Hold.
Once the proving ring starts loading the speed can be varied however, it is better to use a slow speed so the loading can be stopped at the correct point.

9.) Stop the loading of the proving ring at the required dial gauge reading. At maximum load, adjust the load reading by adjusting POT9 on the rear of the CT5, to the value shown corresponding to the dial gauge reading on the certificate, issued with the proving ring. If the original load reading was more than say 1% out, repeat the process.

When the crosshead is returning, and when initially putting the proving ring in place until it is under a small amount of load, ALWAYS hold the proving ring to avoid the ring falling from position.
It may take some practice to use the proving ring for calibration.

6.4 ELECTRONIC CALIBRATION

Pressing the calibrate button connects a high stability resistor into the load cell circuit and gives an apparent load reading on the digital display.

A calibration value (for units of kg) for each load cell supplied with the machine is given on the calibration certificate. When the calibrate button is pressed this calibration value should be displayed on the digital display. These calibration values are only valid for numbered load cells which relate to the corresponding CT5 machine number. If it is required to use load cells on different machines, a load cell calibration value has to be obtained for each machine and load cell combination.

When calibration using a proving ring has been completed the calibration value should be noted and compared to the value given on the calibration certificate. The values should not be significantly different. If in error, the machine should be returned to the manufacturers for servicing and checking against the dead weight loading system.

Calibration using a proving ring or more accurately by dead weight loading should be carried out from time to time.

6.5 CHANGING THE LOAD CELL

Unplug the load cell connector by pulling on the outer metal sleeve of the connector which plugs directly into the load cell.

The load cell will need to be calibrated by Electronic Calibration (see section 6.4) or more accurately by dead weight loading.

Electronic calibration is done by first zeroing the load cell, and then by pressing the calibrate button on the rear of the machine adjusting POT 9 until the value on the digital display corresponds to the electronic calibration value on the calibration certificate.

Dead weight calibration can be done by zeroing the load cell, and then with the load cell detached from the machine and resting on a suitably strong bench top, hanging or balancing weights on the load cell and adjusting POT 9 until the digital display corresponds to the weight on the load cell. Note that to calibrate (with dead weights) to E4 standards the load cell must be calibrated whilst attached to the machine either by using a special calibration rig, or by returning to Engineering Systems for calibration.

WHEN THE LOAD CELL HAS BEEN CHANGED, THE OVERANGE CUT-OUT LEVEL MUST BE ADJUSTED, OTHERWISE THE LOAD RATING OF THE LOAD CELL MAY BE EXCEEDED.

See section 3.14 to adjust the overrange cut-out.

7. COMPONENT PARTS

7.1 MACHINE CONSTRUCTION

The construction is modular. The mechanical loading frame and motor are combined and are mounted onto a baseplate. For efficiency, a re-circulating ball screw is used to drive the crosshead. The electronics are positioned above and below the baseplate and the design ensures that interconnecting wiring is minimised. The main cover is made of 16 gauge steel and incorporates the main control panel, the crosshead control knobs and the printer. The Load Cell is purpose designed and built, and has a diaphragm type force sensing element.

The following parts list, component layout and circuit diagrams show only the major parts. Small items such as individual screws etc. are not listed.

7.2 PARTS LIST

Load Frame
Crosshead
Load Cell
Linear Displacement Potentiometer (TML 3FLP50A-10k)
MAXON Motor - Gearbox - Encoder Unit
MAXON Encoder Controller
Linear Potentiometer Connector
Printer / Power Supply Board Connector
Printer connector board (PRINTER.PCB)
Display Circuit Board (CT5D.PCB)
Main Board (CT5M.PCB)
Mains Input Voltage Selector Switch
Toroidal Transformer (ILP 6D486P)
Power Supply Circuit Board (ET500P.PCB)
Power Supply Board Fuse - 5A 20mm anti-surge
" " " " - 1A 20mm anti-surge
Mains Filtered Input Connector and fuseholder and on/off switch

NOT SHOWN PARTS

24 column Printer (Able Systems Ltd. 03-AP24+IN-NL)
10 turn crosshead control potentiometers (Farnell 351-600)
Multiturn knobs for above potentiometers (Technimeasure MG20-22B6.5)
Guard cut-out Proximity switches

