C105 Circular Case Recorder

Operating Instructions

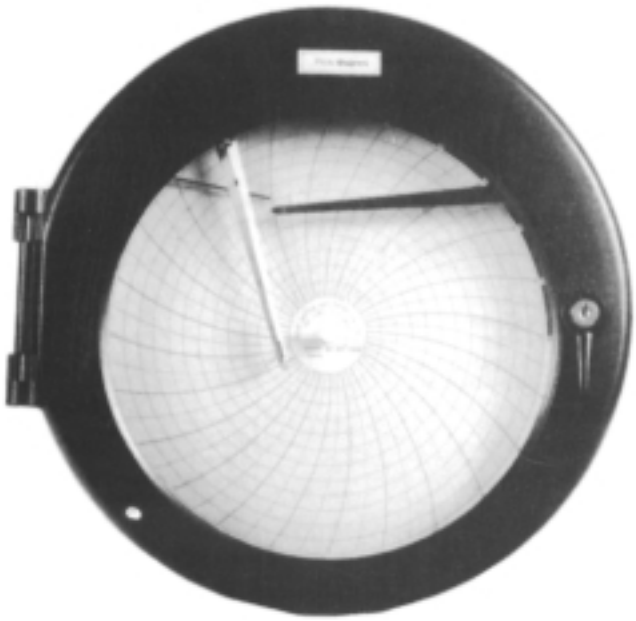


Fig. 1.

CONTENTS

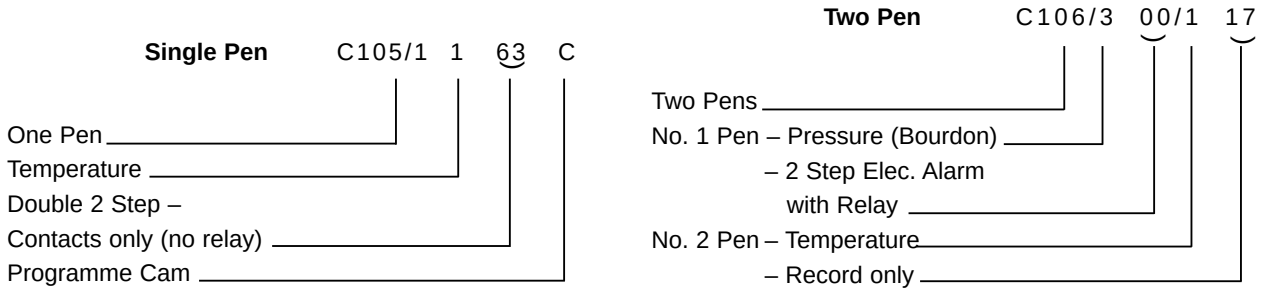
The chart drive and control system on this instrument may be operated from a mains voltage supply. The mains must be switched off before making any mechanical adjustments other than of the set pointers or carrying out any maintenance or fault finding procedures. When making electrical adjustments observe the warning notes in the text.

INTRODUCTION

The C105 series of instruments is designed to measure, record and control process variables such as temperature, pressure and humidity. A maximum of two measuring systems is provided in each instrument; a fluid expansion type or bimetallic system is used for temperature recording, a hygroscopic element or a wet and dry bulb system for humidity and a Bourdon tube or diaphragm for pressure measurement. The measured values are continuously recorded on a calibrated circular chart which is rotated at a constant speed by a mechanical or electric clock. Control of the process variable is provided electrically.

Basic Type Number	No. of Measuring Points	Each Pen: Measured Variable	Each Pen: Alarm or Control Mode	Each Pen: Set Points No. 1	Each Pen: Set Points No. 2	Each Pen: Set Points Nos. 3 & 4	Each Pen: Programme Control Cam (Single Pen only)
C10 Recorder with 105mm pen travel on circular chart	5 One pen 6 Two pen	1 Temperature (Fluid expansion system) 2 Pressure ('C' Spring– 316 st.steel) 3 Pressure (Spiral Bourdon – phosphor bronze) 4 Pressure (Spiral Bourdon – 321 st.steel) 5 Pressure Capsule Stack – beryllium copper) 6 Pressure (Diaphragm Stack – beryllium copper) 7 Relative Humidity (Goldbeater skin) – External 9 Pressure (Coiled Tube – 316 st.steel	17 Record only	–	–	– –	–
			Electric Alarm/Control with Relay Output	**Position of Pen in relation to Set Point when Relay is energised**			
			00 Two Step	Above	–	None, or any	– or C
			01 Two Step	Below	–	combination	– or C
			05 Three Step	Below	Below	applicable	–
			06 Three Step	Above	Above	to Set Points	–
			09 High-low	Above	Below	No. 1 & 2	–
			03 Double 2 Step	Above/Above	–		– or C
			04 Double 2 Step	Below/Below	–		– or C
			Electric Alarm/Control Contacts only – no Relay	**Contact Action at Set Point when Pen moves towards outside of Chart**			
			60 Two Step –Contact Mode C	Make	–		– or C
			61 Two Step –Contact Mode A	Break	–	None, or any	– or C
			65 Three Step –Contact Mode AA	Break	Break	combination	–
			66 Three Step –Contact Mode CC	Make	Make	applicable	–
			69 High-Low –Contact Mode CA	Make	Break	to Set Points	–
			63 Double 2 Step –Contact Mode D	Make/Make	–	No. 1 & 2	– or C
			64 Double 2 Step –Contact Mode B	Break/Break	–		– or C

Notes:
Code No. is built up thus:



Specification

General:		
Chart diameter	255mm	
Writing width	105mm	
Intrinsic error	± 1% span maximum (±2% R.H. for hygroscopic membrane system)	
Operating temperature limits	–10° to +50°C	Except for
Operating humidity limits	0 to 80% R.H.	humidity recorders
Zero error due to ambient temp. variations	±0.05% span/°C typical	
Chart speeds	1 rev every 12 hours, 24 hours or 7 days	
Chart drive	Synchronous electric motor or mechanical clock	
Power supply voltage and frequency	200/250V or 100/120V, 50 or 60Hz	
Mounting	Wall or panel	
Temperature measuring instruments:		
Measuring systems	Fluid expansion	
Maximum length capillary	30m	
Minimum span	40°C	
Maximum span	500°C	
Span limits	– 30°C to +600°C	
Pressure measuring instruments:		
Measuring system	Capsule stack, Bourdon tube or coiled tube	
Minimum span	0 to 1 bar vacuum or pressure.	
Maximum span	1200 bar	
Span limits	–1 bar to 1200 bar	
Connection size	Ranges up to 40 bar: ⅜ inch B.S.P.) with nut and tail	
	Ranges over 40 bar: ½ inch B.S.P.) piece for 8mm tube	
Humidity measuring instruments:		
Measuring systems	Sensitive hygroscopic membrane and fluid filled system for temperature measurement, or wet and dry bulb fluid expansion systems.	
Spans	20 to 100% R.H. (hygroscopic membrane);	
	0 to 40°C (fluid filled systems)	
Operating temperature limits	0 to 40°C	
Operating humidity limits	30 to 85% R.H.	
Maximum length of capillary (wet and dry bulb system)	30m (each bulb)	
Electric alarm or control:		
Instrument contacts	20mA inductive or 30mA non-inductive load max.	
Contact action	Make above or below set point as required	
Relays	Delayed action double pole change-over, 5A, 240V 50Hz non-inductive load, as standard (Refer to wiring Diagram, p.14).	
Relay action	Energised above or below set point as required.	
Overall dimensions	350mm wide; 137mm deep; 350mm high (Temp & R.H. 582mm high)	
Panel cut-out	318mm diameter	
Maximum panel thickness	25mm	
Weight	10kg	

INSTALLATION

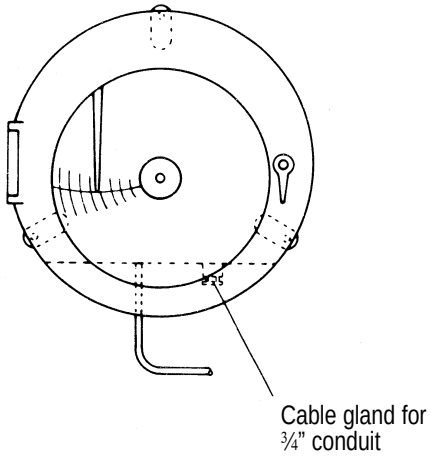
Mounting

The instrument can be wall or panel mounted using the same fixing brackets. Do not install near any very hot apparatus, e.g. ovens, steam pipes or flues. Mount the recorder vertically in a position free from vibration and excessive temperature.

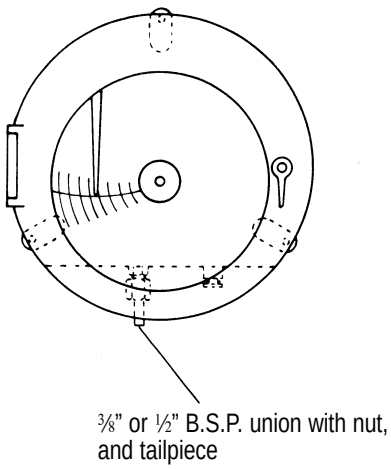
For panel mounting remove the fixing screws and rotate the fixing brackets so that the instrument can be inserted in the hole in the panel. Return the brackets to their original position and insert the fixing screws. Tighten the screws until they bear against the back of the panel.

Hygroscopic measuring instruments have external measuring elements requiring a clearance of 240mm below the case, and must be wall mounted.

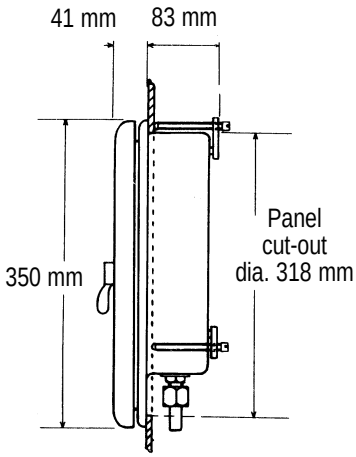
Temperature Recorder



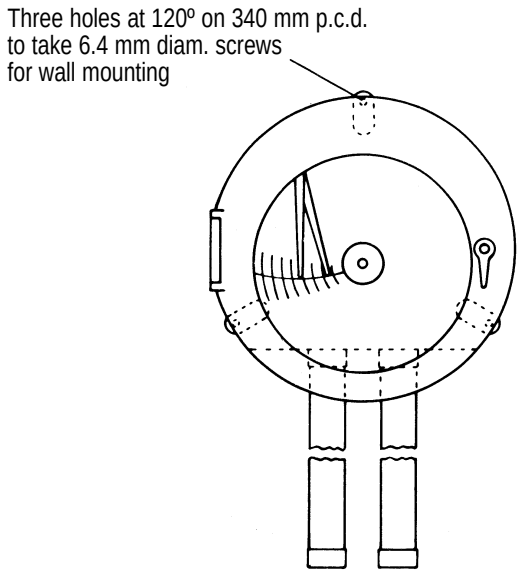
Pressure Recorder



Panel Mounting



Temperature and Relative Humidity Recorder



Wall Mounting

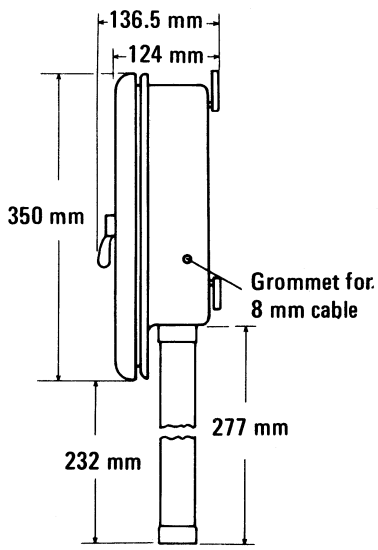


Fig. 2.

Access to Recorder

To open the door, unlock, and turn the latch anticlockwise. As the door is opened the pen lifter raises the pen (or pens) away from the chart. Remove the chart (see page 6).

If the instrument is connected to the mains, switch off the mains supply before dismantling further.

For access to the terminal blocks remove the lower plastic plate from behind the chart by undoing the one retaining screw.

For access to the relays and measuring systems, first remove the chart. Unhook the pens from their mounting (see Fig. 3.). Remove the three screws from the outside edge of the chart plate. (The pen lifter is secured by one of these screws and must also be removed). Lower the chart plate carefully. The chart motor is mounted on the back of the chart plate and if the motor is an electric one it remains connected to the terminal block in the lower part of the case.

When replacing the chart plate reverse the above procedure. The coil on the pen lifter should be against the side of the case when the retaining screw is tightened.

Process Connections

To avoid confusion on instruments with more than one measuring system, setting pointers are labelled and Bourdon tube capillary connections to the instrument are painted with the same colours as the inks used for the corresponding pens.

