WESTON
Schlumberger

WESTON INSTRUMENTS
GREAT CAMBRIDGE ROAD, ENFIELD,
MIDDLESEX, EN1 3RX, ENGLAND

MODEL S.178 FORMS 1 & 2 - INDICATOR, I.L.S.

VARIANTS:

S.178-1-13
S.178-1-19
S.178-2-12
S.178-2-26

COMPONENT MAINTENANCE MANUAL

WITH

ILLUSTRATED PARTS LIST

STATEMENT OF INITIAL CERTIFICATION

This manual complies with British Civil Airworthiness Requirements, Section A, Chapter A6-2.

Signed: Research & Engineering Manager

.....

Date: 30th June 1978

CAA Approval No: DAI/1198/39

NOTE: The above certification does not apply to revisions or amendments made after the date of initial certification by other Approved Organisations. Revisions or amendments made by other Approved Organisations must each be separately certified, and recorded on separate record sheets.

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REVISION RECORD SHEET

The introduction of any amendment or revision not certified in accordance with British Civil Airworthiness Requirements Chapter A6-2 will invalidate the statement of certification on the Title Page.

Amendments or revisions embodied in this manual, which have been certified under an approval authorisation other than that applicable to the initial certification must be recorded on separate record sheets.

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1			23		
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MODIFICATION STANDARDS

Modification standards listed on this page are applicable to all variants of the Model S.178, Forms 1 and 2 indicators.

A modification standard relevant only to a particular variant of the model, will be listed in the related variant information.

A designated modification letter (or letters) which is marked on the scale of the model indicates that the modification has been embodied, this embodiment also applies to a following letter (or letters) of the modification standard.

Modification letter(s)	Service Bulletin No.

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COMPONENT MAINTENANCE MANUAL

MODEL S.178 FORMS 1 & 2 - INDICATOR, I.L.S.

INTRODUCTION

1. General

This manual contains shop verified instructions for the Weston Instruments Model S.178 - Forms 1 and 2 inclusive.

The servicing procedures given are consistent with those accomplished by the manufacturer.

Differences between indicators - such as range, scale presentation and pointer/flag finishes are defined by variant numbers (refer to Introduction - Illustrated Parts List) and details specific to variants are listed separately (refer to the Table of Contents).

To accommodate additions of variants to the manual, which could also require additions to other sections of the manual, the block system as outlined in ATA 100 has been used. The variants are listed in the Description and Operation section of the manual.

Disassembly of parts of an indicator beyond that given in the manual is not recommended nor considered economical.

Although complete disassembly details are given to the extent considered necessary, the operator must use discretion on the actual level of breakdown, and be guided by the history sheet returned with the indicator, or by results obtained in the Testing and Trouble Shooting section. This section is the first reference level to establish the action to be taken if the history sheet is not available or the cause of the return/reject of the indicator not apparent.

Once the required action to be taken is obvious, and if disassembly of the indicator is necessary, refer to the Check and Cleaning sections before re-assembly of the indicator.

Parts available as replacements are given in the Illustrated Parts List.

Where applicable Imperial and Metric measurements are given in the text, the Imperial measurements precede the Metric measurements which are in parenthesis.

The only special tools quoted are balance wrenches; all other tools/equipment quoted can be substituted by similar items if they conform to the requirements specified

DESCRIPTION AND OPERATION

1. Description

Model S.178, Forms 1 and 2 are instrument landing system indicators comprising four separate movements which are housed in a 51mm diameter metal case. Two movements are fitted with pointers, which are at right angles to each other when the indicator is not energised. The vertical pointer, when energised, indicates azimuth bearing. The horizontal pointer, when energised, indicates glide path position. The other two movements are monitor movements and are fitted with flags, when the external circuit is inoperative the flag will obscure the end of its relative pointer.

The four movements each consist of an internal magnet assembly, each movement is self shielding. All movements are energised by direct current.

Connections to the indicator are made via a 10 pin Cannon plug on Form 1 indicators and via a 12 pin Plessey plug on Form 2 indicators. Form 1 indicators are sealed, Form 2 indicators are semi-sealed but an effective seal is provided when a tight-fitting cap is positioned on the connector when the indicator is not in circuit. Neither Form 1 nor Form 2 have external pointer adjusters.

2. Detail (Ref. IPL, Fig.1)

The complete movements (100), (110), (120) and (130) are mounted on threaded pillars which are an integral part of the moulded ring (150). The movements are secured in place by four scale pillars (140) which are tapped to retain the securing screws of the mask (70) and the scale (40).

Spools are fitted on to the spool mounting plate (230) which is assembled on the three pillars of the end plate (270). The pillars pass through the moulded ring (150) and the two assemblies are held in place by three 6 B.A. round head nuts (160) and three special nuts (180). By releasing the three nuts (260) the spool mounting plate (230) can be withdrawn, clear of the assembly, without disassembling the indicator.

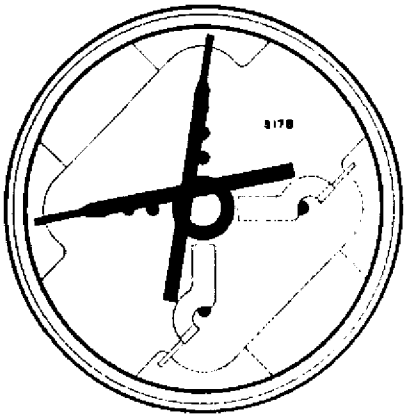
The springs of the monitor movements are suppressed to bring the flag of each movement against a pointer stop, providing a pull-off torque when the movement is unenergised.

Each movement is self-shielding and can be adjusted as a separate unit without magnetic or electrical interaction between movements.

3. Operation (Ref. Fig.2)

When the indicator is energised, the two monitor flags move through 90^0 to clear the scale markings. The movement pointers deflect in proportion to the currents applied to their respective moving coils.

4. Variant Data



Front View of S.178-1-13
Figure 1

A. General

Electrical connections to the indicator are made via a 10 pin Cannon plug.

The scale is as illustrated, the scale centre ring and scale dots are fluorised; the scale background is matt black. The indicator pointers are also fluorised, the flags of the monitor movements are matt black.

B. Pointer Movements (Ref. Fig.2)

Resistance of moving element	480 - 760Ω
Total resistance	1000 ± 30Ω
Sensitivity (Unshunted)	60 - 80μA (Centre to either end)
Sensitivity (Shunted)	150 ± 10 - 0 - 150 ± 10μA
Indicator shunt spools:	resistance between 550 - 700Ω
Indicator series spools:	resistance between 650 - 680Ω

MODEL S.178-1-13

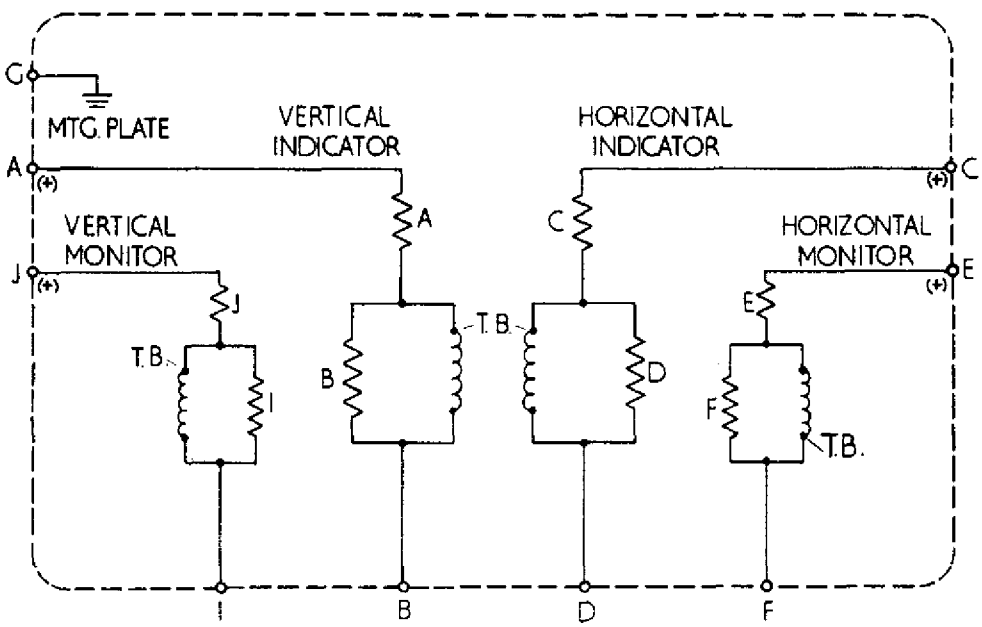
C. Monitor Movements

Resistance of moving element	200 - 300Ω
Total resistance	400 ± 20Ω

Sensitivity	Unshunted	Shunted
To just move flag	170μA - 195μA	200μA - 226μA
To deflect flag 90^0	320μA - 360μA	375μA - 400μA

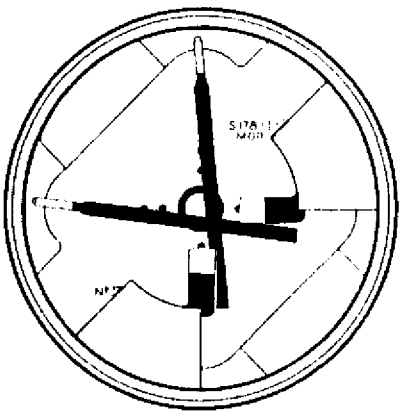
Monitor shunt spools: resistance between 1500 - 8000Ω

Monitor series spools: resistance between 120 - 220Ω



Circuit diagram of S.178-1-13
Figure 2

4. Variant Data



Front View of S.178-1-19
Figure 1

A. General

Electrical connections to the indicator are made via a 10 pin Cannon plug.

The scale is as illustrated, the scale centre ring and scale dots are fluorised; the scale background is matt black. The indicator pointers are fluorised; the flags of the monitor movements are white, with day-glow red tips. The flags disappear from view behind black masks, which are painted on the glass of the case assembly, when the movements are energised.