COMPONENT LAYOUT – Top view

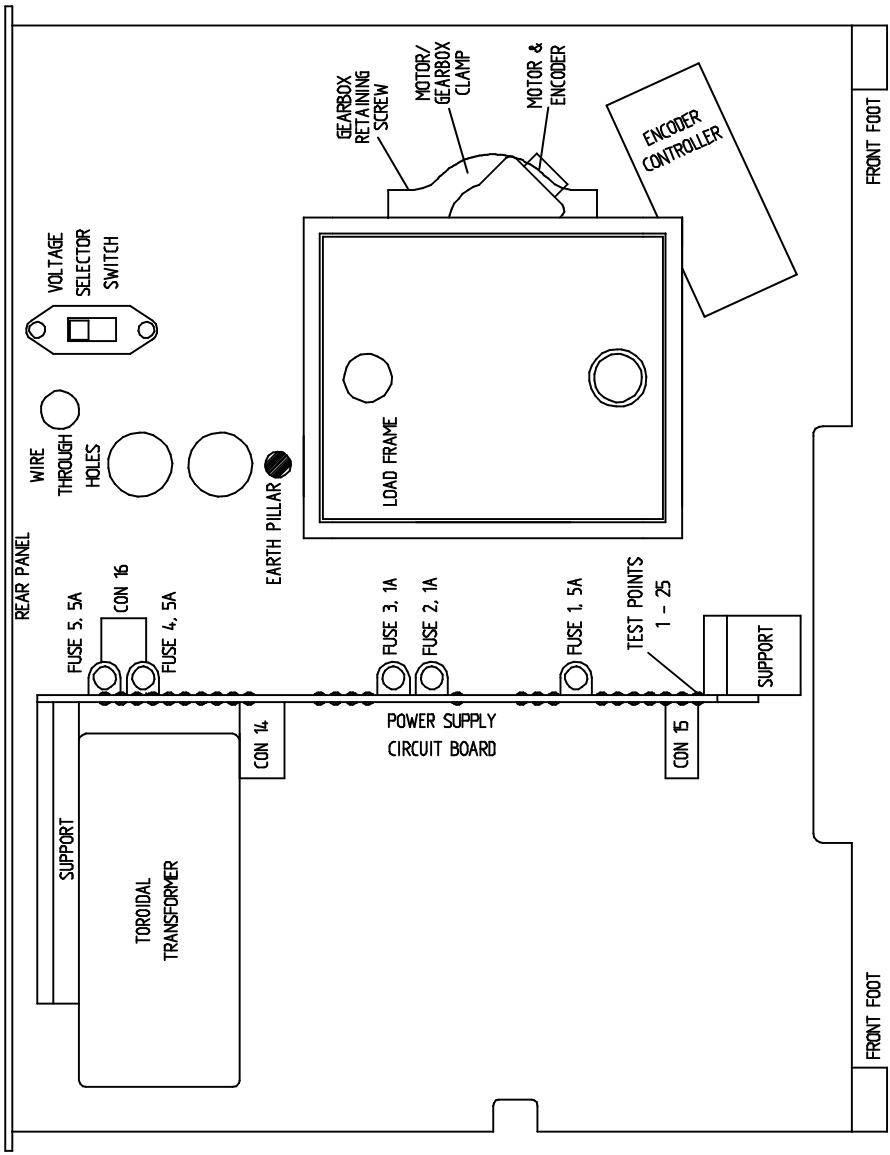


Figure 13

COMPONENT LAYOUT – Bottom view

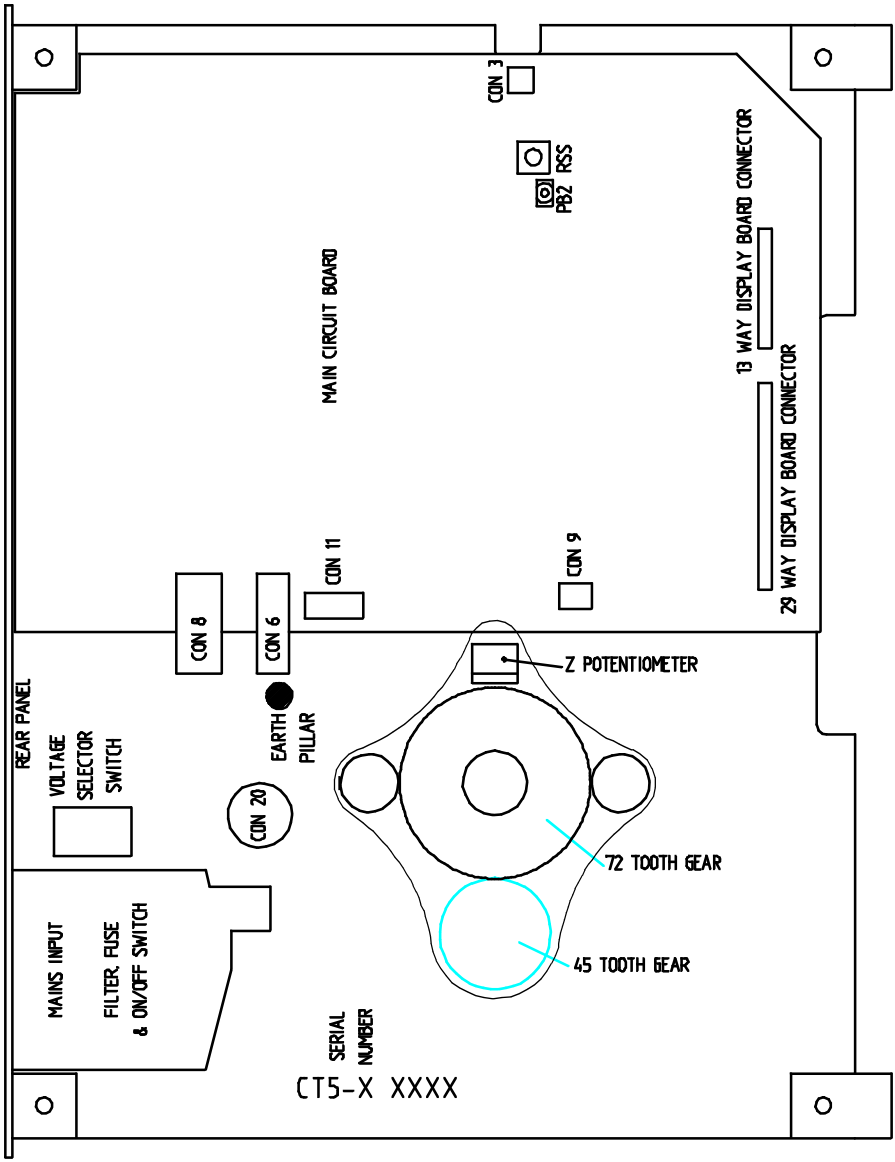


Figure 14

7.3 ELECTRONIC BOARDS FITTED

There are 3 electronic boards boards fitted to the CT5 machine, these boards are identified by a name and number. The name is self explanatory, the number is composed as follows:-

CT5 stands for Compression/Tension 5kN load cell
The LETTER, e.g., D, is the board type i.e. DISPLAY.
The Numbers, e.g. 9912 give the date on which the board was designed or last updated. i.e. Week 12, 1999
The letters, e.g. DC are the initials of the designer of the board

Boards fitted:-
Main board.....CT5M.PCB-9915-DC
Display Board.....CT5D.PCB-9902-DC
Power Supply.....ET500P.PCB-9212-DC
In addition there is an EPROM situated on Main board CT5M.PCB
EPROM..CT5 - v?? The v?? indicates the software version which is fitted, this is printed by the printer when the machine is first switched on.

The toroidal transformer which is fitted, is designed and manufactured to Engineering Systems specifications. Toroidal transformers are more efficient, smaller and most important, give less electromagnetic interference than a conventional transformer. The penalty is a higher unit cost.
Toroidal Transformer.....6D486P

7.4 MACHINE SERIAL NUMBER

The serial no. is to be found on the underside (bottom) of the base plate. This number should be quoted in any correspondence regarding the machine.