Process connections – temperature measuring instruments:

Install the sensing element (bulb) of the instrument in the apparatus where the temperature is to be measured. The circulation around this element should be good and it should not be too close to any heating or cooling coil or other controlling medium. Fasten the capillary tubing at frequent intervals to rigid supports avoiding sharp bends of less than 50mm. radius anywhere along its length. The tubing must not touch or run close to any hot apparatus and should take the path least subject to temperature variation. If the temperature source is likely to move or vibrate allow one or two coils of 100mm. diameter of the capillary tube to eliminate stress of the tubing.

If the atmosphere around the capillary tube is likely to be corrosive, paint the tube with anti-corrosive paint and ensure this is maintained.

Process connections – pressure measuring instruments:

Connect the Bourdon tube sensing element to the measuring point on the apparatus using pressure tubing of the same or similar material as the Bourdon tube and of sufficient pressure rating. Slope the run of the tubing so that any condensate is drained away from the instrument and does not affect the accuracy of measurement. For measurement of steam pressure or other hot vapours, form a condensate trap below the instrument.

Process connections – humidity measuring instruments (wet and dry bulb):

Install the sensing elements (bulbs) where the humidity is to be measured as described for temperature measuring instruments. The wet bulb (red pen system) is kept moist by a fabric covering, forming a wick which dips into a constant level water bath. A distilled water supply tank should be connected to the inlet feed pipe with a head of between 1 and 6 metres.

It is important to install the bulbs in a position where the air speed is 3.6 metres per second or more. Below this speed inaccuracies of bulb depression may occur. The air should pass over the bulbs in such a direction that the water evaporating from the wet bulb does not pass over the dry bulb. The water must be kept clean and free from impurities. The temperature of the bath and all piping must not fall below 0°C. See also page 13.

Electrical Connections

Before making any connections to the instrument switch off the mains supply to be connected.

All electrical connections are made to terminal blocks in the lower part of the case behind the lower section of the chart plate.

Insert the leads through the cable gland in the underside of the case (see Fig. 2.) and make the connections as shown on the terminal labels or Wiring Diagram (page 14). The live line should be switched and fused with a 2 amp fuse. If the instrument is mounted on an insulated panel the case should be earthed.

OPERATION

Mechanical Clock

To wind the mechanical clock first remove the chart as described below.
This exposes the clock key, which is permanently fitted in the front recess of the clock moulding.
To wind the clock turn the key clockwise. Do not overwind.

Fitting a Chart (Spider Clamp)

Unscrew the milled head on the centre of the clock spindle until the spider retracts. Remove the chart. Fit the new chart over the spider head onto the locating boss. Rotate the chart until the pen tip coincides with the correct time line and clamp by screwing down the milled head. On a two-pen instrument the outer (red) pen, should be set on the correct time line.

Fitting a Chart (Lever Clamp) – Fig 2(a)

Release the clamp as shown. Remove the old chart. Fit the new chart on the spindle and rotate the chart until the pen tip is on the correct time line. Lower the chart clamp and press on it firmly to ensure that the locating pips pierce the chart.

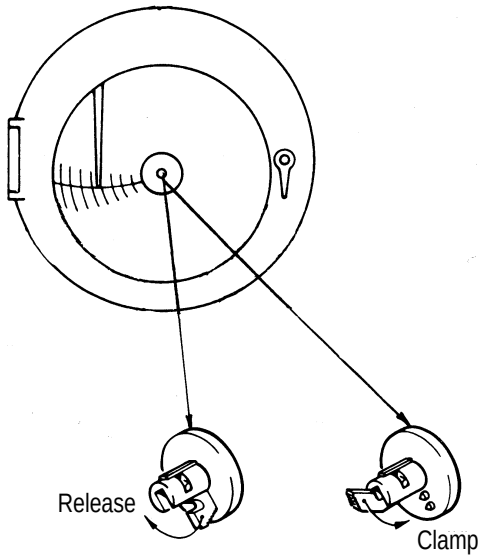


Fig. 2(a) Chart Lever Clamp

Set Pointer Adjustment

To set the desired alarm/control point slacken the clamping knob at the right-hand end of the setting pointer (Fig. 5), position the pointer on the desired value and re-tighten the clamp.

Inking System

The pen is tied during transit, but if dislodged it can be simply reassembled as shown. The pen arm is forked, one prong being pointed, the other curved. The pointed prong fits into a conical hole in screw S and curved one into the V shaped groove V. The pen is held in position by a spring X and hook Y. On the rear pen the hook Y faces towards the rear.

The writing system uses fibre pen capsules. A dovetail on the capsule fits into a slot at the end of the pen arm and the capsules are easily replaced when the ink is exhausted. To fit a capsule, pull the pen arm gently clear of its mountings S and V and unhook it from instrument. Slide off the used capsule and replace it with a new one of the appropriate colour. Where there are two measuring systems, different coloured inks are used to distinguish the traces. The fibre tip is protected by a plastic cap, which should be removed by pulling in line with its length, gripping the end only and gently twisting. Do not bend. The front pen (red) has a long fibre tip and the rear pen (green) a short tip.

Place the spring X over the hook Y and gently pull the pen arm to locate it in its mountings S and V. Take care not to bend the pen arm.

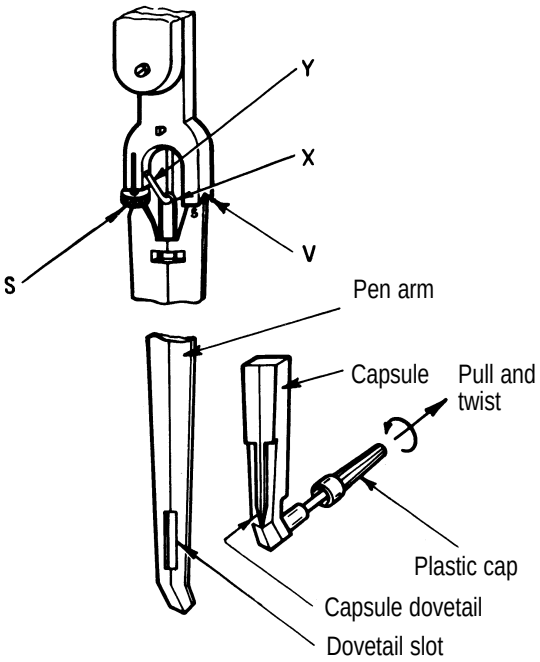


Fig. 3

In some instruments, (supplied to special order only) fibre pen capsules are not used and each pen reservoir must be filled with ink using the dropper supplied in the ink bottle. Each pen should be cleaned occasionally by drawing the edge of a piece of stiff paper through it. If it becomes dirty or greasy remove the pen arm and wash the pen methylated spirits.