B. Pointer Movements (Ref. Fig.2)

Resistance of moving element	480 - 760Ω
Total resistance	1000 ± 30Ω
Sensitivity (Unshunted)	60 - 80μA (Centre to either end)
Sensitivity (Shunted)	150 ± 10 - 0 - 150 ± 10μA
Indicator shunt spools:	resistance between 550 - 700Ω
Indicator series spools:	resistance between 650 - 680Ω

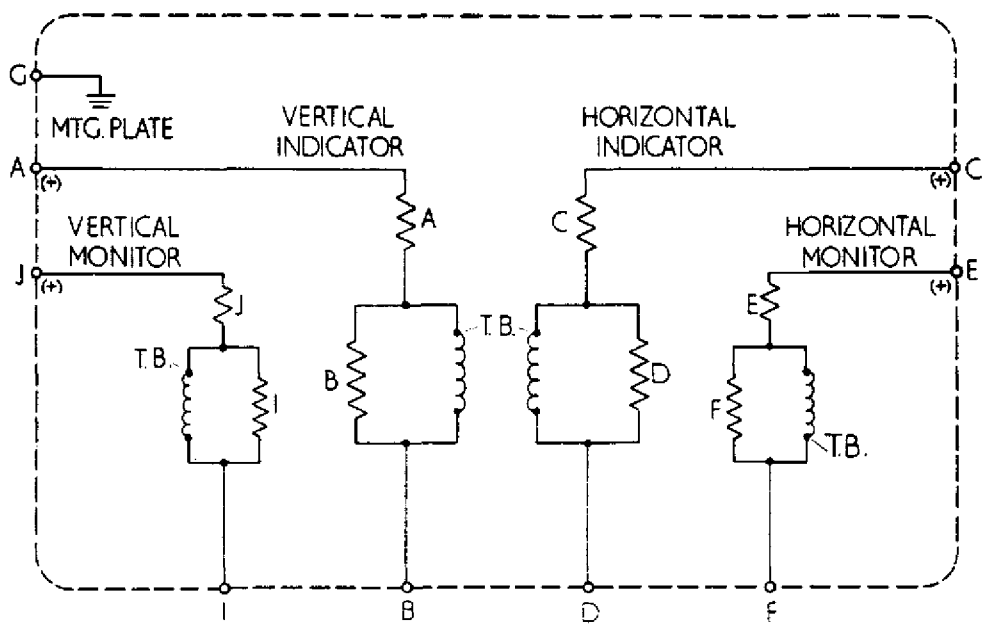
C. Monitor Movements (Ref. Fig.2)

Resistance of moving element	200 - 300Ω
Total resistance	400 ± 20Ω

Sensitivity	Unshunted	Shunted
To just move flag	170μA - 195μA	200μA - 225μA
To deflect flag 90^0	320μA - 360μA	375μA - 400μA

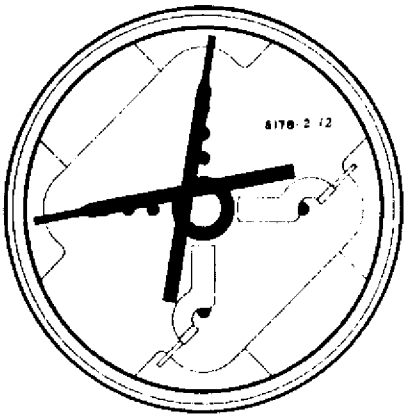
Monitor shunt spools: resistance between 1500 - 8000Ω

Monitor series spools: resistance between 120 - 220Ω



Circuit diagram of S.178-1-19
Figure 2

4. Variant Data



Front View of S.178-2-12
Figure 1

A. General

Electrical connections to the indicator are made via a 12 pin Plessey plug; the indicator is semi-sealed, an effective seal is formed when a tight-fitting cap is fitted to the connector. The indicator is sealed when connected to the aircraft circuit.

The scale illustration is as shown in Fig.1; the scale centre-ring and scale dots are fluorised, the scale background is matt black. The pointers are fluorised and the monitor flags are finished matt black.

B. Pointer Movements (Ref. Fig.2)

Resistance of moving element	480 - 760Ω
Total circuit resistance	1000 ± 30Ω at 20°C
Sensitivity (Unshunted)	60 - 80μA (Centre to either end)
Sensitivity (Shunted)	150 ± 10 - 0 - 150 ± 10μA
Indicator shunt spools:	resistance between 550 - 700Ω
Indicator series spools:	resistance between 650 - 680Ω

MODEL S.178-2-12

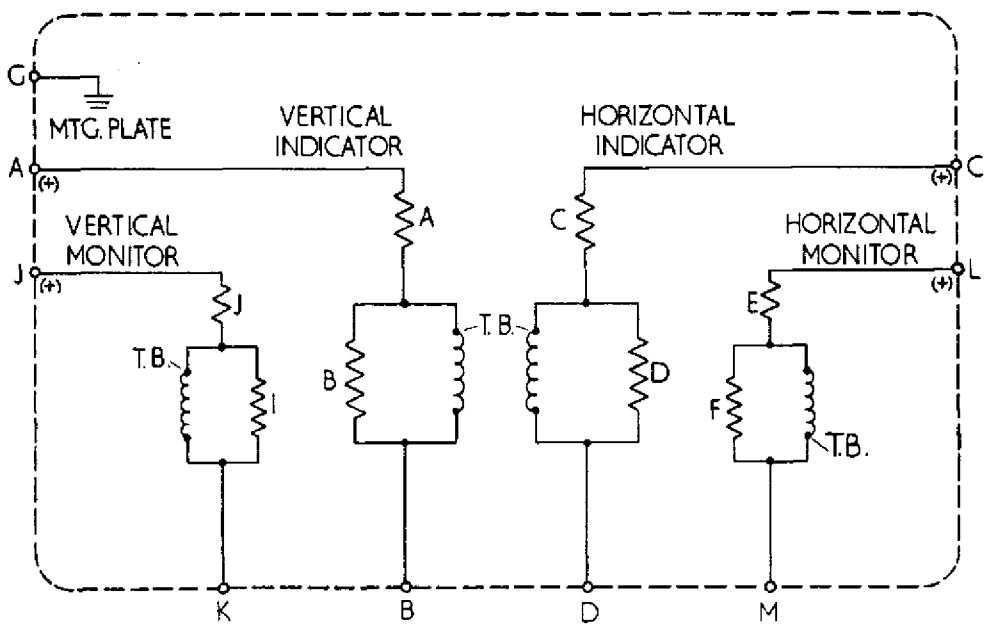
C. Monitor Movements (Ref. Fig.2)

Resistance of moving element	200 - 300Ω
Total circuit resistance	400 ± 20Ω

Sensitivity	Unshunted	Shunted
To just move flag	170μA - 195μA	200μA - 225μA
To deflect flag 90^0	320μA - 360μA	375μA - 400μA

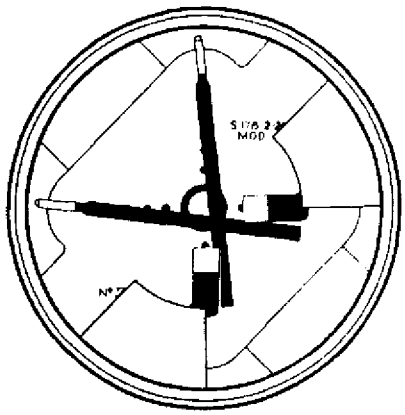
Monitor shunt spools: resistance between 1500 - 8000Ω

Monitor series spools: resistance between 120 - 220Ω



Circuit diagram of S.178-2-12
Figure 2

4. Variant Data



Front View of S.178-2-26
Figure 1

A. General

Electrical connections to the indicator are made via a 12 pin Plessey plug; the indicator is semi-sealed, an effective seal is formed when a tight-fitting cap is fitted to the connector. The indicator is sealed when connected to the aircraft circuit.

The scale illustration is as shown in Fig. 1; the scale centre-ring and scale dots are fluorised, the scale background is matt black. The pointers are fluorised and the monitor flags are finished black with fluorescent dayglow tips. The flags disappear from view behind black masks, which are painted on the glass of the case assembly, when the movements are energised.

B. Pointer Movements (Ref. Fig.2)

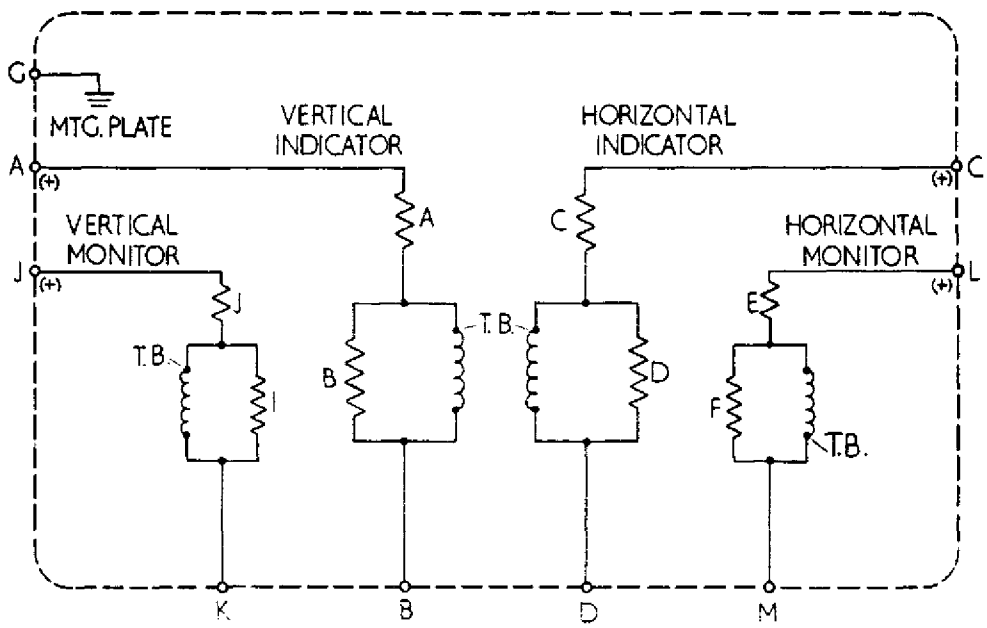
Resistance of moving element	550 - 720Ω
Total circuit resistance	1000 ± 30Ω at 20°C
Sensitivity (Unshunted)	60 - 80μA (Centre to either end)
Sensitivity (Shunted)	150 ± 10 - 0 - 150 ± 10μA
Indicator shunt spools:	resistance between 550 - 700Ω
Indicator series spools:	resistance between 650 - 680Ω

C. Monitor Movements (Ref. Fig.2)

Resistance of moving element	560 - 695Ω
Total circuit resistance	1000 ± 50Ω at 20°C

Sensitivity	Unshunted	Shunted
To just move flag	95μA - 111μA	115μA - 135μA
To deflect flag 90°	194μA - 218μA	235μA - 265μA

Monitor shunt spools:	resistance between 8k - 3k
Monitor series spools:	resistance between 350 - 550Ω



Circuit diagram of S.178-2-26
Figure 2

TESTING AND TROUBLE SHOOTING

1. General

The procedure given presupposes that the indicator has been removed from the aircraft because of a fault condition. However, the numerical testing sequence follows a step-by-step procedure which combines with a diagnosis of faults that can occur at the Assembly and Testing levels.

2. Preparation

NOTE: Equivalent substitutes may be used for listed equipment.