7.5 LOAD CELL SERIAL NUMBER

This is etched and printed on the load cell

7.6 TOOL KIT

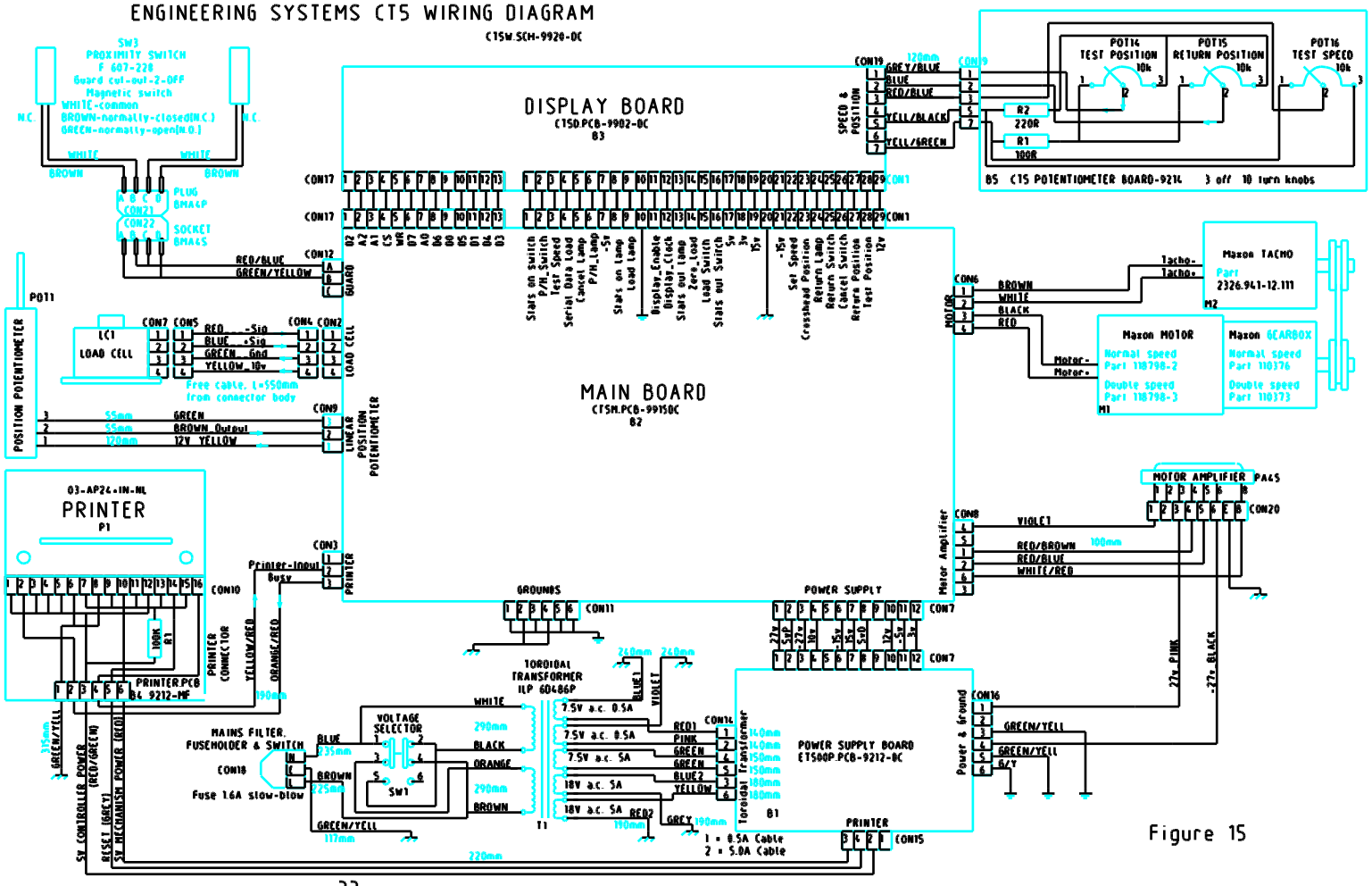
The tool kit and the CT5 HANDBOOK are contained in the draw underneath the base plate.

7.7 TOOLS, PARTS AND SPARES SUPPLIED

Tools
1.5, 2, 2.5, 3, & 5mm hexagon (Allen) wrenches
2.5 & 3mm hexagon ball drivers
Trimmer for adjusting rear set pots
22 A/F open end wrench spanner
Small Screwdriver

Parts
Lower adapter plate, ∅30mm
Lower platen, ∅25 x 15mm
Upper platen, ∅25 x 27mm
Guard Simulator Bar

Spares
2 x Printer ribbon
5 x Paper rolls


ENGINEERING SYSTEMS CTS WIRING DIAGRAM
CTSW.SCH-9920-0C
DISPLAY BOARD
CTSD.PCB-9902-0C
03
MAIN BOARD
CTSM.PCB-9915DC
02
SW3
PROXIMITY SWITCH
F 607-228
Guard cut-out-2-OFF
Magnetic switch
WHITE-common
BROWN-normally-closed(N.C.)
GREEN-normally-open(N.O.)
PLUG
BMA6P
SOCKET
BMA6S
POT11
POSITION POTENTIOMETER
LC1
LOAD CELL
Free cable, L=550mm
from connector body
LINEAR POSITION POTENTIOMETER
LOAD CELL
03-AP24-IN-NL
PRINTER
P1
PRINTER.PCB
04 9212-MF
PRINTER CONNECTOR
Printer-Input
Busy
PRINTER
MAINS FILTER, FUSEHOLDER & SWITCH
Fuse 1.6A slow-blow
VOLTAGE SELECTOR
SW1
TOROIDAL TRANSFORMER
ILP 60486P
T1
Toroidal Transformer
GROUNDS
POWER SUPPLY
POWER SUPPLY BOARD
ETS00P.PCB-9212-0C
B1
Motor Amplifier
MOTOR AMPLIFIER
PA45
Power & Ground
SPEED & POSITION
POT14
TEST POSITION
POT15
RETURN POSITION
POT16
TEST SPEED
10k
R2
220R
R1
100R
B5 CTS POTENTIOMETER BOARD-9214 3 off 10 turn knobs
MOTOR
Maxon TACHO
Part
2326.941-12.111
M2
Maxon MOTOR
Normal Speed
Part 118798-2
Double speed
Part 118798-3
M1
Maxon GEARBOX
Normal Speed
Part 110376
Double speed
Part 110373
1 = 0.5A Cable
2 = 5.0A Cable
Figure 15