Zero adjustment

NOTE: After making any zero adjustment to instruments fitted with control or alarm contacts the relay operating point must be checked and adjusted as described on page 10.

Zero adjustment – temperature recorders and wet and dry bulb humidity instruments:

All instruments are calibrated against a standard thermometer before despatch but should be checked in case of slight disturbance during transit. Immerse a standard thermometer with the bulb and check the readings. If adjustment is necessary open the door and rotate the small knurled screw S (in Fig. 3.) to bring the pen to the correct reading.

Zero adjustment – pressure recorders:

Use a reliable pressure gauge to check the readings and adjust, if necessary, as for the temperature recorder.

Zero adjustment – temperature and humidity recorders:

Check the temperature reading against a standard mercury-in-glass thermometer and the humidity reading against a whirling hygrometer using hygrometric tables to relate humidity to wet and dry thermometer readings.

Hygrometric tables are compiled by the Meteorological Office and obtainable from H.M. Stationery Office. Alternatively use the Psychrometric tables by C.F. Marvin (issued by U.S. Department of Commerce Weather Bureau) and obtainable from C.F. Casella & Co. Ltd., Regent House, Brittania Walk, London N.1.

The zero setting may be adjusted using screw S (Fig. 3). If the humidity reading requires more correction than that provided by S, screw J, accessible through the bottom of the guard, may be adjusted (Fig. 4).

In a bimetallic temperature measuring system the linkages and zero adjustments are the same as for the hygroscopic measuring system.

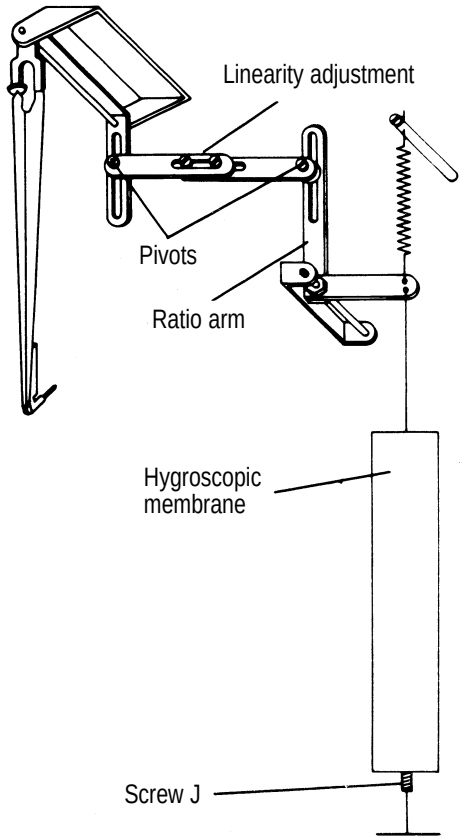


Fig. 4

Start-up Check

Before putting the controller into operation make certain it is correctly installed and operational by checking that:

1. The pens operate freely, write cleanly on the chart and can pass each other without touching.
2. Measuring elements are correctly installed.
3. Measuring systems are indicating correctly. If not refer to **Zero Adjustment**, above.
4. On electrical controllers:
   Relays are energised above or below set point as required. If they are not, see **Changing the Control Action**, page 10.
5. If a mechanical clock is fitted check that it is wound up (see **Mechanical Clock**, page 6).

Start-up procedure

Be sure that all steps in the start-up check have been completed.

1. Switch on mains supply to recorder.
2. Position setting pointers on desired alarm/control values.
3. Switch on mains supply to external electric alarm/control systems.