TABLE 101

EQUIPMENT AND SPECIAL TOOLS

A. Equipment

Equipment	Code	Supplier
Portable d.c. μ Ammeter 100/200/500μA Accuracy: ± 1.0% f.s.d. (Class index 1.0) B.S.89:1977	-	Salford Electrical Instruments Ltd, Eccles, Manchester.
Insulation test meter 250/500V.d.c.	1905L	Comark Electronics, Rustington, Sussex.
Portable Wheatstone Bridge (Substitute must measure to ± 0.5% over 100-1000 ohms)	5785/4	H. Tinsley & Co. Ltd., Stanger Road, London, SE25
Decade resistance box - 2 off. (Max. resistance 11,111 ohms - minimum step 1 ohm)	5274/4	H. Tinsley & Co. Ltd., Stanger Road, London, SE25
Potentiometer: 1500 ohms, 1 Watt (R3 in Fig.101)	CLR 1106	Colvern Ltd., Romford, Essex.

Continued

TABLE 101

EQUIPMENT AND SPECIAL TOOLS (CONT.)

Continuation

Equipment	Code	Supplier
Resistors: 390K, 300mW 47K, 300mW (Used in Fig.101)	CR 25	Mullard Ltd., Torrington Place, London, WC2
Raiser/Demagnetiser. Jig (for holding movement complete).	M.S.C.2 J2A	Hirst Electrical Industries, Gatwick Road, Crawley, Sussex.

B. Special Tools

Description	Code	Supplier
Balance wrenches (11 off)	271157 to 271167	Weston Instruments, Great Cambridge Road, Enfield, EN1 3RX

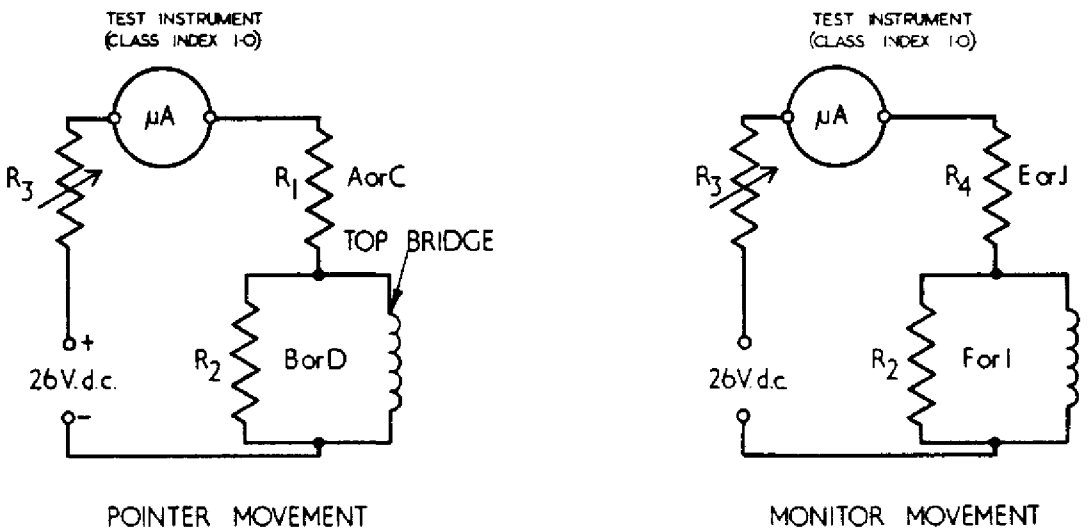
NOTE: Use the balance wrenches, if necessary, to rectify mechanical balance errors if revealed in the Test/Fault procedures, Figs. 102/103.

The circuit of Fig.101 is used for Testing and isolation of faults.

Figure	Description
101	Test Circuit Diagram
102	Test/Fault Flow Diagram for Pointer movements
103	Test/Fault Flow Diagram for Monitor movements

The Pointer movements are tested and faults located with the aid of the Flow Diagram, Fig.102, and Monitor movements with the aid of Fig.103.

When reference is made to balancing the movement use the wrenches specified in Table 101, Special Tools.



Test Circuit Diagram
Figure 101

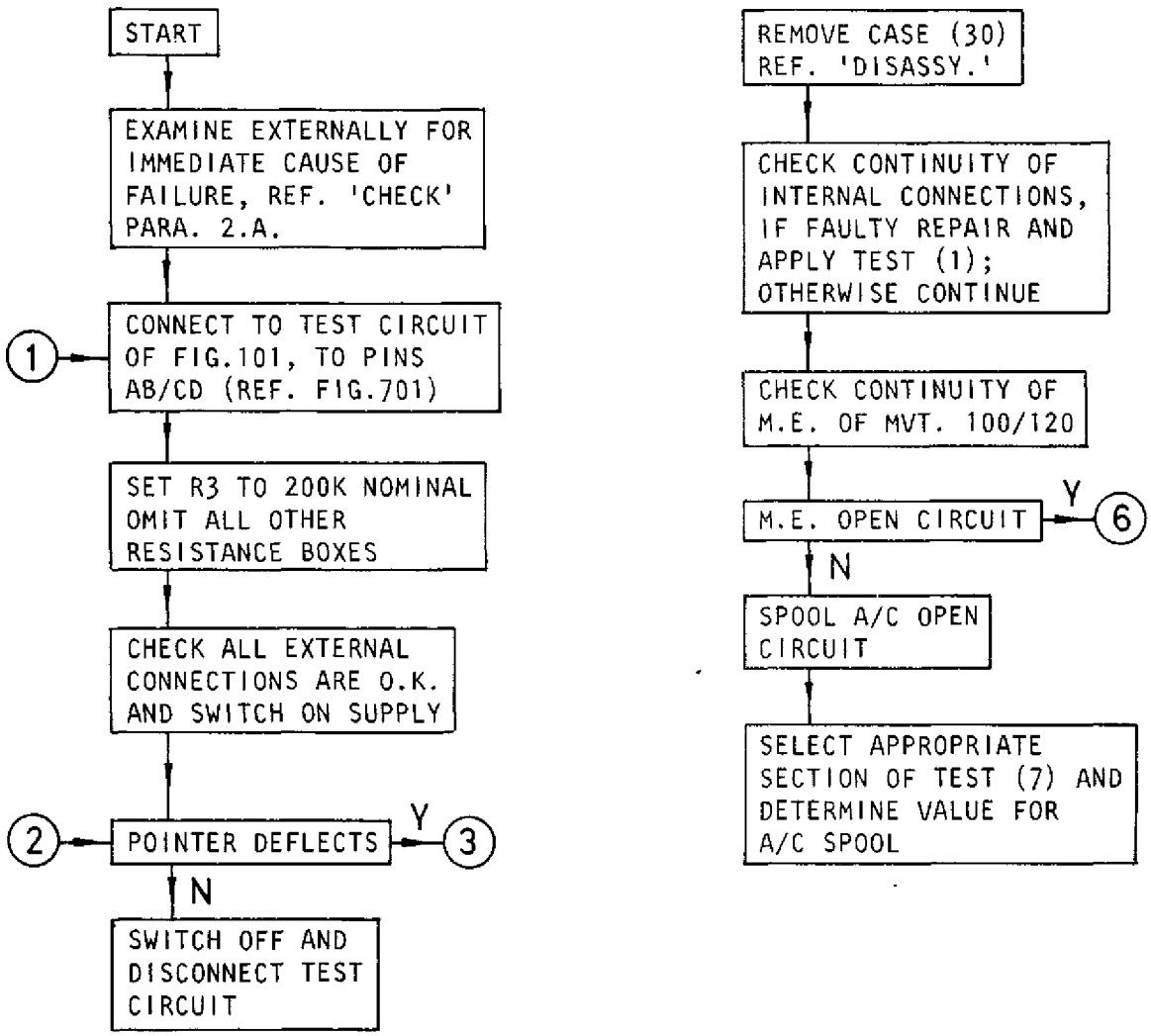
3. Testing and Trouble Shooting Procedure (Ref. Figs.101/102/103)

Apply the procedure given in Fig.102/103. Commence with 'START' box and follow direction of arrows.

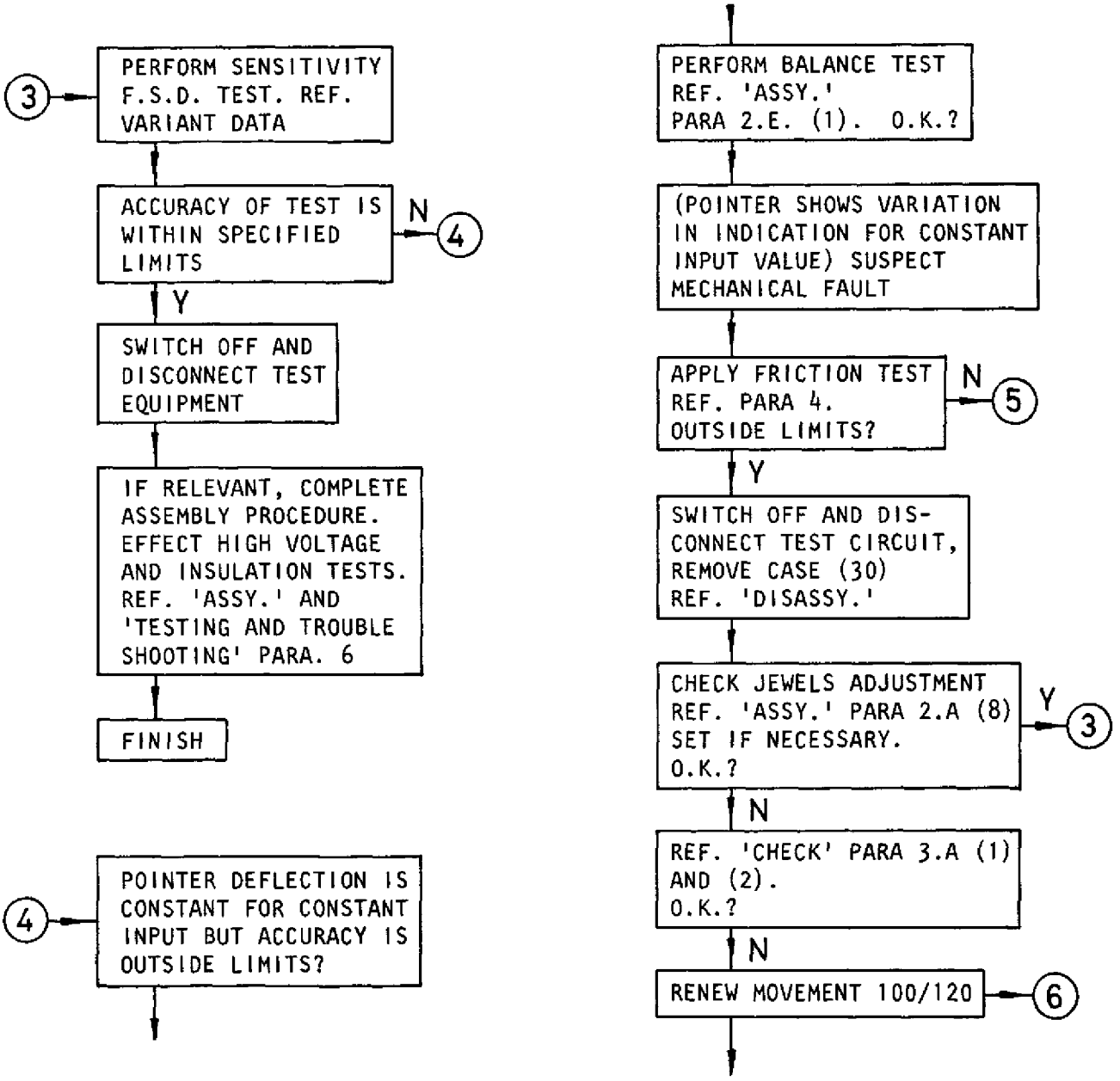
CAUTION: DO NOT EXCEED RATED CURRENTS OR VOLTAGES FOR CIRCUIT ELEMENTS. IN PARTICULAR ENSURE THAT NO MORE THAN TWICE THE STATED F.S.D. CURRENT IS PERMITTED TO PASS THROUGH THE MOVING ELEMENT OF THE MOVEMENT COMPLETE.