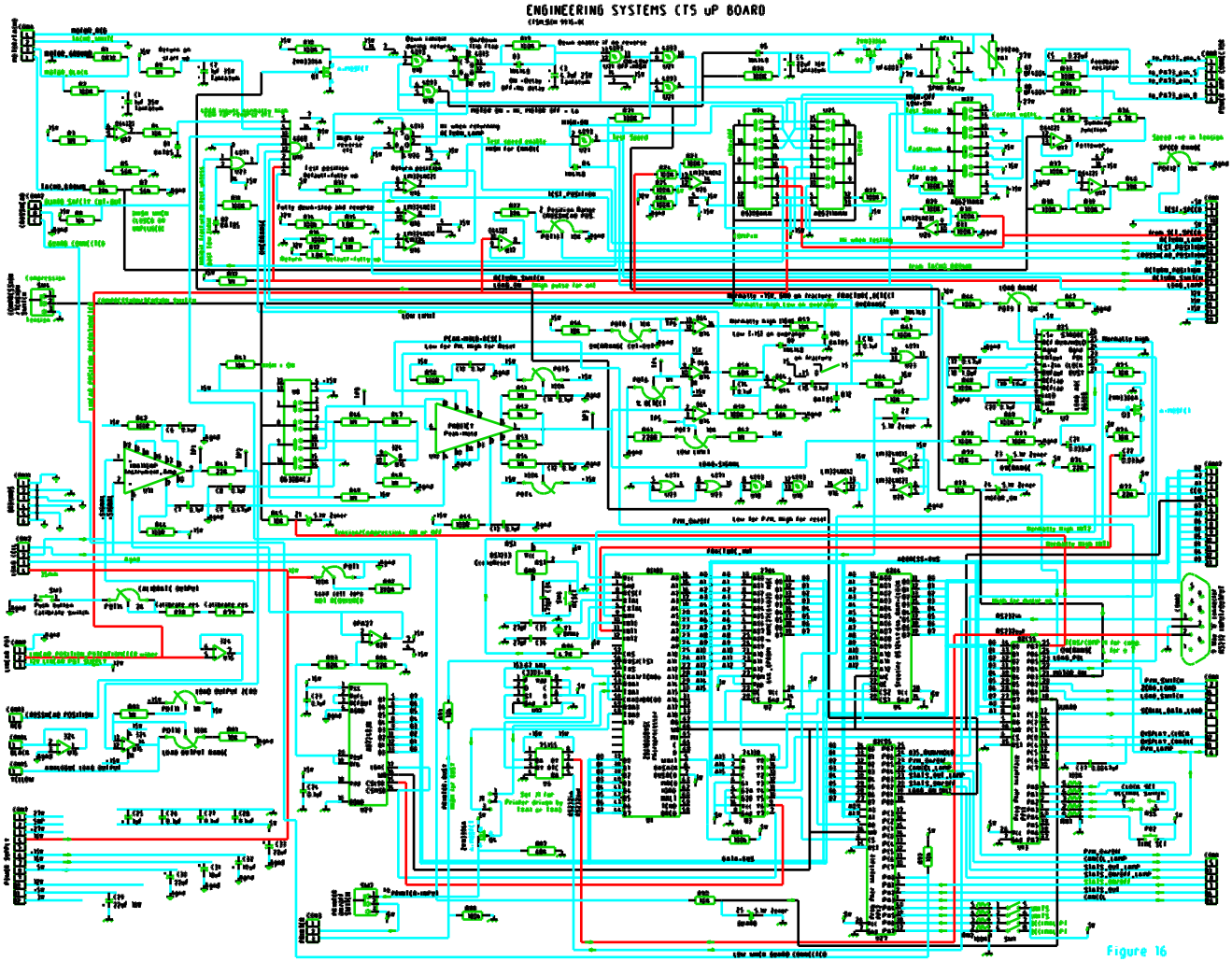


Figure 16

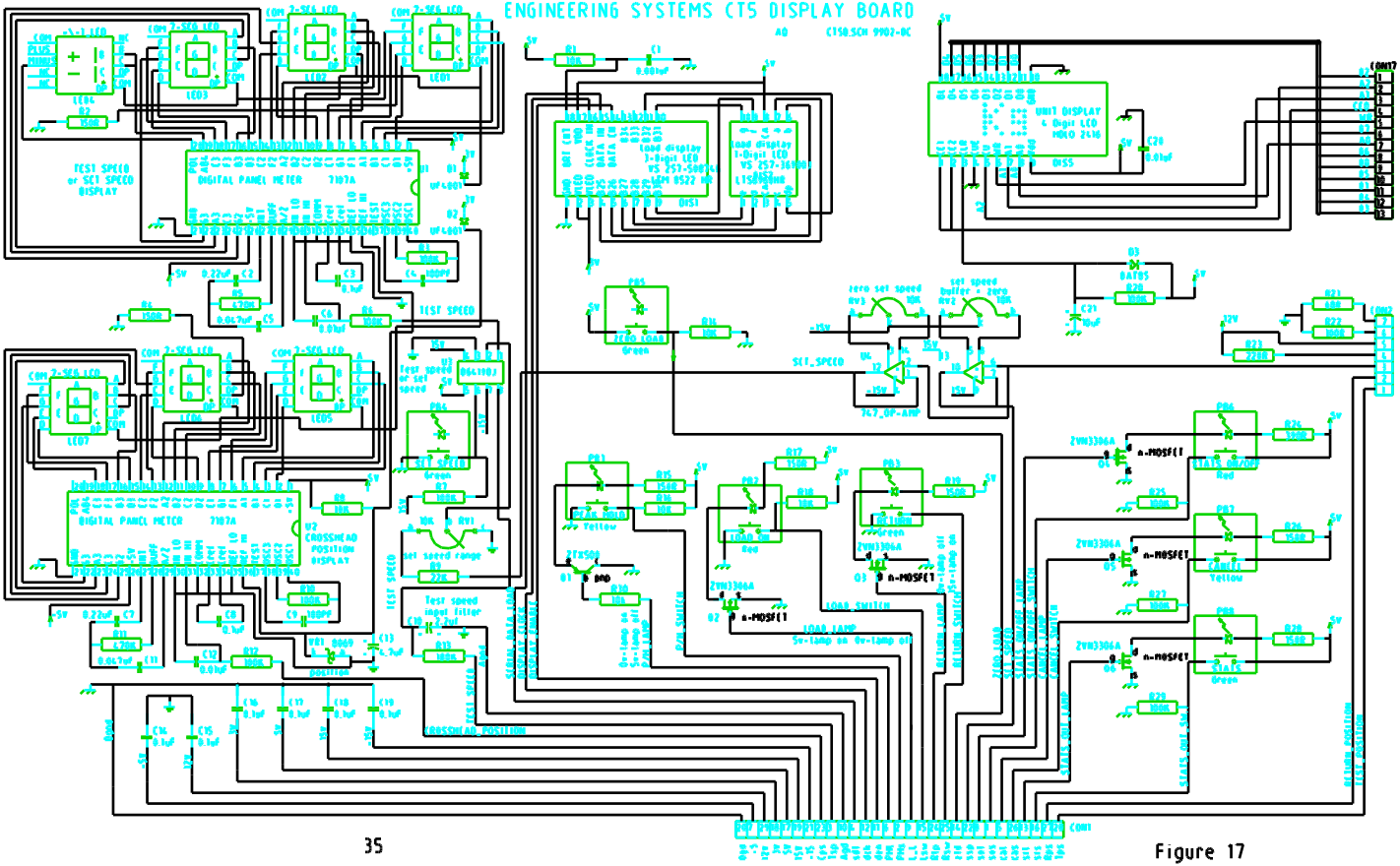

ENGINEERING SYSTEMS CT5 DISPLAY BOARD
A0
C150.SCH 9902-DC
DIGITAL PANEL METER 7107A
TEST SPEED or SET SPEED DISPLAY
CROSSHEAD POSITION DISPLAY
UNIT DISPLAY 4 Digit LCD
load display 3-Digit LED
load display 1-Digit LED
zero load
set speed range
Test speed input filter
LOAD SWITCH
LOAD LAMP
n-MOSFET
TEST SPEED
CROSSHEAD POSITION