Description of Operation

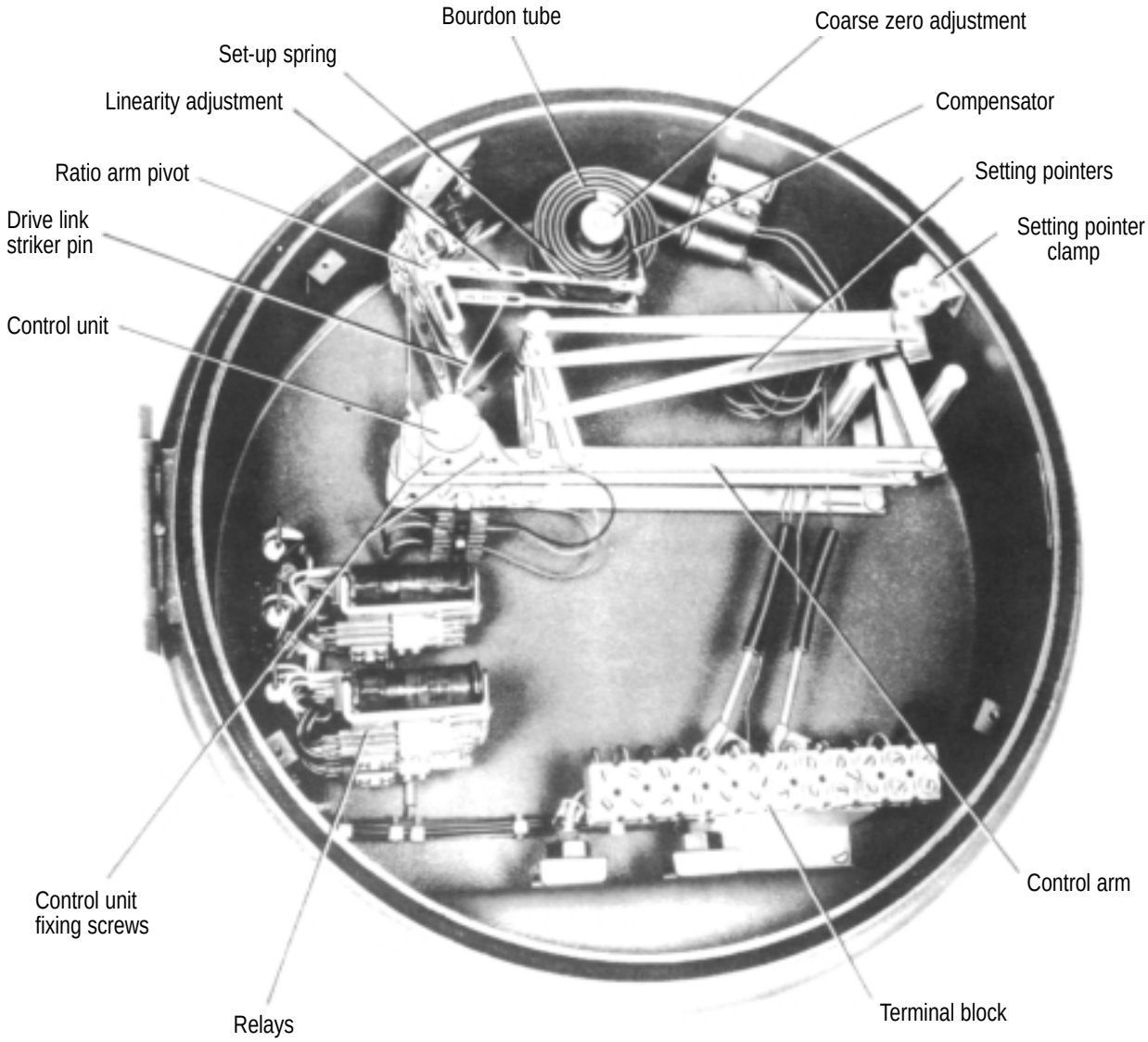


Fig. 5

Temperature recorder (see Fig. 5.)
As the temperature rises, the fluid in the thermometer bulb expands and partially uncoils the spiral Bourdon tube fitted inside the instrument. This movement is transferred by a mechanical linkage to the pen arm which records the temperature on a calibrated chart.

Pressure recorder
On medium and high pressure ranges an increase in pressure partially uncoils a Bourdon tube fitted inside the instrument. This movement is transferred by a mechanical linkage to the pen arm which records the pressure on a calibrated chart.

A capsule stack or diaphragm system is fitted for low pressure ranges and the expansion of the system resulting from an increase in pressure is transferred by a mechanical linkage to the pen arm.

Temperature and humidity recorder (see Fig. 4)

The air circulates around a strip of animal tissue (Goldbeater skin) the length of which varies with the relative humidity. The membrane is mounted under light spring tension and is connected by means of a bell crank lever and linkage to a pen arm which records the humidity on a calibrated chart. Temperature is measured by a fluid filled system which is mounted to the left of the humidity element and mechanically linked to a second pen arm.

Humidity recorder – wet and dry bulb

The relative humidity can be obtained from the temperatures measured by the wet and dry bulb thermometer using hygrometric or psychrometric tables.

Set up and Overload Protection Springs

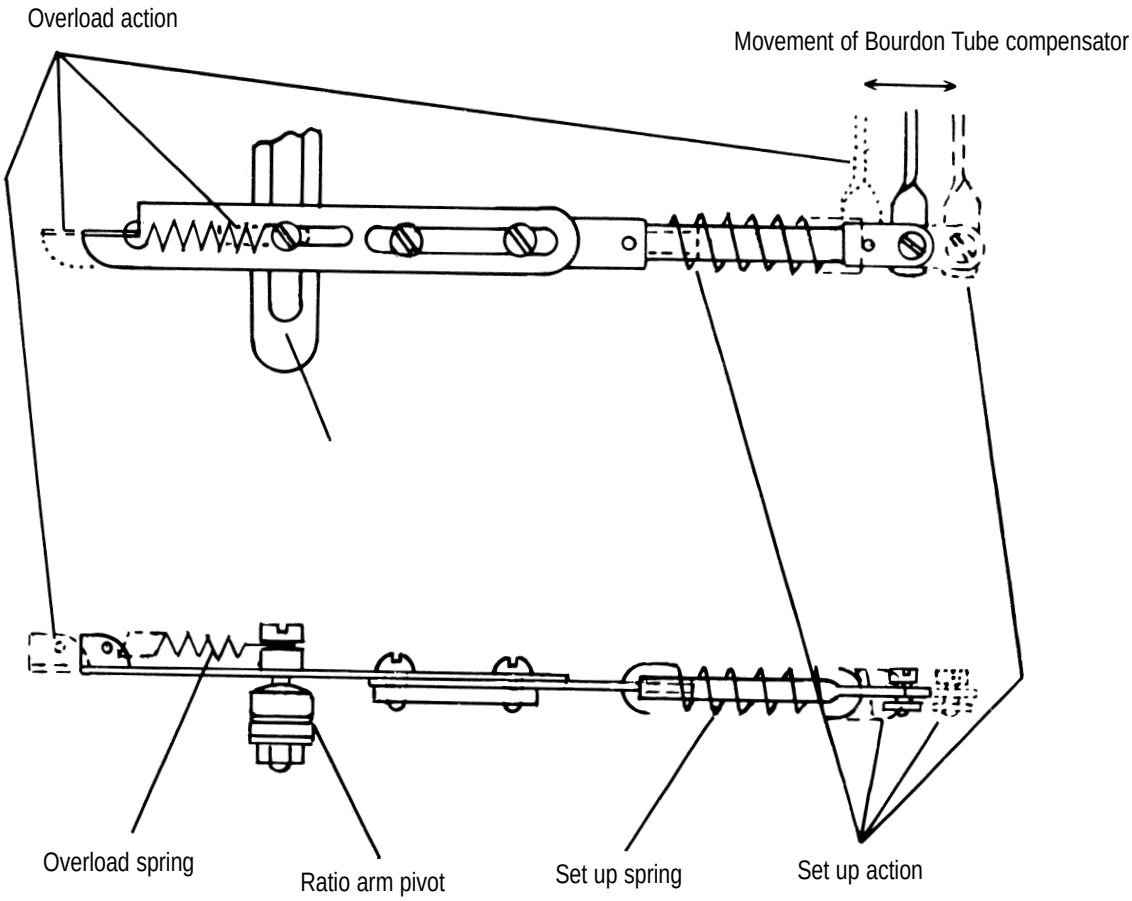


Fig. 6

To protect the pen mechanics if the measured variable goes significantly outside the span of the instrument the connecting link may incorporate “set up” and/or “overload” springs (see Fig. 6.).

The set up spring (also shown in Fig. 5.) is used if the measured variable is liable to go significantly below the chart zero reading, e.g. on a temperature recorder calibrated 100–600°C where the measuring element is subject to normal ambient temperatures during transit. Under these conditions the movement of the Bourdon tube compensator extends the spring allowing the pen mechanism to rest against the zero stop.

The overload spring is used if the measured variable is liable to go significantly above the maximum chart reading. Under these conditions the movement of the Bourdon tube compensator extends the spring allowing the pen mechanism to rest against the top point stop.