Abbreviations used in Figs.102/103 are as follows:

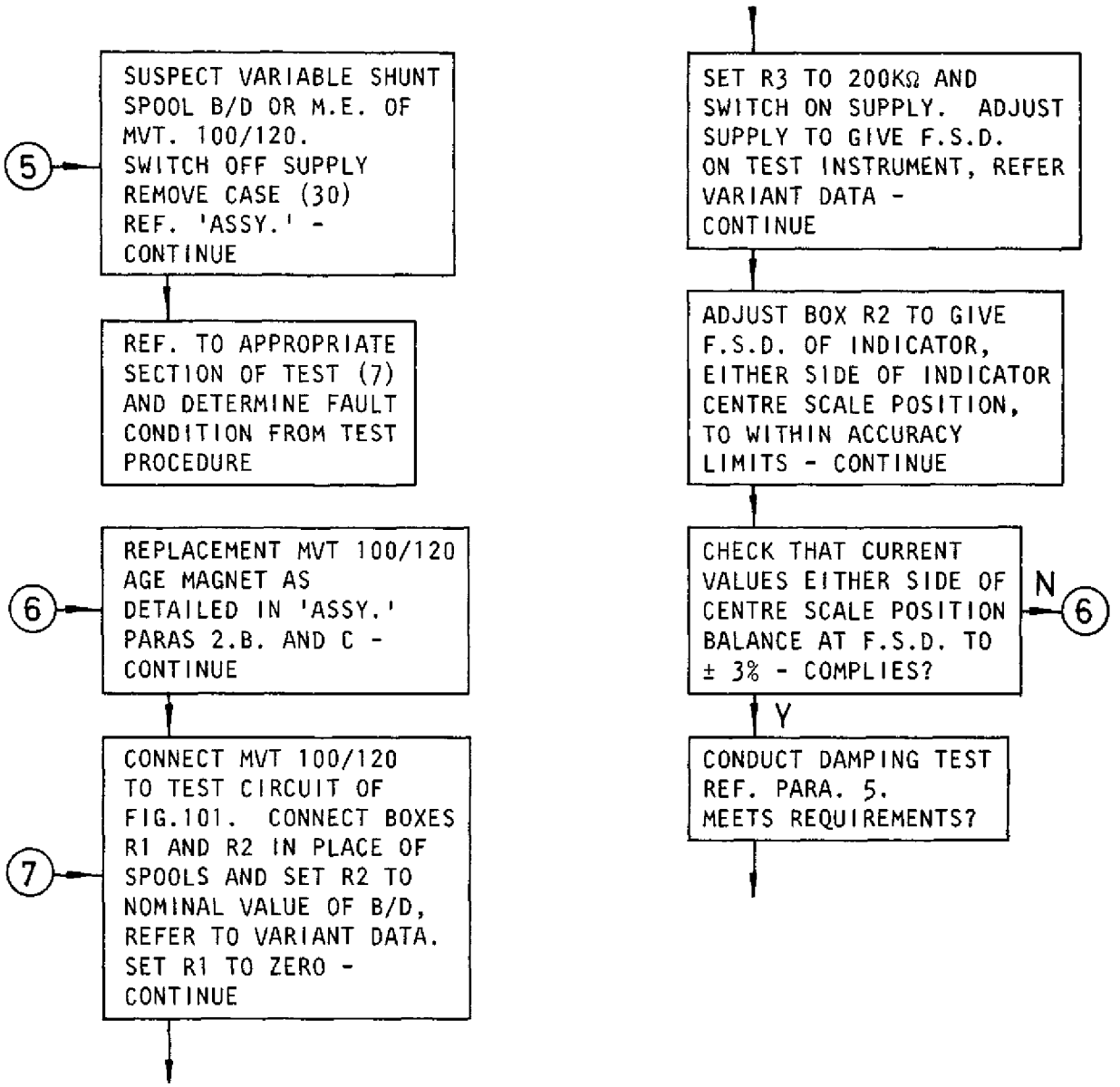
O.C.	OPEN CIRCUIT	Y	YES
M.E.	MOVING ELEMENT	N	NO
F.S.D.	FULL SCALE DEFLECTION	MVT	MOVEMENT
ASSY	ASSEMBLY	DISASSY	DISASSEMBLY



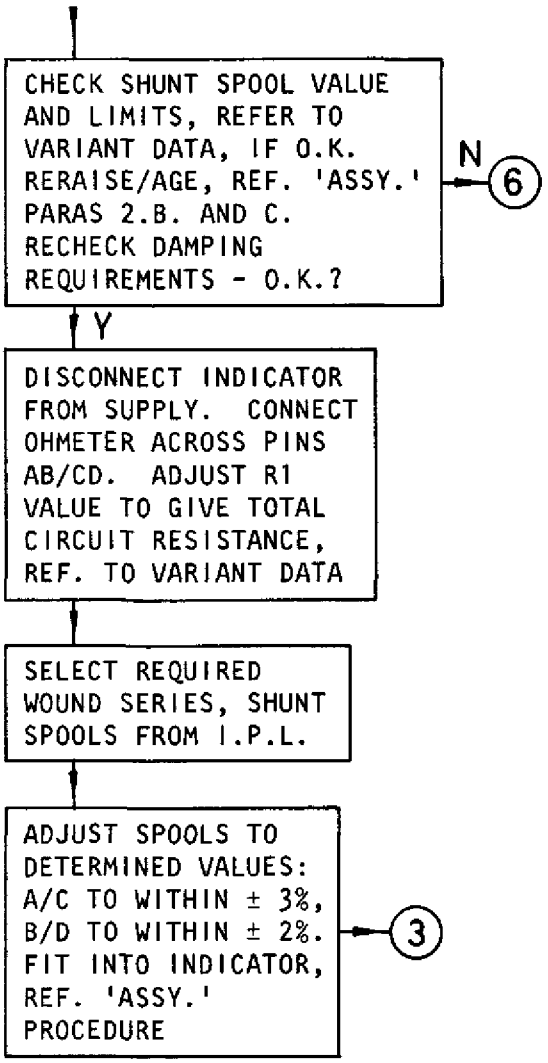
Test/Fault Flow Diagram
(Pointer Movements)
Figure 102 (Sheet 1 of 4)



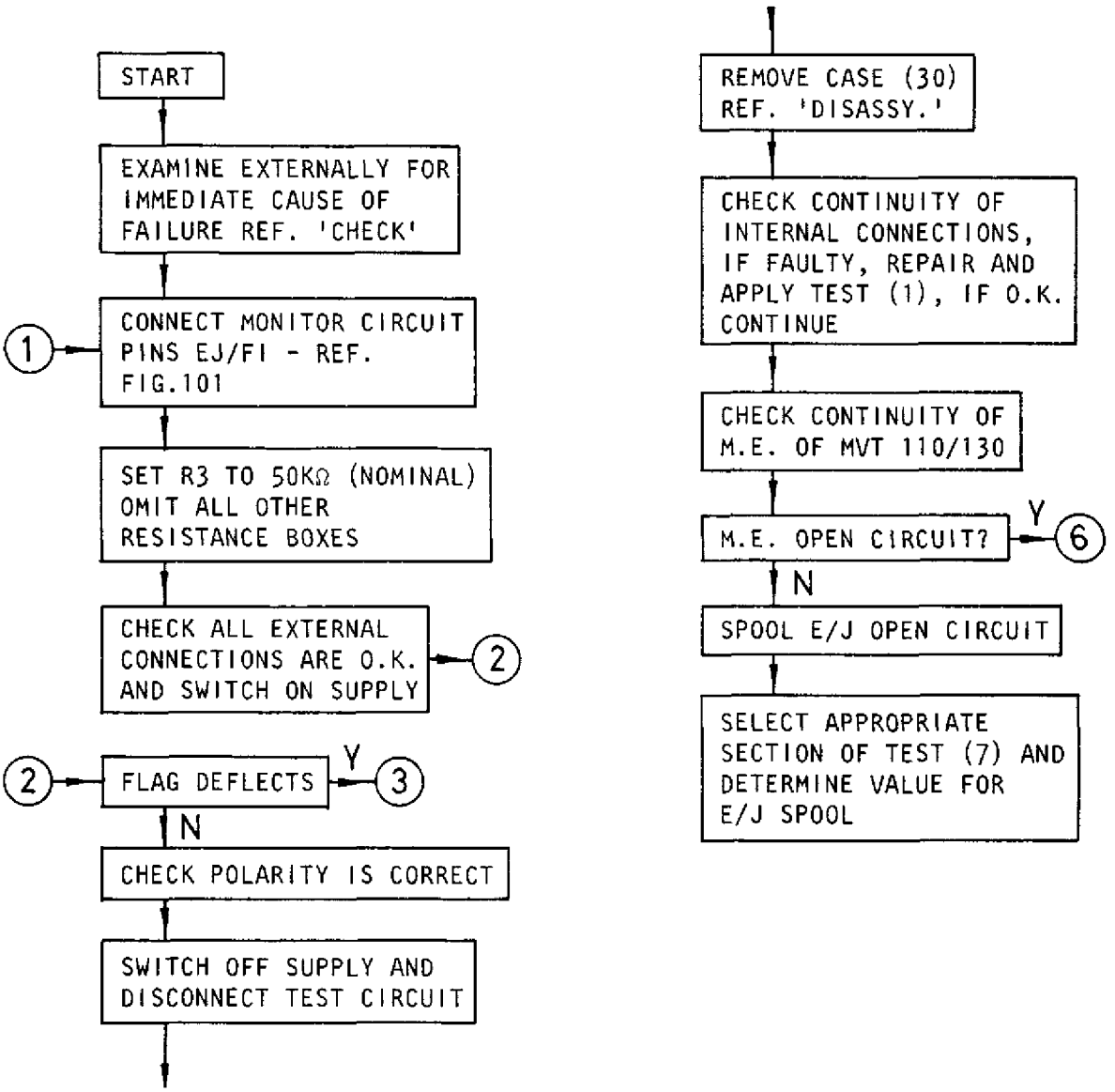
Test/Fault Flow Diagram
(Pointer Movements)
Figure 102 (Sheet 2 of 4)