Figure 17

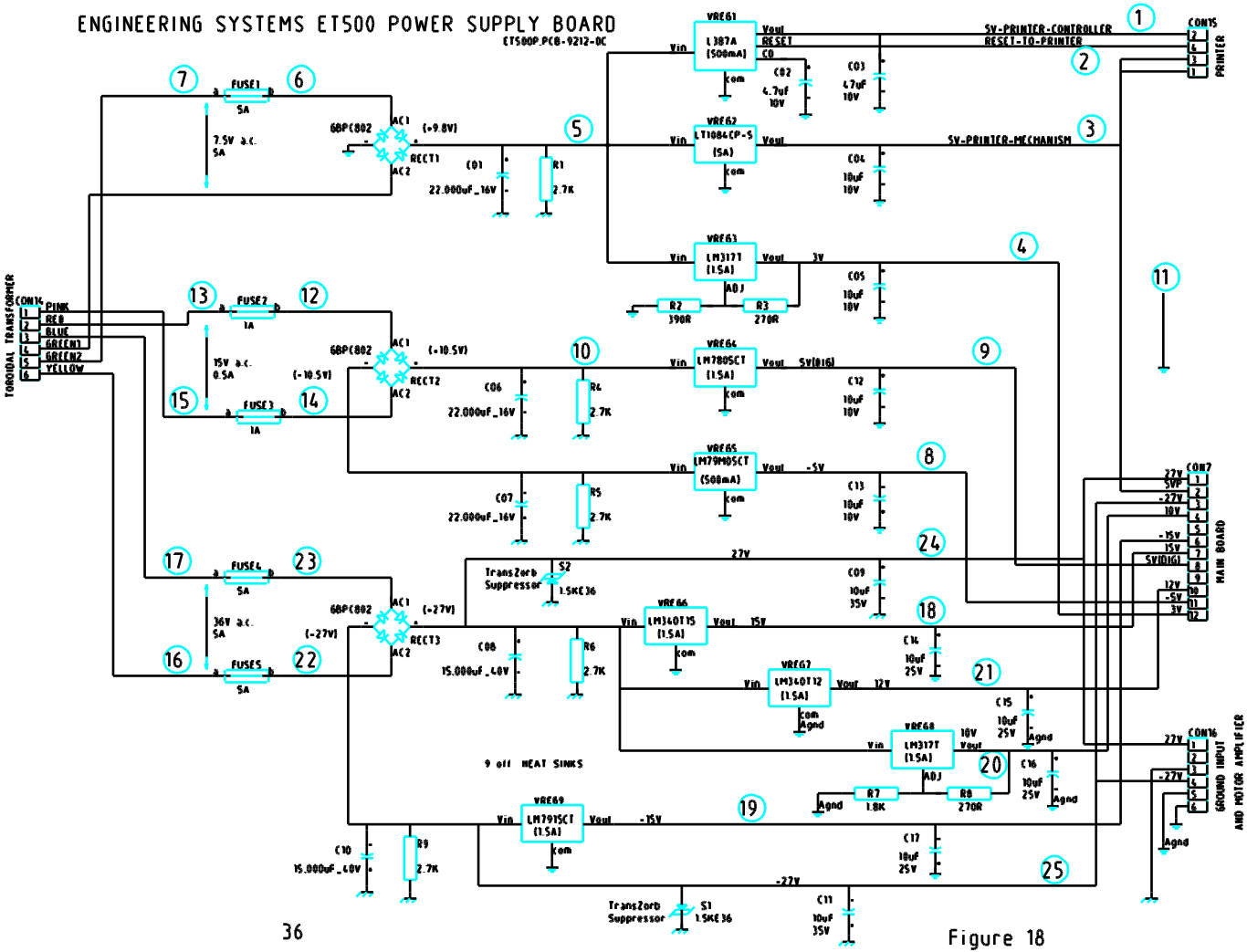

ENGINEERING SYSTEMS ET500 POWER SUPPLY BOARD
ET500P.PCB-9212-0C
TOROIDAL TRANSFORMER
CON14
PINK
RED
BLUE
GREEN1
GREEN2
YELLOW
FUSE1
FUSE2
FUSE3
FUSE4
FUSE5
7.5V a.c. 5A
15V a.c. 0.5A
36V a.c. 5A
6BP(802
RECT1
RECT2
RECT3
(+9.8V)
(-10.5V)
(-27V)
C01
22.000uF_16V
C06
C07
C08
15.000uF_40V
C10
R1
2.7K
R4
R5
R6
R9
VREG1
L387A (500mA)
VREG2
LT1084CP-5 (5A)
VREG3
LM317T (1.5A)
R2
390R
R3
270R
VREG4
LM7805CT (1.5A)
VREG5
LM79M05CT (500mA)
VREG6
LM340T15 (1.5A)
VREG7
LM340T12 (1.5A)
VREG8
LM317T (1.5A)
R7
1.8K
R8
270R
VREG9
LM7915CT (1.5A)
C02
4.7uF 10V
C03
C04
C05
C12
C13
C14
10uF 25V
C15
C16
C17
C09
10uF 35V
C11
10uF 35V
TransZorb Suppressor
S1
1.5KE36
S2
1.5KE36
9 off HEAT SINKS
5V-PRINTER-CONTROLLER
RESET-TO-PRINTER
5V-PRINTER-MECHANISM
3V
5V(816)
-5V
27V
15V
12V
-15V
CON5
PRINTER
CON7
MAIN BOARD
CON16
GROUND INPUT AND MOTOR AMPLIFIER
Agnd

Figure 18

8. MAINTENANCE AND REPAIR

8.1 DISMANTLING PROCEDURE

First switch off the mains and remove the IEC/MAINS lead.
The mechanical and electronic components are mounted on an aluminium alloy base plate which is contained within the outer casing.
This outer casing consists of two separate removable parts, i.e. Main Case and Bottom Cover. These can be removed as follows:-

BOTTOM COVER. Turn the machine to rest on its left hand side.
Unscrew the 4 rubber feet and remove the bottom cover.

MAIN CASE. First disconnect the ribbon connectors which join the main board (underneath the baseplate) to the front board (mounted behind the front of the Main Case). This connector pulls out from the front board, some care is needed to re-connect on assembly. The Main Case is attached to the Main Frame by 4 hexagon screws. Unscrew the 2 hexagon screws which are located one on each of the front foot mounting pillars.
Turn the machine to its normal upright position.
Unscrew the two hexagon button head screws from the rear foot mounting pillars.
Lift the main case upwards so that it just clears the machine and place the casing onto its right hand side taking care not to damage or dislodge the printer connecting cable.
Remove the printer connector cable from the printer.

For reassembly it should be noted that the case fits between the baseplate and the rear bottom back panel.

Refit the Main Case and Bottom Cover, having first installed the printer connector.

Refit the ribbon connectors to the front board and replace the Bottom Cover.

Check the operation of the machine.

8.2 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.

8.3 FIRST STEPS IN FAULT FINDING.

Digital Displays do not illuminate when switched on.

Check mains fuses, Machine 1.6A Slow blow, square pin plug 5A. For 220-240V a.c.

Motor does not start when motor button pressed.

Check internal fuses

However the ability to cure the more subtle or elusive faults requires some understanding of how the machine works. The following diagram shows, in outline, how the CT5 operates :-

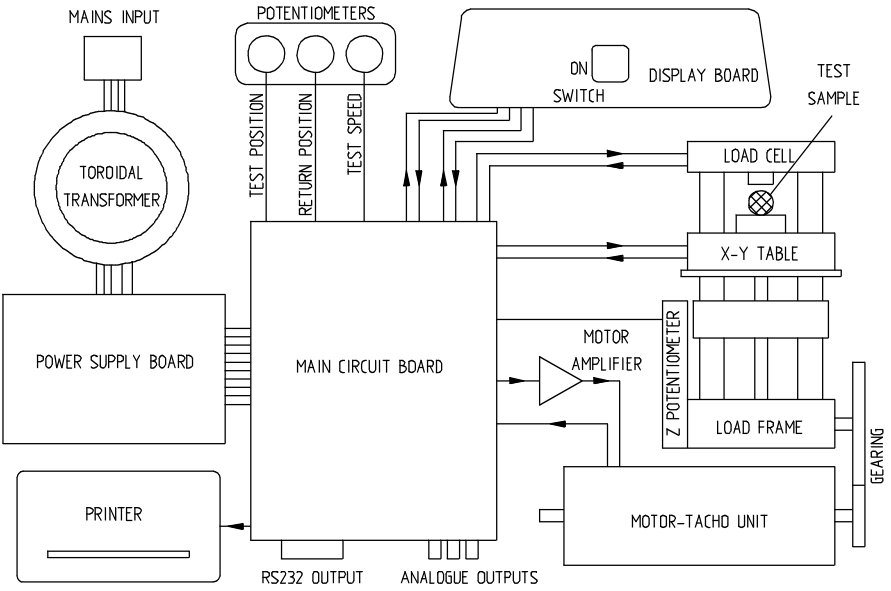


Figure 19

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.