Electrical alarm/control system

Each relay is switched by a contact mounted on an arm linked to the setting pointer which makes or breaks with a contact attached to the recording pen linkage when the pen reaches the set point (see Fig. 5.). The striker is fixed relative to the pen arm and a spring loaded contact is fitted to the setting pointer linkage. One set of changeover contacts is available for external connection for each set point. The contacts are usually labelled “normally closed” (NC), “common” (C) and “normally open” (NO) where normally means that no current is flowing through the relay coil. Refer to page 14 for any special wiring information.

On wet and dry bulb humidity controllers in addition to standard control contacts for the dry temperature a contact may be fitted on the dry bulb pen linkage so that the wet bulb depression may be controlled.

Alarm systems should have an independent power supply to safeguard alarm operation in the event of mains failure.

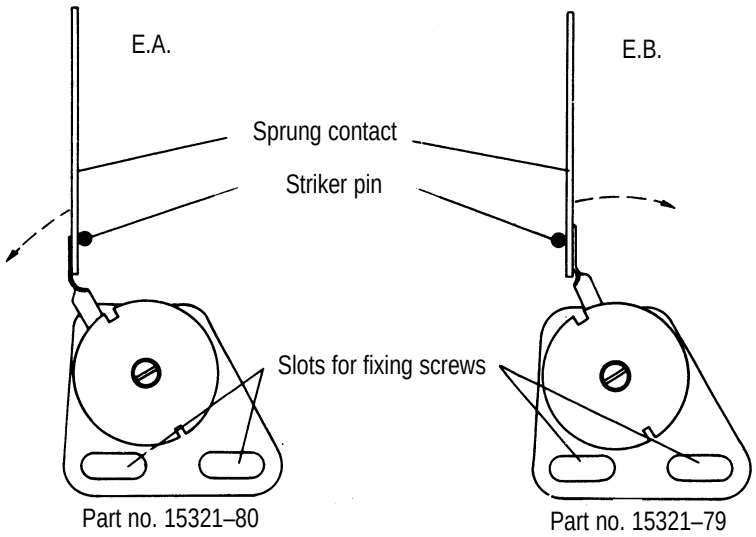


Fig. 7. Electrical Control Contacts

Adjusting the relay operating point

If the measured value indication is correct and the relay operates at a value other than that shown by the setting pointer, the error may be corrected as follows. Move the setting pointer to the indicated value. Switch off the electrical supply to the recorder and remove the chart, pens and upper chart plate. Slacken the two nylon screws on the control unit (see Figs. 5 and 7) and slide it along the control arm until the sprung contact just touches the fixed contact. Re-tighten the screws and replace the chart plate etc. Check the relay now operates at the desired set point.

Changing the Control Action

Switch off the electrical supply to the recorder and remove the chart, pens and upper chart plate.

To change the relay action from energised below set point (E.B.) to energised above set point (E.A.) or vice-versa the control unit incorporating the spring loaded contact should be unscrewed from the control arm and a unit with the contact spring loaded in the reverse direction fitted in its place (see Fig. 7). Adjust the relay operating point as described above. Tighten the screws and replace the chart plate etc.

Programme Control

Programming is provided by a shaped transparent cam driven by the chart motor and linked by a cam follower to a control unit inside the instrument case. The control unit continually operates external regulating equipment in accordance with the configuration of the cam. The measuring system monitors and records the process variable as in the basic C105 instrument.

The programming cam is mounted over the chart directly on to the chart drive shaft. The cam follower is a pivoted arm with a roller lightly sprung against the edge of the cam at one end and a linkage to the internal control unit at the other. The cam follower is deflected as the cam rotates and actuates the electrical control unit. All cams are interchangeable.

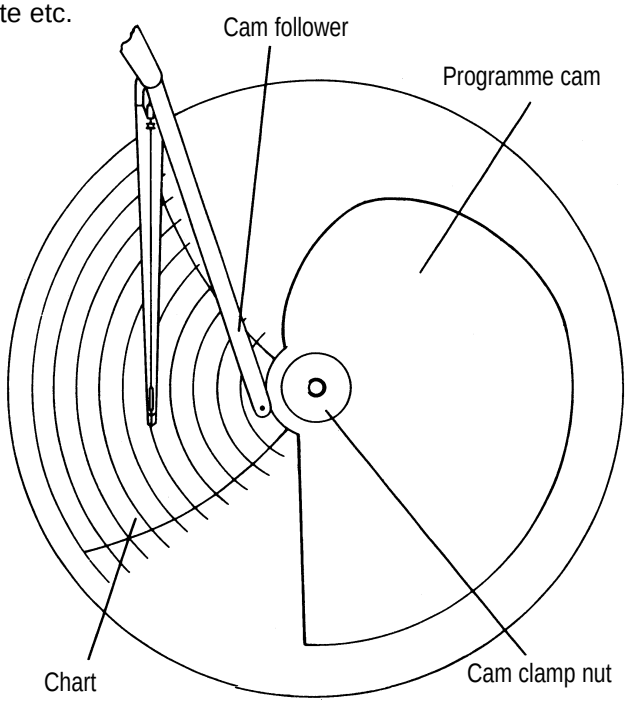


Fig. 8

MAINTENANCE

Cutting a programme cam

The required programme should be drawn on to a spare recorder chart and transferred using carbon paper or a similar method to the paper covering on the cam blank. Mark on this trace significant points of the programme where the process state is important. Mark drilling centres on the radii of these programme points exactly 3mm out from the points. Drill through with a 6mm drill. Join up the programme points using a saw, and smooth off the profile between the points.

A cam cut in this way will only provide a programme which is an approximation to the requirement owing to variations in the distance between the cam-follower and the pen at different positions on the chart. If required, precise programme cams can be supplied to customers' specifications.

Fitting a new pen arm

Refer to the **SPARES LIST**, page 15 for the part numbers of the two pen arms. Make sure the correct replacement arm (front or rear pen) is obtained. Follow the fitting instructions outlined under **Inking System**, page 6.

After fitting a new arm check the pen indication on the chart near the zero end of the range. See **Zero Adjustment**, page 7.

Pen Adjustment

The pen lifter must be below the arm before the clock is started. If the pen is bent, the effective length of the pen arm will be altered so that the pen will not record the correct time at all temperatures. If when the chart is stationary the time increases as the pen moves towards the outside of the chart, the pen arm is too long, and vice versa, see Fig. 9. The error can be corrected by careful straightening of the pen or by bowing the pen arm slightly. Adjust the pressure if necessary by bending the hook Y in Fig. 3.