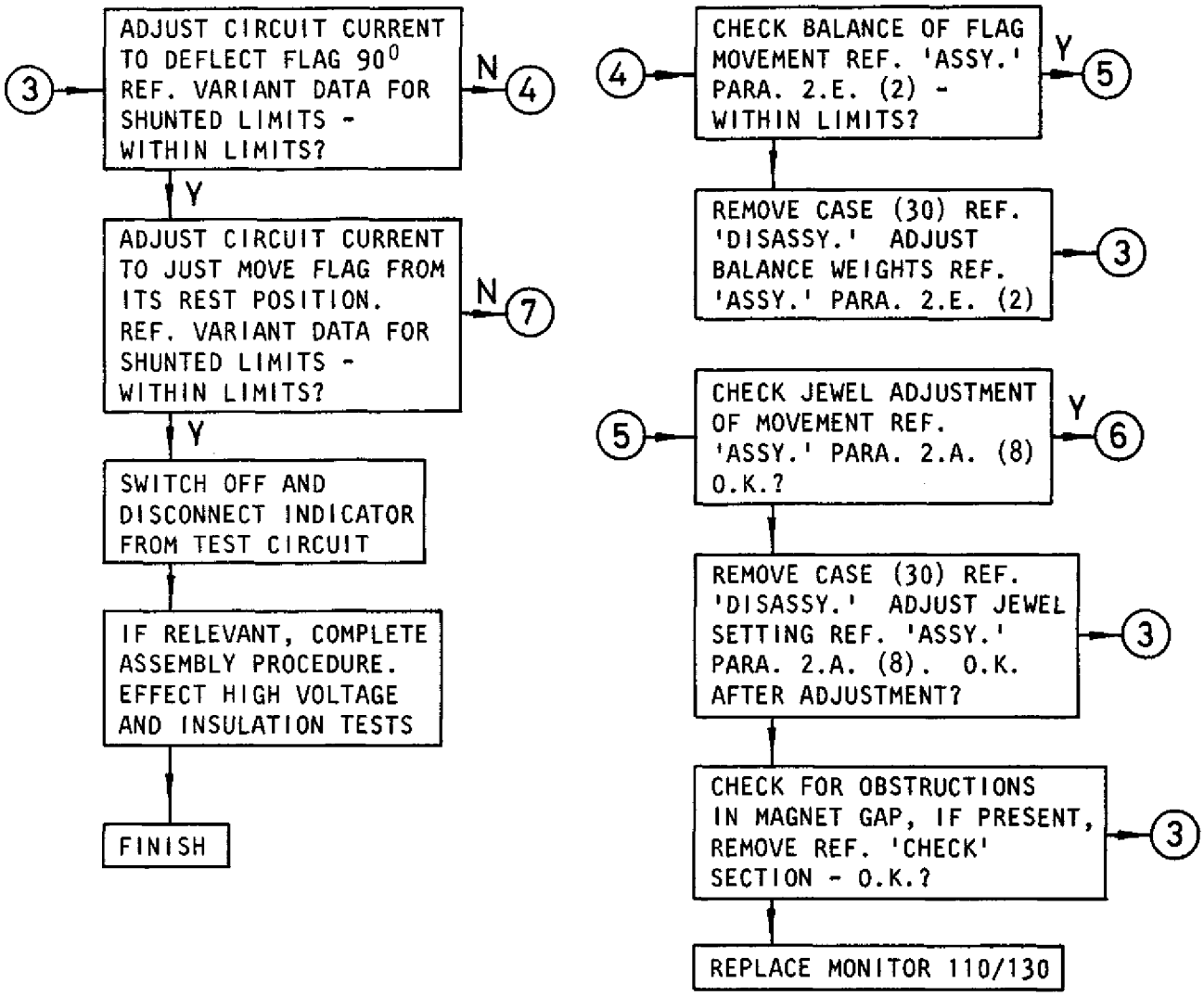
Test/Fault Flow Diagram
(Pointer Movements)
Figure 102 (Sheet 3 of 4)



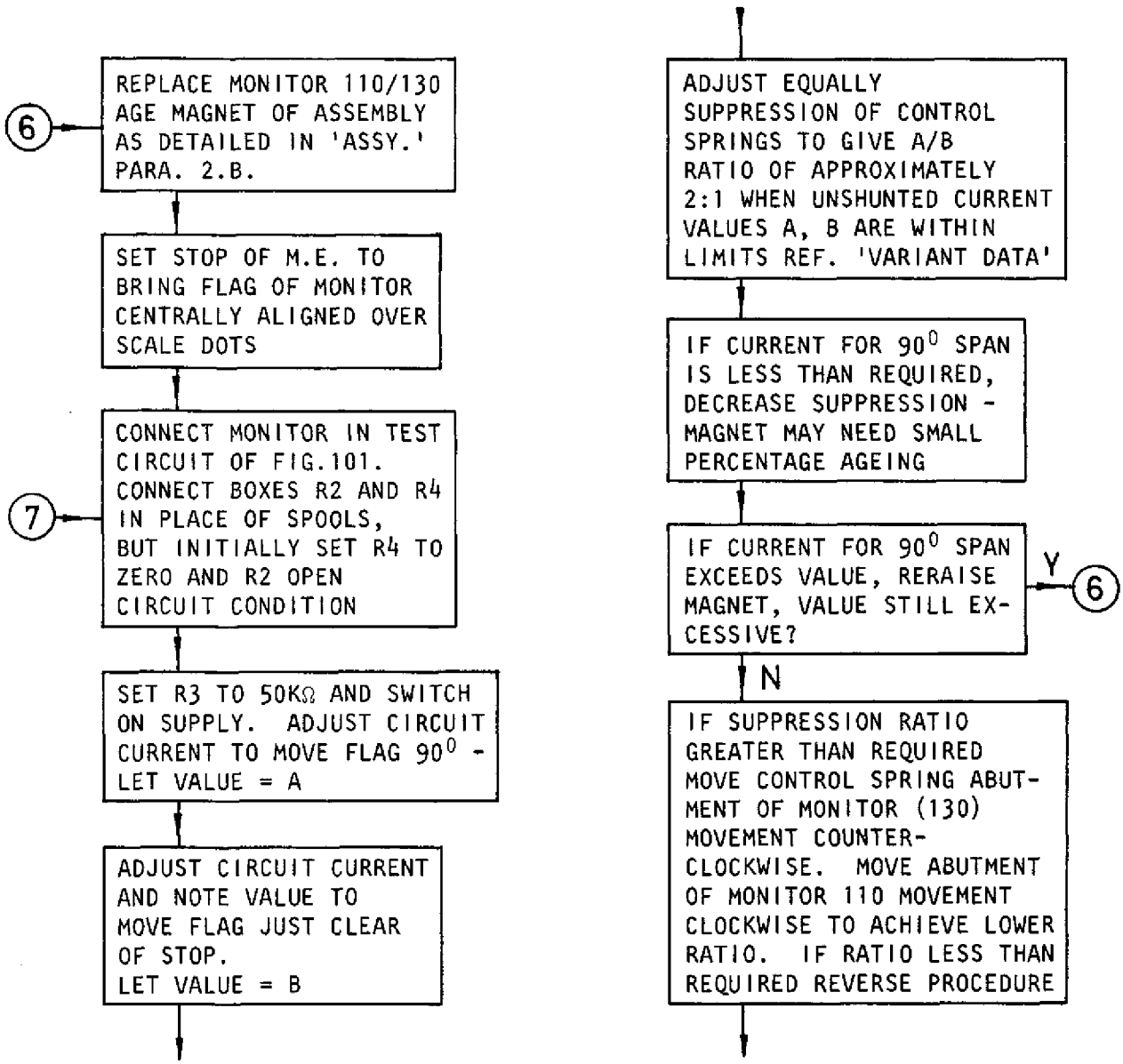
Test/Fault Flow Diagram
(Pointer Movements)
Figure 102 (Sheet 4 of 4)



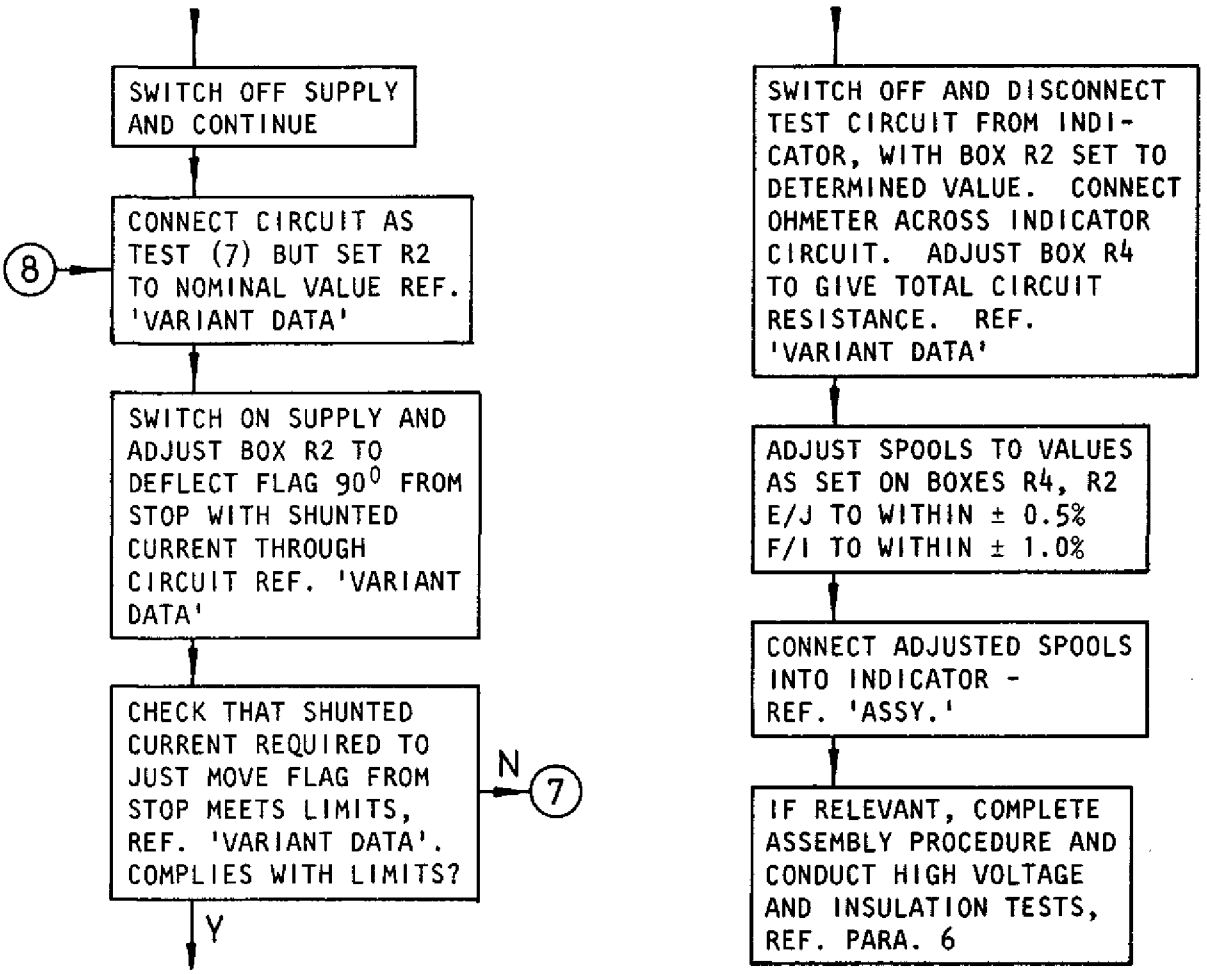
Test/Fault Flow Diagram
(Monitor Movements)
Figure 103 (Sheet 1 of 4)