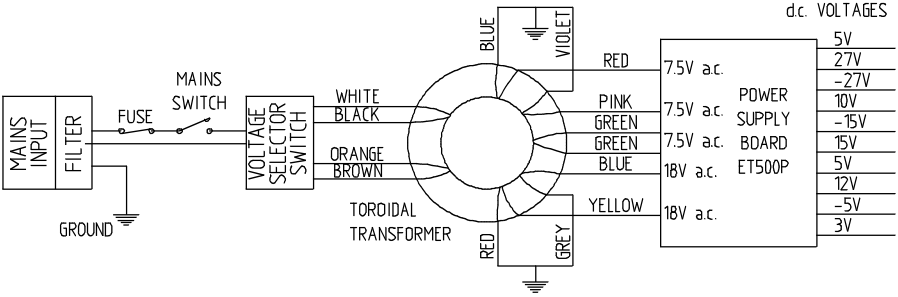


Figure 20

This diagram reads left to right, and shows how the mains input voltage is FILTERED, FUSED, TRANSFORMED and finally RECTIFIED & STABILISED by the Power Supply Board 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. 6 easily replaceable main modules which are fitted above and below the BASEPLATE to which the wiring 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 Toroidal Transformer.
ELECTRONIC Power Supply board, Display board, Main board, Printer.

8.4 SECOND 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 INTERMITTENT faults.

8.5 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.
AVOID AREAS IN THE VICINITY OF NYLON CARPETS etc.

8.6 GENERAL ELECTRICAL FAULTS

FUSES - Check fuses as described in section 5 of the handbook.
POWER SUPPLY - Check the voltages. 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 a.c. output voltages which should appear on the power supply board. Cure - replace the power supply board or the toroidal transformer

8.7 CHECKING THE POWER SUPPLY VOLTAGES

To aid diagnostics the Power Supply board has 25 test points positioned along its top edge. These points are numbered to correspond to the circled numbers shown on the Power Supply board circuit diagram. e.g.

The number pairs 6 & 7, 12 & 13, 14 & 15, 16 & 22, 17 & 23 check the continuity of the 5 board mounted fuses.

Pin 11 is ground and the remaining fourteen test points voltages can be checked against pin 11. i.e. 1 & 11 should give 5 Volts, 25 & 11 should give approx. 27 Volts, etc. Refer to the Power Supply Circuit Diagram, shown in Figure 16, for values (both a.c. & d.c.) of the complete range of voltages.

If the voltages measured are not correct, check the voltages again with the printer connection and the main board removed. Either of these items could upset or drag low the power supply voltage(s) if a faulty component is present within the printer or main board.

8.8 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 nuts at the top of the 'EARTH WIRE PILLARS' are 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.

8.9 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 be obtained from Engineering Systems or the machine sent back for repair.

8.10 MECHANICAL FAULTS

These 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 disastrous! Check the tightness of all 'nuts & bolts' etc., check the gears for tightness. Now try connecting the mains and pressing the start button, listen for and isolate any peculiar noises.

8.11 SPECIFIC FAULTS

PRINTED MESSAGES

If the load cell is not plugged into its rear connector, or if there is a catastrophic fault within the load cell, The message :-Load Cell Error will be printed out by the printer.

MOTOR will not start - Are the return & test controls in the correct position,

Is the speed setting knob set to non-zero?

Faulty main 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.

DISPLAYS do not light up - check fuses especially the 5A fuse on the power supply board. These fuses must all be of the anti-surge (T) or slow-blow type. Check the 23 & 13 way connectors between the display and the main board.
DISPLAYS Will not settle to a constant value - Main board faulty. Load cell or connections faulty.
LOAD DISPLAY jumps up a few digits when peak/hold is switched on:- incorrect internal adjustment of trimmers on peak hold chip on Main board.
PRINTER not working correctly, check that the rear printer connector is connected correctly. Replace printer if a spare is available. Replace Main 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 Main board as there is only a small amount of extra circuitry on this board to drive the printer. Make sure that the paper is not trapped inside the printer body.
TIME & DATE This chip is situated on the Main board and incorporates the RAM. If the time is incorrect - adjust as described in Appendix 3. If the time is again incorrect the next time the machine is switched ON, then the clock has reached the limit of its internal battery life (10 years)? Cure :- renew the 'clock chip' Part No. DALLAS DS1244Y.

NOTE : the various internal trim adjustments, on the main 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 3. in this handbook gives details of the majority of adjustments which can be made. If malfunction is still suspected, return the Main board to the manufactures for complete re-adjustment.

8.12 REPAIR

The CT5 is built from modules both mechanical and electronic. 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.

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.

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 5.1)

8.13 GUARANTEE & SERIAL No.

The guarantee operates for one year from delivery date and covers parts and labour only. Malfunction due to misuse or accidental damage are not covered. Defective components or machines should be returned, at the users expense, to the address below where they will be examined and wholly or partially replaced if necessary.

Users or customers should contact Engineering Systems, before any returns are made, as problems can often be solved by telephone or FAX.

The Serial No. is to be found on the bottom side of the base plate and is visible when the bottom cover is removed. This number should be quoted in any correspondence regarding the machine.

8.14 REPLACEMENT ELECTRONIC BOARDS

Engineering Systems operate a fixed price replacement board exchange service for the Main board, the Power Supply board and the Display board.

9. SPECIFICATION

Maximum Load	500kg or 5000N or 999.9lb
Load accuracy	Better than 0.5% FSR
Load resolution	0.1kg or 1 Newton or 0.1lb
Load indication	4 Digit display & printout
Width between pillars	60mm
Crosshead travel	48mm
Test Height	Depends on pillar extension length Maximum extension of 300mm
Test Speed range	0.05-24mm/min.
Power requirements	110/120 V a.c. 3.15A or 220/240 V a.c. 1.6A
Machine dimensions	Width 370mm, Depth 290mm, Height 330mm with crosshead at the top of its travel
Machine Weight	18kg

ILLUSTRATION & SPECIFICATION NOT BINDING TO DETAIL AS IMPROVEMENTS ARE INCORPORATED FROM TIME TO TIME.

APPENDIX 1

Further consideration of the % fracture detect and low limit settings. (see also section 3.12) 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.)

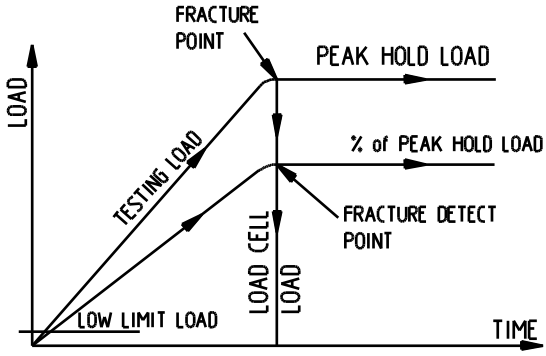


Figure 21

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 drops below 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 meaningful test results can be obtained.