Instruments with more than one pen are adjusted in the same way as those with only one. Each pen is adjusted independently. The mounting for the pen arm closest to the chart (the green pen) is reversed and the fibre tip nib is shorter so that each pen can move freely across the other's path. Only the red pen will indicate the correct time; the green pen being set to record 4mm in advance of the red.

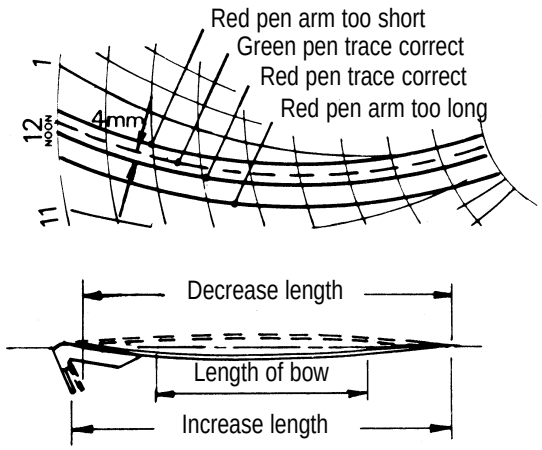


Fig. 9

Calibration – Temperature or Pressure System; Wet and Dry Bulb Relative Humidity System

Switch off the electrical supply to the recorder.

Make sure all pivots and linkages are free moving and adjust as follows:

1. Allow recorder to stabilise with measuring element in a low temperature (or pressure) just above scale minimum. Pen should record within ±1% of span of correct value. If necessary adjust zero screw S, Fig. 3. If pen is significantly out of line with cockpiece, i.e. more than about 5 angular degrees, adjust screw S to line up pen with cockpiece. Loosen the coarse zero adjustment screw holding the serrated compensator carrier, Fig. 5. and adjust pen to record true value, making a fine adjustment on screw S after the coarse zero adjustment screw has been re-tightened.
2. Allow the recorder to stabilise with measuring element in high temperature (or pressure) just under scale maximum. Pen should record within ±1% of span of correct value. If not, adjust by moving the link connecting the compensator arm to the ratio arm on the cockpiece, see Fig. 5. In order to move the link, loosen the nut at the back of the ratio arm pivot. Raising the pivot will increase the pen movement and lowering the pivot will reduce the movement. Re-tighten after adjustment.
3. Repeat steps 1 and 2 until no further adjustment is necessary.

Calibration – Relative Humidity System (hygroscopic membrane)

Switch off the electrical supply to the recorder.

During manufacture the measuring element is calibrated in atmospheres of known equivalent relative humidity. These atmospheres are generated by specific salt solutions at constant temperature in apparatus which is unlikely to be available to the average instrument user.

Calibration checks can be made without salt solution by using a Whirling Hygrometer and comparing the pen record with figures obtained from psychrometric tables (see page 7) in various ambient relative humidities, taking care to allow the recorder time to stabilise at each reading.

Make sure all pivots and linkages are free moving and adjust as follows:

1. Allow the recorder to stabilise with the measuring element in a low ambient R.H. Pen should record within ±2% R.H. of correct value. If not, adjust zero screw J Fig. 4, in the mounting of the humidity element.
2. Allow the recorder to stabilise with the measuring element in a high ambient R.H. Pen should record within ±2% R.H. of correct value. If not, adjust by moving the position of the link pivot on the cockpiece ratio arm, Fig. 4. In order to move the link loosen the nut at the back of the pivot. Raising the pivot will increase the pen movement and lowering the pivot will reduce the movement. Re-tighten after adjustment.
3. Repeat steps 1 and 2 until pen records within ±2% of true R.H. at both positions on chart.

Linearity Adjustments to the measuring systems

Linearity adjustments are only likely to be needed if a measuring element has been replaced. Switch off the electrical supply to the recorder. Follow the appropriate calibration procedure making an additional calibration check at approximately centre span after the instrument has been adjusted to record correctly at high and low readings. If necessary, slightly adjust the length of the connecting link (see Figs. 4 and 5). To gain access to the connecting link remove the chart, pens and upper chart plate as described under **Access to Recorder**. After adjusting the length of the link replace the chart plate, etc. recalibrate at high and low readings and then repeat the centre span calibration check. Continue to make adjustments in this order until the record at all three points is within specification.

Servicing – General

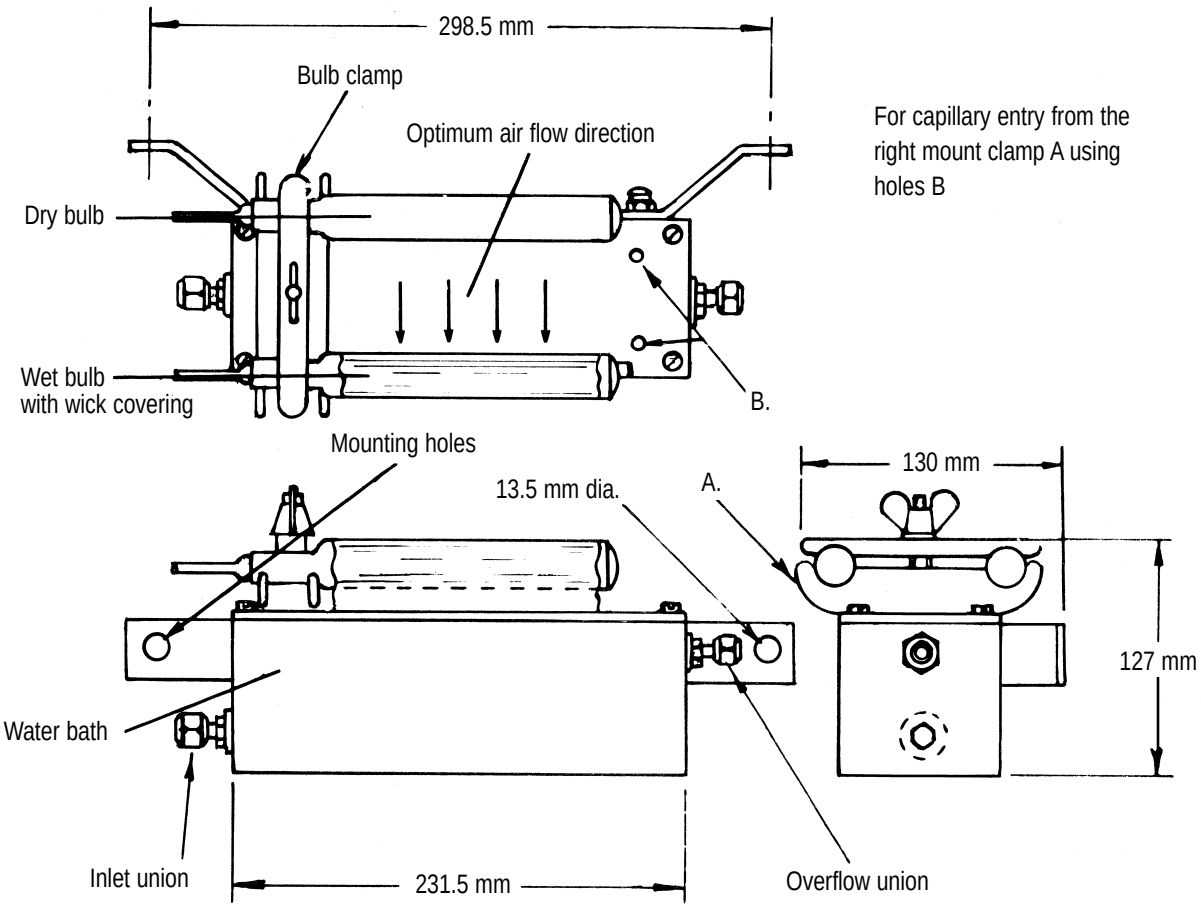
Every six months lubricate metal bearings using a good quality molybdenised clock oil, such as Moebius 8040/35 clock oil. Do not use this lubricant on any nylon parts. Wipe off any excess lubricant with a clean lint free cloth.