Test/Fault Flow Diagram
(Monitor Movements)
Figure 103 (Sheet 2 of 4)



Test/Fault Flow Diagram
(Monitor Movements)
Figure 103 (Sheet 3 of 4)



Test/Fault Flow Diagram
(Monitor Movements)
Figure 103 (Sheet 4 of 4)

4. Friction Test

A. Place indicator, dial vertical, and rotate to bring pointer vertical when deflected to first dot on scale from centre-zero position.

B. Set pointer at centre-zero, lightly tap indicator energise circuit, gradually increase current and align pointer over first dot, do not overshoot dot, note current value on test instrument, increase current until pointer indicates f.s.d., lightly tap indicator.

C. Gradually reduce current until pointer is again aligned over first dot, do not overshoot, note reading on test instrument.

NOTE: Error must not exceed 3%. The error is the difference between the two noted indications on the test instrument as a percentage of f.s.d.
Full scale deflection (f.s.d.) for the standard indicator is 150-0-150μA. Therefore allowable error is ± 9μA.

5. Damping Test Requirements

A. When the movement being tested is suddenly energised to deflect its pointer to f.s.d. and from a high resistance source, the pointer must reach and remain within ±1% of its final deflection within 1.2 to 2.4 seconds.

6. High Voltage and Insulation Tests

A. High Voltage

Apply 500 Volts r.m.s. between the indicator circuits bonded together and its case for a period of 1 minute. There must be no insulation breakdown.

B. Immediately following the high voltage test, check the insulation of the indicator as below.

(1) Between all circuits bonded together and the case. The insulation resistance must not be less than 20 megohms after the application of 500 Volts d.c. for not less than 15 seconds.

DISASSEMBLY

1. General

Ascertain if the indicator has been returned with a history sheet, which may indicate any part needing particular attention. Complete disassembly details are not given as such action is not generally necessary.

NOTE: Refer to Testing and Trouble Shooting to establish the condition of the indicator or most probable cause of its malfunction. This is to determine the extent of disassembly required without completely dismantling the indicator.

2. Procedure (Ref. IPL, Fig.1)

NOTE: Discard all lockwashers that are disturbed or removed and renew at assembly.

(1) Using a pair of pliers, grip the projecting end of the sealing wire (10), break solder joint and pull it away clear of the case.

(2) Grasp the connecting plug and withdraw the main assembly from the case until there is sufficient clearance to prise out the seating ring (20). Remove the indicator assembly from the case (30), taking care not to damage glass.

(3) Unscrew the two scale retaining screws (50) with lockwashers (60). Carefully remove scale (40), and avoid damage to pointers or monitor flags.

(4) Unscrew the two mask retaining screws (80) with lockwashers (90). Carefully remove mask (70), taking care not to damage pointers or monitor flags. Unsolder earth lead, and lift away mask.

(5) Unsolder all wires connected to the pointer movements and monitor movements. Record the wire positions and colour codings.

(6) Remove the four, hexagon-shaped threaded pillars (140) and carefully remove the movements in the order :-

Vertical Pointer (100)
Vertical Monitor (130)
Horizontal Pointer (120)
Horizontal Monitor (110)

(7) Unscrew the three 6 B.A. round nuts (160) with lockwashers (170). Remove the moulded ring (150).

(8) Unscrew the three special nuts (180) and withdraw the spool mounting plate (230). Record the positions of the connecting wires on the plate and unsolder all connections: remove the spool mounting plate (230).

NOTE: The spool mounting plate may be removed without the necessity of disassembling the movement. Slacken off three nuts (260) towards the base and withdraw the spool plate.

(9) Unscrew the four, spool retaining screws (200) and lockwashers (210). Collect the four, twin-mounted spools (190 - 193). If necessary, part the spool pairs and remove the spool stud (220).

(10) Remove the three plain washers (240), lockwashers (250) and 6 B.A. nuts (260) from the base assembly (270).

CLEANING

1. Preparation

TABLE 401

MATERIALS

A. Materials

Material/Specification	Supplier
Acetone, B.P.	Commercially available
Spirits, Methylated	Commercially available
Brush, Bristle	Commercially available
Leather, Chamois	Commercially available

NOTE: Equivalent substitutes may be used for listed items.

2. Procedure (Ref. IPL, Fig.1)

WARNING: USE ACETONE IN A WELL VENTILATED AREA AND AVOID BREATHING FUMES. ACETONE AND METHYLATED SPIRITS ARE HIGHLY FLAMMABLE.

CAUTION: ENSURE THAT ACETONE DOES NOT COME INTO CONTACT WITH INSULATING OR COATED SURFACES.

(1) Use acetone applied with a brush to remove Bostik (or alternative used) adhering to threads of screws, buts and components which have been removed from assemblies and are not to be renewed.

(2) Remove surplus flux from all metal surfaces with methylated spirits.

(3) Use a soft brush to remove dust from the case assembly; clean the glass with a chamois leather.

CAUTION: AVOID DAMAGE TO THE CONTROL SPRINGS OF THE MOVING COILS WHEN USING THE AIRLINE.

(4) If the movement assemblies (100), (110), (120) or (130) have been removed, blow out their magnet gaps with a jet of clean, dry air. Place movements in a covered, dust-free container until required for reassembly.

NOTE: Air from workshop compressed air lines is not suitable for cleaning purposes; use air at a pressure not exceeding 5 pounds per square inch (30 kPa).

CHECK

1. Preparation

NOTE: Equivalent substitutes may be used for listed items.

TABLE 501

MATERIALS AND EQUIPMENT

A.

Materials	Type/Code	Supplier
Magnifying glass		Commercially available
Non-metallic tool	-	-

B.

Equipment		
Multi-minor tester	Mk.5	Avo Ltd., Archcliff Road, Dover.
Resistor: 10K, 300mW	Type CR25	Mullard Ltd., Torrington Place, London, WC2.

2. General Procedure (Ref. IPL, Fig.1)

Apply the following checks throughout to the specified components of the indicator. Any necessary additional checks are given in sub-para. 3.

A. Examine visually all components for:

(1) Corrosion and wear of plug pins on end-plate (270).

(2) Serviceability of all threads.

(3) Scores or dents in case (30).

(4) Security of components not dismantled; also examine with finger pressure for security of mounting, the spools (190 - 193).

3. Detail Procedure (Ref. IPL, Fig.1)

A. Examine parts as follows :-

CAUTION: UNDER NO CIRCUMSTANCES USE A METALLIC NEEDLE FOR THE REMOVAL OF OBSTRUCTIONS DETAILED IN (1). AVOID DAMAGE TO THE CONTROL SPRINGS OF MOVEMENTS.

(1) The gap in which the moving coil rotates for obstructions; also examine the magnetic core and adjacent surfaces. Remove any particles adhering to these surfaces with a shaped piece of wood, plastic or non-metallic tool.

(2) The control springs of the moving coils of movements complete (100), (110), (120), (130), to ensure that when pointers/flags are deflected, the convolutions of the control springs do not touch each other.

(3) The glass of case (30) for security of mounting, cracks and cleanness.

(4) The surface of the scale for good finish; the scale markings must not be broken nor defaced.

(5) The finish of the pointers and flags. The items must be free of distortion and the pointers must align with their appropriate scale markings.

CAUTION: WHEN USING THE TESTER (OR EQUIVALENT SUBSTITUTE) AVOID EXCESSIVE CURRENT THROUGH THE MOVING COILS BY INSERTING A 10K RESISTOR (SEE TABLE 501) IN SERIES WITH THE MOVING COILS. ALLOW FOR THE MEASURED VALUE OF THE RESISTOR AND CALCULATE THE MOVING COIL RESISTANCE.

(6) Check the resistance values of the moving elements of the movements complete. The resistance values are detailed in Description and Operation, 4 Data. Use the equipment listed in Table 501.

REPAIR

1. Case Assembly (30) (Ref. IPL, Fig.1)

   If either the case or glass is damaged the assembly must be renewed.

2. Movement Assemblies: (100), (110), (120) and (130)

   These items are not repairable beyond minor remedial action - refer to the Check paragraph of the manual.

3. End-plate (270/270A)

   Any damage to the end-plate or the connector plug will necessitate replacement of the end-plate (270).

ASSEMBLY (INCLUDING STORAGE)

1. Materials, Equipment and Special Tools

NOTE: Equivalent substitutes may be used for listed Material and Equipment. The materials can be ordered directly from Weston Instruments or quoted manufacturers.

TABLE 701

MATERIALS, EQUIPMENT AND SPECIAL TOOLS

A. Materials

Material	Specification	Supplier
Red Thermolene lacquer No.185	MILS 22473 GRADE B	W. Cannings & Co. Ltd., Great Hampton Street, Birmingham.
Scotchclad coating EC 776	MMA122A	3M United Kingdom Ltd., 57 Croydon Road, London SE20.
or		
Bostik B.S.104	Bostik No.772 thinned with acetone B.P.C. to a brushable consistency.	Weston Instruments, Great Cambridge Road, Enfield EN1 3RX
Shell Teepol (514/610)		Shell Chemical U.K. Ltd., 41 Strand, London WC2
Solder, resin cored 50/50 Solder, resin cored 59/41	QQS571-Type SN60	E.G.M. Solder Ltd., Wolsey Road, Mitcham, Surrey.