When using the machine for general purpose testing, the following discussion may prove useful :-

Soft crumbly objects may require a lower % setting because the testing load may drop momentarily (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 platen Geometries i.e. convex, may have to be considered.

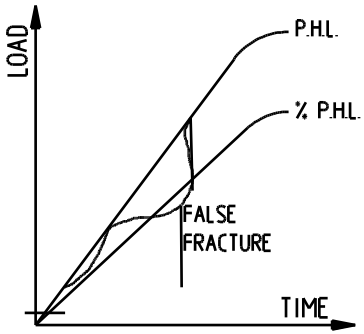


Figure 22

Hard objects in compression may fracture but leave some of the fractured test object in the test position between the loading platens. 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 Low Limit Fracture Detect Suppression, 3.13) will give a fracture detect and the test will be halted.

CHECKING THE % SETTING.
Connect a digital voltmeter, set to its 200mV d.c. range, into the load cell output terminals (see Fig. 8).
With the peak hold switch on, and with the TEST SPEED set at a low speed setting press the load on switch (i.e. crosshead moving down). Slowly depress the load cell by hand to obtain a reading of say 5kg, and note the voltmeter reading, gradually release the pressure on the load cell until the motor stops. At this point (and without further releasing the load on the load cell) note the reading displayed on the external digital voltmeter. Comparison of the peak hold load and the digital voltmeter reading gives the % fracture detect setting.
Note : some practice may be required before consistent percentages are obtained.

ALTERNATIVE SETTING METHOD
With the bottom cover removed and the machine resting on its LHS, set pot 6 so that TP4 reads approx. 70% of the reading on TP2 when the calibrate button is pressed.

ADJUSTING THE % SETTING Turning Pot. 6 clockwise decreases the % setting.

APPENDIX 2

SETTING UP THE MAIN BOARD FOR THE CT5

This is the procedure for setting up the main board during manufacture. This procedure should not be used for setting up an existing board. The instructions given in chapter 3 should be followed for existing boards.

Turn the machine onto its side

Install the main board into machine without any IC's installed, make sure that the ground connectors are in position, check that the incoming DC supply voltages are correct, i.e. that they are not being pulled low by a short.

Insert the IC's and re-check the DC supply voltages after insertion.

With the PEAK HOLD disabled (unlit), adjust Pot4 so that TP3 is equal in voltage to TP8.

Adjust Pot5 so that TP3 is the same when the Peak Hold is enabled or disabled.

Set Pot6 (%Detect) so that TP4 reads approx. 70% of the reading on TP8 when the calibrate button is pressed.

Set Pot7 (Low Limit) to give approx. 30mV on TP5. Turning clockwise decreases the low limit setting.

Calibrate the Load using the Proving ring and adjusting Pot9.

Set Pot11 (Zero) so that the Analogue Load Output = 0V. Turning clockwise decreases the Load Output.

Set Pot10 (Output Range)so that the Analogue Load Output corresponds to the Load reading when the calibrate button is pressed.

With the machine positioned on its side, set the Maximum Load Cut Out using Pot8.

To set to 490 kg [or 49 kg]. (4805 N) :-
Use the formula CUTOUT = (490 [or 49] x R)/C
Where C= Load reading when Calibrate switch is pressed.
and R= corresponding reading on TP8.
Set the calculated CUTOUT voltage onto TP6 by adjusting Pot8.
Note :- the calibration button must not be pressed at this stage.

Setting the Z Distance display. Set the external Return Position & Test Position Pots to zero and press the Load button, when the machine has stopped measure the distance between the crosshead and the X-Y table top. Set the Return Position Pot to its maximum position (10) and measure the new distance between the crosshead and the table top. Set Pot13 so that the reading shown on the Z distance meter is equal to range of crosshead movement i.e. the difference between the two readings.

Setting the Speed display.
Note :- Machine gearbox ratio for normal speed is 316.9/1 and for double speed is 158.7/1.
Gearbox to ball screw ratio is 72/45 = 1.6
1 turn of ball screw = 2.5mm crosshead travel
Set the External Test Position Pot to its maximum position and press the Load On button, set the external TEST SPEED pot so that the gearbox gear (smaller, with 45 teeth) rotates 10 times in 1 minute. Now adjust Pot12 (Speed Range) so that the SPEED display shows 15.6 mm/min. A clockwise rotation of Pot 12 increases the range adjustment.
Turn the external TEST SPEED pot to its lowest setting and with the Test Speed on, adjust RV2 (on display board, see Fig. 10) until it is in its centre position (10 turns from the end).
Then with the TEST SPEED off, press the SPEED SETTING switch and adjust RV3 (display board) so that the SPEED display shows 0. With the Test Speed on, turn the external TEST SPEED pot until the speed display shows 15.6 mm/min., and with the SPEED SETTING switch pressed, adjust RV1 (display board) so that the SPEED display shows 15.6 mm/min.
A clockwise rotation of RV3 decreases the reading on the speed display.
A clockwise rotation of RV1 increases the speed display.

LOAD CELL & CROSSHEAD CYCLING
This is only for use during manufacture (for running in) and testing.
With the machine switched off & the guard unplugged, press both the Load and Peak Hold buttons, on the front panel, and switch on the machine. Keep the two buttons pressed until the printing has finished. Releasing the buttons will cause cycling between the bottom of crosshead travel and the upper set position. Pressing the Load button exits from this routine. Note that if the Load button is pressed during the downward travel, the Return button must also be pressed.

APPENDIX 3

RESETTING THE TIME & DATE CLOCK

With the bottom cover removed, press the black push button switch (PB2, situated next to the blue 10 way rotary switch) and then, with PB2 still pressed, press and release the black push button RESET switch (PB1), wait until the printing has finished before releasing PB2; this activates the clock resetting routine. The printer switch on the rear panel must also be switched on. The printer will print out the time and date at this point.
The new time and date are input into the clock in a sequence of 13 operations. Each operation involves setting the 10 way rotary switch to the correct position and then pressing the push button switch SW9. After each push the printer prints out the latest change in setting.

The clock does not update the time whilst in the reset mode. The clock restarts after the last operation in the reset cycle.

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, 100's & 1000's Years.

These are set in order. To change the time; activate the clock reset as described above. Allow the printer to print out the current time and date. Set the 10 way rotary switch (RSS) to the units of minutes and push the Push button switch (PB2). The printer now prints the new time. Continue the sequence, setting the decimal switch to the ten's of minutes and pressing PB2, repeat this cycle until the sequence of 13 operations has been completed. The final printed output is the newly set time and the machine is then ready for use.

e.g. The clock is to be completely reset to:- 2.30pm, Monday 4th July 2001
The best way to avoid making a mistake is to write out the numerical data in reverse i.e.