Oiling the mechanical clock

After a long period of operation the clock should be oiled. The complete clock can be detached by unscrewing the three fixing screws when the chart plate is removed. Use a high grade of clock oil. (This operation should only be carried out by a suitably experienced person).

Wet and Dry Bulb Water Bath

The wick should be changed frequently, the period between changes depending on the surrounding atmosphere. In wood drying kilns, etc., the wick should be renewed once a week but in clean atmospheres, e.g. offices, it can be left as long as three weeks. The water must be kept clean and free from impurities.



Note: Water supply maximum pressure 6 metre head.

Fig. 10. Wet and Dry Bulb Water Bath

SPECIAL INSTRUCTIONS & DIAGRAMS

FAULT FINDING

Recorder pen is inaccurate or gives no indication

1. Measuring element broken; capillary plugged or broken on temperature recorder.
   Check elements or capillary and replace as necessary.
2. Disconnected linkage in recorder.
   Re-connect or repair as necessary.
3. Recorder out of calibration, measuring element not damaged.
   Check and calibrate if necessary, pages 11 and 12.

No record on chart

1. Pen not inking.
   Fit new pen capsule, page 6.
2. Chart drive motor stopped.
   Rewind, page 6. Replace if broken.
3. Chart clamp broken.
   Replace by new assembly.

Poor Control – Electrical

1. Faulty relay.
   Replace relay.
2. Friction in measuring system.
   Correct action of measuring system.
3. Lack of electrical power in circuit being controlled.
   Increase power rating of control equipment.
4. Power in circuit being controlled too high.
   Decrease power rating of control equipment.

SPARES LIST

Description	Part Number	Reference
Chart	Quote the number on the chart supplied or duration and range.	Fig. 1
Chart clamp assembly (not programme controllers)	15321/608	Fig. 2(a)
Chart drive motor – electrical (assembled on moulding)	Quote chart speed voltage and mains frequency.	
Chart drive motor – mechanical	Quote chart speed and specify “mechanical”.	
Circlip – setting pointer spindle	600353	
Electrical Control with spring contact on the Control Arm:		
Spring contact assembly-relay energized below set point	15321 / 79 (min. type A)	Fig. 7
Spring contact assembly-relay energized above set point	15321 / 80 (max. type C)	Fig. 7
Striker contact pin	19 s.w.g. silver wire	Figs. 5 & 7
Hinge	15 / 240	Fig. 1
Hinge – pin	15 / 243	
Hinge – screw	15 / 211	
Hinge – spring	15 / 220	
Key for lock	FA 558	
Lock with spring washer and catch	22656 / 142	Fig. 1
Pen arm – green (rear position)	15321 / 328 (stamped 8 on pen arm)	Figs. 1 & 3
Pen arm – red (front position)	15321 / 327 (stamped 7 on pen arm)	Figs. 1 & 3
Pen capsule – green	P105M/0302 (pack of 5)	Fig. 3
Pen capsule – red	P105M/0301 (pack of 5)	Fig. 3
Pen lifter	15 / 277	

SPARES LIST (continued)

Description	Part Number	Reference
Pressure Recorders:		
Tailpiece St/St ½" BSP	22251 / 9	Fig. 2
Tailpiece St/St ⅜" BSP	17600 / 01	
Tailpiece Brass ½" BSP	22251 / 22	
Tailpiece Brass ⅜" BSP	16992 / 51	
Nut St/St ½" BSP	22251 / 10	
Nut St/St ⅜" BSP	17599 / 01	
Nut Brass ½" BSP	22251 / 20	
Nut St/St ⅜" BSP	16692 / 01	
Fibre washer ½" BSP	22 / 745	
Fibre washer ⅜" BSP	22 / 746	
Programme Controllers:		
Chart carrier	17271 / 26	Fig. 8
Chart clamp nut	17271 / 27	
Cam clamp nut	17271 / 6	
Cam blank	17271 / 29	
Relay (electrical) – 5 amp	87294	
3 amp	600492	
Setting pointer clamp nut	15321 / 245	
Stud – panel mounting	100013	Fig. 2
Temperature and Humidity Recorders:		
Element guard	22 / 401	
Wick for Wet & Dry Bulb Water Bath	100016	Fig. 10
Window glass	15 / 204	
Window perspex	15 / 204C	
Zero screw 'S'	15 / 228	Fig. 3
Made Up kits:		
Relay type 2400 (Part No. 600169) is no longer available as a spare part and is replaced by one of the following relay kits.		
Single relay replacement:		Refer to Service Aid No. 15321 / 545
(200/250V, 50 or 60 Hz supply)	15321 / 542 / 1	
(100/120V, 50 or 60 Hz supply)	15321 / 542 / 2	
Double relay replacement:		
(200/250V, 50 or 60 hz supply)	15321 / 543 / 1	
(100/120V, 50 or 60 Hz supply)	15321 / 543 / 2	

For information on other Spare Parts or Kits contact British Rototherm.

We reserve the right to amend specification without notice

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