TABLE 701

MATERIALS, EQUIPMENT AND SPECIAL TOOLS (CONTD)

B. Equipment

Equipment	Code	Supplier
Charger/Demagnetiser Jig (For holding movement)	M.S.C.2	Hirst Electrical Industries, Crawley, Sussex.
Sealing Equipment:		
Vacuum Pump, Speedivac 2, (220V-240V s.ph. 50Hz)	A134-51-912	Edwards High Vacuum, Crawley, Sussex.
Moisture Trap, DT20	A133-03-000	- " -
Vacuum Gauge, Pirani 10 100-125V/200-250V, 50Hz.	D035-15-000	- " -
Gauge Head, PR10 (Voltage as for Vacuum Gauge)	D024-21-000	- " -
Pressure Controller, VPC1	D083-01-000	- " -
Speedivalves, SC5 - 3 off	C330-04-000	- " -
Cylinder - Dry Nitrogen (Capacity 1.24m^3 -136 bars)	Ref. No.3	British Oxygen Co. Ltd. London
with		
Two-stage Regulator (Delivery pressure 4.8 bars)	SRX 70	- " -
Pressure Gauge, 0-30 p.s.i.	842261	- " -

C. Special Tools

Equipment	Code	Supplier
Balance wrenches (11 off)	271157 - 271167	Weston Instruments, Great Cambridge Road, Enfield EN1 3RX

2. Procedure (Ref. IPL, Fig.1, Figs. 701, 702 and 703)

A. Assemble indicator

CAUTION: USE GREAT CARE AND PREVENT THE FINISHING MATERIALS FROM COMING INTO CONTACT WITH THE MOVING PARTS.

NOTE: During assembly coat with solution EC 776 all nuts, threaded holes and screw heads to lock against vibration. Apply Thermolene lacquer to the jewel screws and bridge abutments after these items have been finally adjusted. Solder all spool and circuit connections using 50/50 solder and then coat the solder joins with Thermolene lacquer. Refer to Table 701 for the listed materials.

(1) If the base assembly (270)/(270A) has been renewed, solder connecting wires to the pins as detailed in the wiring diagram. Fit insulating sleeves over the connecting wires.

(2) Assemble 6 B.A. nuts (260), lockwashers (250) and plain washers (240), 3 off each item, on the threaded pillars of the base assembly.

(3) Join series spools to shunt spools using the 10 B.A. stud (220); refer to wiring diagram Fig.701, for spool pairs.

(4) Secure spools (190-193) to the spool mounting plate (230) with 10 B.A. lockwashers (210) and screws (200). Connect the wires as recorded at dismantling, or refer to the wiring diagram.

(5) Locate the assembled spool mounting plate in position on the base assembly, resting it on the plain washers (240). Screw the special nuts (180) on the threaded pillars of the end plate but do not tighten to the spool mounting plate at this point.

(6) Fit the moulded ring (150) on to the special nuts (180) and secure with 6 B.A. lockwashers (170) and 6 B.A. round nuts (160), 3 off each item. Adjust the special nuts (180) and the round nuts (160) to give a spacing of 2.32" (58.9mm) from the outside surface of the endplate (270) to the shoulders of the pillars integral with the moulded ring (150). Tighten both sets of nuts (180 and 160) progressively to lock the moulded ring into the correct position.

NOTE: If the spacing dimension is correctly adjusted the gap between the cover glass and the pointers will be correct, when the movements are assembled in position.

(7) Adjust the 6 B.A. nuts (260) to bring the spool mounting plate (230) firmly against the special nuts (180) to lock the plate in position.

(8) Check the jewel bearing adjustment of the movement, pointer flop should be just discernible. Pointer flop is the movement of the pointer caused by the pivots moving laterally in their bearings. If the bearings need adjustment, check that the coil is evenly centred and then adjust the jewel screws, in the top and bottom bridges, in increments of one tenth of a turn until pointer flop is just eliminated. Then back off the top jewel screw by between one tenth and one eighth of a turn until slight pointer flop is just perceptible.

(9) If a new 'movement complete' has been supplied, age and stabilise the magnet as described in sub-paras C and D respectively.

NOTE: All 'movements complete' leave Weston Instruments with their magnets saturated.
If, however, a magnet is inadvertently 'overaged' the magnet must be re-raised as set down in sub-para. B.
It may also become necessary or convenient to age/raise the magnet of a movement complete of an indicator returned as faulty to maintain electrical sensitivity requirements.
If either raising or ageing of magnets is necessary, the movement complete must be stabilised as instructed in sub-para. D.

(10) Fit the movements complete, in the order:- Horizontal monitor movement (110), Horizontal pointer movement (120), Vertical monitor movement (130), Vertical pointer movement (100), to the appropriate pillars of the moulded ring (150).

(11) Resolder all connections broken at disassembly - refer to Fig.701 wiring diagram for connections and spool dispositions of the indicator.

NOTE: All connections between movements and spools, spools and plugs are made with 7/9.2mm P.T.F.E. covered silver-plated copper wire, colour coded as below:

Vertical pointer movement	-	Red
Horizontal pointer movement	-	Blue
Horizontal monitor movement	-	Black
Vertical monitor movement	-	White

All solder joints on the plug connector must be covered with suitable sleeving.

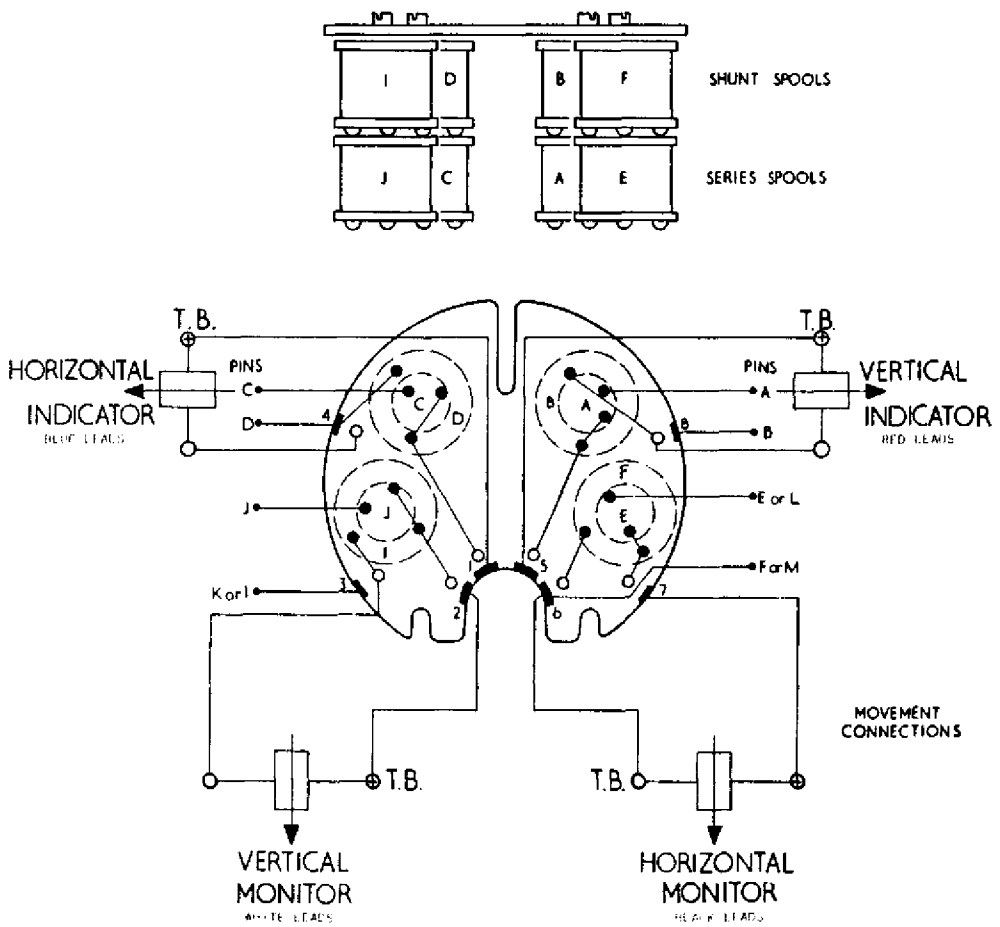
(12) Lock the movements in position with the four, hexagonal scale pillars (140).

(13) Balance the movements as described in Section E.

CAUTION: CARE MUST BE EXERCISED WHEN ASSEMBLING THE MASK AND THE SCALE TO ENSURE THAT POINTERS AND MONITOR FLAGS ARE NOT DAMAGED.

(14) Fit the mask (70) to the appropriate hexagonal pillars (140) and secure with 10 B.A. lockwashers (90) and 10 B.A. screw (80) - 2 off each item. Solder earth connection to mask.

(15) Manoeuvre the scale (40) into position on the hexagonal pillars (140) and secure with 10 B.A. lockwasher (60) and 10 B.A. screw (50) - 2 off each item.



Wiring Diagram
Figure 701

(16) Determine from Testing/Trouble Shooting that the indicator complies with the resistance and sensitivity requirements. When the tests and, if necessary, adjustments have been satisfactorily completed, fit the indicator into the case (30).

(17) Manoeuvre seating ring (20) over end plate (270)/(270A) with its ridged periphery facing outwards. Place sealing wire (10) in position resting it against the seating ring (20). Position the end plate (270) and seating ring (20) to be flush with each other and the end of case (30). Allow the solder to run over the sealing wire (10) and give a seal between the case (30) and the end plate (270). The soldered join shall be flat, level with the end plate (270) and leave no gap but allow the projecting end of sealing wire (10) to be prised up for removal of the wire when necessary. It is essential to complete the operation as quickly as possible and avoid excessive heating of the case (30). Use solder 59/41 as detailed in Table 701. Wipe excess solder away with a dry, clean rag; do not use solvents.

(18) Effect the sealing procedure as detailed in sub-para G.

B. Ageing the Magnets of Movements Complete (100/110/120/130)

NOTE: Polarity of the magnets must give pointer or flag deflections in the stated directions as below, when the specified currents for the variant are applied to the bridges of the appropriate movements.

Movement	Form 1	Form 2
Vertical Pointer	Pin A +ve; B -ve Deflection right	Pin A +ve; B -ve Deflection right
Horizontal Pointer	Pin C +ve; D -ve Deflection upwards	Pin C +ve; D -ve Deflection upwards
Vertical Monitor	Pin J +ve; I -ve Deflection left	Pin J +ve: K -ve Deflection left
Horizontal Monitor	Pin E +ve; F -ve Deflection upwards	Pin L +ve; M -ve Deflection upwards

(1) Age the magnet using the Raiser/Demagnetiser specified in Table 701 to give the required sensitivity as stated in the Variant Data section and with circuit conditions as given in Fig.101 of the Testing and Trouble Shooting section of the manual.

(2) Support a test scale to enable the pointer deflection to be observed of the movement being aged.

(3) Apply to each movement in turn a current of sufficient value to deflect its pointer over the normal scale angle, that is, approximately 80^0 for pointer movements and 90^0 for monitor movements. The full scale values of current for the movements in their saturated condition will be less than the values given in the Variant Data section of the manual.

(4) Note the value of the current for full scale deflection. Gradually increase the noted current by 3 - 5% and age the magnet until the pointer again aligns with the full scale mark. If a movement is over-aged it must be re-raised as detailed in para. C.