2002	July	4th	Monday	24hr time	Minutes
2002	07	04	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 the previous printing has stopped.

QUICK METHOD FOR RESETTING THE MINUTES & HOURS

The minutes and the hours can be changed without having to remove the bottom cover and completely reset the clock. When the machine is first switched on, the Statistics and the Cancel button are reconfigured to be able to update the hours and minutes. The procedure is:-

To increment (increase) the minutes, when the machine is first switched on, the Statistics button must be pressed i.e. press Statistics and then the ON switch; the time & date are printed and as long as the button continues to be pressed, the minutes will gradually be incremented & printed. Release the button when the minutes are correctly set.

To decrement the minutes, Follow the above procedure but use the Cancel button instead of the Statistics button
If the Cancel (decrement) button is pressed before the Statistics (increment) button is released and the Statistics (but not the Cancel) button then released! the minutes will be decremented for as long as the Cancel button is pressed. - And Visa-versa -.

To increment the hour, When the machine is first switched on, wait until printing of the title commences and then press the Statistics button. Hold the button down (a few seconds) until the printing has completely stopped. Release the button, printing will then continue for a short period and the hour will have been increased by 1. It is only possible to increase 1 hour at a time by this method. Larger increases can be achieved by completely resetting the clock or by switching the machine off and on and repeating the above procedure a number of times.

To decrement the hour, Follow the above procedure but use the Cancel button instead of the Statistics button.

When the printing of the title has finished, the Statistics and Cancel button revert to their normal use and cannot (without the machine being switched off or the internal reset button being pressed) subsequently be used for changing the time.

APPENDIX 4

1. TORQUE LIMITER
A special tool is required and the correct setting is 2.5 Nm.
At 200mm, the force required is 12.5 N or 1.3 kg

2. LOAD CELL OFF CENTRE LOADING
The 500kg diaphragm Load Cells supplied with the CT5 are only partially compensated for off centre loading. Errors of up to 5% can be incurred if loading takes place at the edge of the ∅25mm platen.

Since the handbook was last completely revised, there have been a few changes in design:-

The guard is now constructed from polycarbonate sheet which is contained in an aluminium frame.

The load cell is thicker, more robust and is attached to the loading pillars using hexagon cap screws instead of domed nuts.

The main loading pillars are enclosed within a two piece telescopic guard to prevent the ingress of debris into the pillar bearings.

3. GREASE THE MAIN PILLARS
Arrange for the loading pillars to be at the top of their travel. Occasionally (annually? depending on usage) remove the Shoulder Screws which hold the Load Cell onto the top of the main pillars. From the pillars, lift off the top telescopic guard, unscrew (by hand) the bottom guard, if the pillars appear to be dry of lubricant, apply a little ROCOL MTS 1000 (or equivalent) grease. This will lubricate the top pillar bearings. If the pillars were very dry, it would be advisable to check the bottom pillar bearings by removing the outer casing (see section 8.1).

APPENDIX 5

4. NOTES:-

From and including CT5 Serial No. CT5-060-0236 the Motor/Tacho unit has been replaced by a Motor/Encoder unit.
The main reason for this change is that the drive belt between the Motor and Tacho had a limited life and required changing at intervals. With the Encoder and associated electronics, the sensitivity of the feedback speed control system is similar or at least as good as with the Tacho.
There are 10 dip switch settings on the Encoder Controller. These are set to:- 6 & 9 are on (down), the rest are off. These switches are set at the factory and are only accessible if the Encoder Controller is removed.

Associated changes:

Figure 15 shows the addition of the Encoder (replacing the Tacho) and Encoder Controller and the associated change in the wiring diagram.

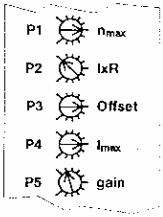
Figure 16, Main board.
Removed: D7, D8, R6, R7, R33, R34, R36, C5, REL1, VA1, CON6
Replace: R35 with link and D6 with 4.7k resistor.
Link: REL1-pin1 to CON8-Pin5 (Relay pin1 to pin 5 on Power Amp Connector)

Added 22k – 100k divider in front of R38 to bring the ±15 volts down to ±12 volts so that the speed display gives the true fast up and down speed.

Figure 17, Display board.
R22 & 23 not necessary and are removed. R21 was 68R now changed to 18R

The following table shows how to adjust the Encoder controller. This is set to its optimum before the C50 is despatched and should not need further adjustment. Care must be exercised if adjustment is made and it will change the speed settings and speed display.

Function of potentiometers



Potentiometer		Function	Turning direction left ↺	Turning direction right ↻
P1	n_{max}	maximum speed at maximum set value	Speed lower	Speed higher
P2	IxR	IxR compensation	weak compensation	strong compensation
P3	Offset [1]	Adjustment = 0 rpm at 0 V set value	Motor turns CCW	Motor turns CW
P4	I_{max}	Current limit	lower min. approx. 0 A	higher max. approx. 2 A
P5	gain	Speed control gain	lower	higher

Adjustment

Encoder operation
DC tacho operation
Voltage regulator
IxR compensation

1. Apply max. set value (10 V or 3.9 V) and turn potentiometer **P1 n_{max}** until required max. speed is reached.
2. Adjust potentiometer **P4 I_{max}** to required limit value.
   Limited current in the 0…2 A range can be adjusted in linear fashion with the P4 potentiometer.
   Important: The limit value I_{max} should be below the max. permissible continuous current as per motor data sheet.
3. Slowly increase potentiometer **P5 gain** until the gain is set sufficiently high.
   Important: If the motor is unsteady, vibrates or makes noises, the selected amplification is too high.
4. Apply 0 V set value and adjust the motor to speed 0 rpm with potentiometer **P3 Offset**.
   Important: DIP switch 9 must be set in the "ON ↓" position for offset adjustment.

Applicable to IxR compensation only:

5. Slowly increase potentiometer **P2 IxR** until compensation is set sufficiently high so that the motor speed does not drop or only drops very slightly at higher motor load.
   Important: If the motor is unsteady, vibrates or makes noises, the selected compensation is too high.

Current regulator

1. Adjust potentiometer **P4 I_{max}** to required limit value.
   Limited current in the 0…2 A range can be adjusted in linear fashion with the P4 potentiometer.
   Important: The limit value I_{max} should be below the max. permissible continuous current as per motor data sheet.
2. Apply 0 V set value and adjust the motor to current 0 A with potentiometer **P3 Offset**.
   Important: DIP switch 9 must be set in the "ON ↓" position for offset adjustment.

Note 1: DIP switch 10 in position:
"ON ↓":set value range -3.9 ... +3.9 V equivalent to approx. -2 ... +2 A motor current
"OFF ↑":set value range -10 ... +10 V equivalent to approx. -2 ... +2 A motor current

Note 2:
In current regulator operation, potentiometers P1 n_{max}, P2 IxR and P5 gain are not active.

ERRATICA:- Previously, the speed display LED's (front panel) showed the actual loading speed because the display was driven by the Tacho output voltage. Now that there is no Tacho voltage output, the speed display is derived from the Motor control voltage. Also, when testing, it is possible that at low speeds and high loads, the actual speed may be slower than that shown on the display.