NOTE: To ensure stability of the magnet the flux density should be reduced by a minimum of 3 - 5% of full scale sensitivity.

C. Raising the Magnets of Movements Complete (100/110/120/130)

(1) If the movement has been inadvertently over-aged it will be necessary to raise the magnet of the movement complete. Use the Raiser/Demagnetiser as specified in Table 701.

D. Temperature Stabilisation

After the raising and ageing procedures have been completed, place the four complete movements in a suitable housing which will prevent contamination of the movements but permit good temperature conduction.

(1) Raise the temperature of the housing by heating it in a controlled oven to 70^0C (158^0F) $\pm$ 2^0C (-3.6^0F) for a period of 8 hours and then allow it to cool to room temperature.

NOTE: It is essential that the stabilisation procedure is applied to all movements.

E. Balance Movement (Ref. IPL, Fig.1)

Balance each movement after checking the adjustment of the jewelled bearings - refer to 2, A. Procedure, (8). Temporarily assemble each movement in turn on to the pillars on which it locates on moulded ring (150), and then fit a finished scale to the pillars. Ensure

that the pointers are in alignment with the scale dots and that when the monitor flag is moved over the scale dots the flag edges are parallel with the scale dots.

(1) Pointer Movements (100, 120)

Adjust the balance weights of the moving elements with the indicator in the positions given. The tip of the pointer must not move more than half its width from the centre line while in the positions given.

(a) With the pointer horizontal and its pointer tip to the left.

(b) With the pointer horizontal and its pointer tip to the right.

(c) With the pointer vertically upwards.

NOTE: The scale must be kept in the horizontal plane and turned to give the correct positions (a) to (c) before gently raising the scale to the vertical plane.

(2) Monitor Movements (110, 130)

If the control springs are suppressed the movement circuit must be energised to achieve the balance adjustment of the moving elements.

(a) Connect each flag movement in turn into a circuit as shown in Fig.101 of the Testing/Trouble Shooting paragraph of the manual.

(b) Adjust the circuit current to bring the flag in a half way position and the full scale deflection.

(c) Adjust the balance weights to give the best balance obtainable. Disconnect supply from flag movement.

NOTE: When adjusting balance weights ensure that the weights are fully on the cross-arms; they must not overhang the ends of the arms. Use the balance wrenches specified in TABLE 701, C, Special Tools.

F. Adjust Spool

Determine resistance values of spools as instructed in the Testing/ Trouble Shhoting section of the manual. If it is not possible to obtain

the required values with the existing spools - refer to the Illustrated Parts List to obtain the required values of spools.

(1) Shunt and series spools must be adjusted to the following tolerances of the required values.

Pointer movement shunt spools	± 3%
Monitor movement shunt spools	± 1%
Series spools	± 0.5%

(2) If necessary, adjust spools as described in the Testing/Trouble Shooting paragraph of the manual.

Because of the wide variation in resistance values of some of the spools, if it is necessary for any reason to renew a spool, always select a spool of resistance value which entails the minimum reduction in resistance value.

G. Sealing Procedure (Ref. Fig.702 and IPL, Fig.1)

This follows the completion and checking of the calibration of the indicator.

CAUTION: FORM 2 INDICATORS MUST HAVE A TIGHT-FITTING WATER-PROOF CAP FITTED OVER THE CONNECTOR PLUG THROUGHOUT THE SEALING PROCEDURES. THIS CAP SHOULD BE LEFT ON, AFTER SEALING AND AT ALL TIMES THE INDICATOR IS NOT IN CIRCUIT.

(1) Connect the exhaust stud on the indicator end plate (270/270A) to the sealing equipment in order to remove air from the case.

(2) Ensure that a tight seal is made between the exhaust stud and the manifold.

WARNING: PLACE THE INDICATOR IN A SAFETY TANK TO AVOID POSSIBLE INJURY TO PERSONNEL IN THE EVENT OF THE CASE GLASS DISINTEGRATING.

(3) Check that the manifold valve is closed and also that the vacuum pressure controller and valve A are closed.

(4) Start the vacuum pump and obtain a vacuum of between 0,01 and 0,1mm mercury pressure (1,3 and 13 Pa).

(5) When the correct vacuum is indicated open valve B and the manifold valve and allow the system to regain the required vacuum.

NOTE: If it is not possible to maintain the vacuum, close the manifold valve, remove the indicator from safety tank and check for leakage as detailed in sub-paras (8) and (9). Inspect and if necessary re-seal the indicator. Repeat the sealing procedure.

(6) Close valve B and open valve A to admit dry nitrogen into the indicator. Adjust vacuum pressure controller to obtain a pressure of 15 P.S.I.G.

NOTE: Ensure that any air in the pressure line is bled off before pressurising indicator.

(7) After 30 seconds adjust vacuum pressure controller to reduce the indicator pressure to 10 P.S.I.G.

Sealing Procedure - Equipment
Figure 702

(8) The indicator, still under pressure, must now be completely immersed in a tank containing 99.5% distilled water and 0.5% wetting agent.

NOTE: A suitable wetting agent is Shell Teepol 514.

(9) Shake the indicator to remove any trapped air that may be present and then check, over a period of 5 minutes, for any sign of leakage. Leakage will be shown by the presence of bubbles leaving the case. In the event of leakage, mark the case at the defective part so that the leak can be repaired on the removal of the indicator from the system.

Particular care must be taken to check for leakage at the sealing join of the end plate (270/270A) and the case (30). (IPL, Fig.1).

(10) At the completion of the check for leakage, reduce the dry nitrogen pressure to zero gauge by operating the vacuum pressure controller.

(11) Close the manifold valve, remove the indicator from the tank and dry with a clean piece of muslin.

(12) Disconnect the indicator from the manifold and seal as instructed below.

(a) Case (30) fitted with a sealing tube.

Crimp the tube in a suitable fixture and seal the end of the tube with solder.

(b) Case (30) fitted with a sealing stud.

Place a sealing pin in the stud aperture and complete the sealing process by carefully soldering the pin to the stud.

NOTE: The final sealing of the indicator must be made immediately after the removal of the indicator from the sealing equipment.

3. Storage

A. If the original packing is not available, obtain the following:

(1) Packing for temperate areas.

(a) Oven dried silica gel.

(b) A polythene bag to contain the indicator together with the silica gel. Heat seal the opening of the bag.

(c) A rubberised hair mould to enclose the indicator in its polythene bag.

(d) A cardboard box to contain the hair mould.

(e) Gummed paper strip to seal the cardboard box.

(f) A label to be affixed to the box and giving the following information.

1. Identification, e.g. S.178.1.13.

2. Modification standard

3. Date of removal from aircraft.

4. Date of last service.

5. Details and date of any component change.

6. Reason for return of indicator.

(2) Packing for tropical areas:

(a) Water resistant paper to completely enwrap the indicator; then proceed as described in A (1) (a) to (c).

(b) A polythene bag large enough to hold the rubberised mould. Heat seal the bag and proceed as described in A (1) (d) to (e).

(c) A wooden box of suitable dimensions to enclose the cardboard box; secure it and affix a label as in A (1) (f).

B. If the original packing is available, repack the indicator and affix a label as in A (1) (f).

(3) Indicators must be stored under conditions where humidity does not exceed 50% and the temperature is within the range -20°C (-4°F) to +50°C (122°F).

(4) Indicators which have been in store must be connected into a circuit as shown in Figure 101 of the Testing and Trouble Shooting section, and checked to ensure that their shunted sensitivities comply with the values given in 4. Data, of the Description and Operation section before being put into service.

SPECIAL TOOLS, FIXTURES, AND EQUIPMENT

1. General

The special tools and equipment required to effect the repair and testing of the indicator are listed below in Table 901.

The indicator should be repaired and tested in a clean atmosphere, free from corrosive fumes.

NOTE: Equivalent substitutes may be used for listed items.

TABLE 901

SPECIAL TOOLS AND EQUIPMENT

A. Special Tools

Description	Code	Supplier
Balance wrenches (11 off)	271157 to 271167	Weston Instruments, Great Cambridge Road, Enfield, EN1 3RX

B. Equipment

Equipment	Code	Supplier
Portable d.c. μ Ammeter 100/200/500μA Accuracy: ± 1.0% f.s.d. (Class Index 1.0) B.S.89:1977	-	Salford Electrical Instruments Ltd., Eccles, Manchester.
Insulation test meter 250/500V d.c.	1905L	Comark Electronics, Rustington, Sussex.
Portable Wheatstone Bridge (substitute must measure to ± 0.5% over 100-1000 ohms)	5785/4	H. Tinsley & Co. Ltd., Stanger Road, London, SE25

Continued

TABLE 901

SPECIAL TOOLS AND EQUIPMENT (CONTD)

Continuation

Equipment	Code	Supplier
Decade resistance box - 2 off. (Max. resistance 11,111 ohms - minimum step 1 ohm).	5274/4	H. Tinsley & Co. Ltd., Stanger Road, London, SE25
Potentiometer: 1500 ohms, 1 Watt (R3 in Fig.101)	CLR 1106	Colvern Ltd., Romford, Essex.
Resistors: 390K, 300mW 47K, 300mW (Used in Fig.101)	CR 215	Mullard Ltd., Torrington Place, London, WC2
Multi-minor tester	Mk. 5	Avo Ltd., Archcliffe Road, Dover.
Resistor: 10K, 300mW	CR 25	Mullard Ltd., Torrington Place, London, WC2
Magnifying glass	-	Commercially available.
Sealing Equipment:		
Vacuum Pump, Speedivac 2, (220V-240V s.ph. 50Hz)	A134-51-912	Edwards High Vacuum, Crawley, Sussex.
Moisture Trap, DT20	A133-03-000	- " -
Vacuum Gauge, Pirani 10 100-125V/200-250V, 50Hz	D035-15-000	- " -
Gauge Head, PR10 (Voltage as for Vacuum Gauge)	D024-21-000	- " -

Continued

TABLE 901

SPECIAL TOOLS AND EQUIPMENT (CONTD)

Continuation

Equipment	Code	Supplier
Sealing Equipment (cont.):		
Pressure Controller, VPC1	D083-01-000	Edwards High Vacuum, Crawley, Sussex.
Speedivalves, SC5 - 3 off	C330-04-000	- " -
Cylinder - Dry Nitrogen (Capacity 1.24m^3-136 bars)	Ref. No.3	British Oxygen Co. Ltd., London.
Two-stage Regulator (Delivery pressure 4.8 bars)	SRX 70	- " -
Pressure Gauge, 0-30 p.s.i.	842261	- " -

WESTON INSTRUMENTS

COMPONENT MAINTENANCE MANUAL

MODEL S.178 FORMS 1 & 2 - INDICATOR, I.L.S.

ILLUSTRATED PARTS LIST

1. Introduction

(1) This section lists and illustrates parts for Forms 1 and 2 of the Model S.178 indicator.

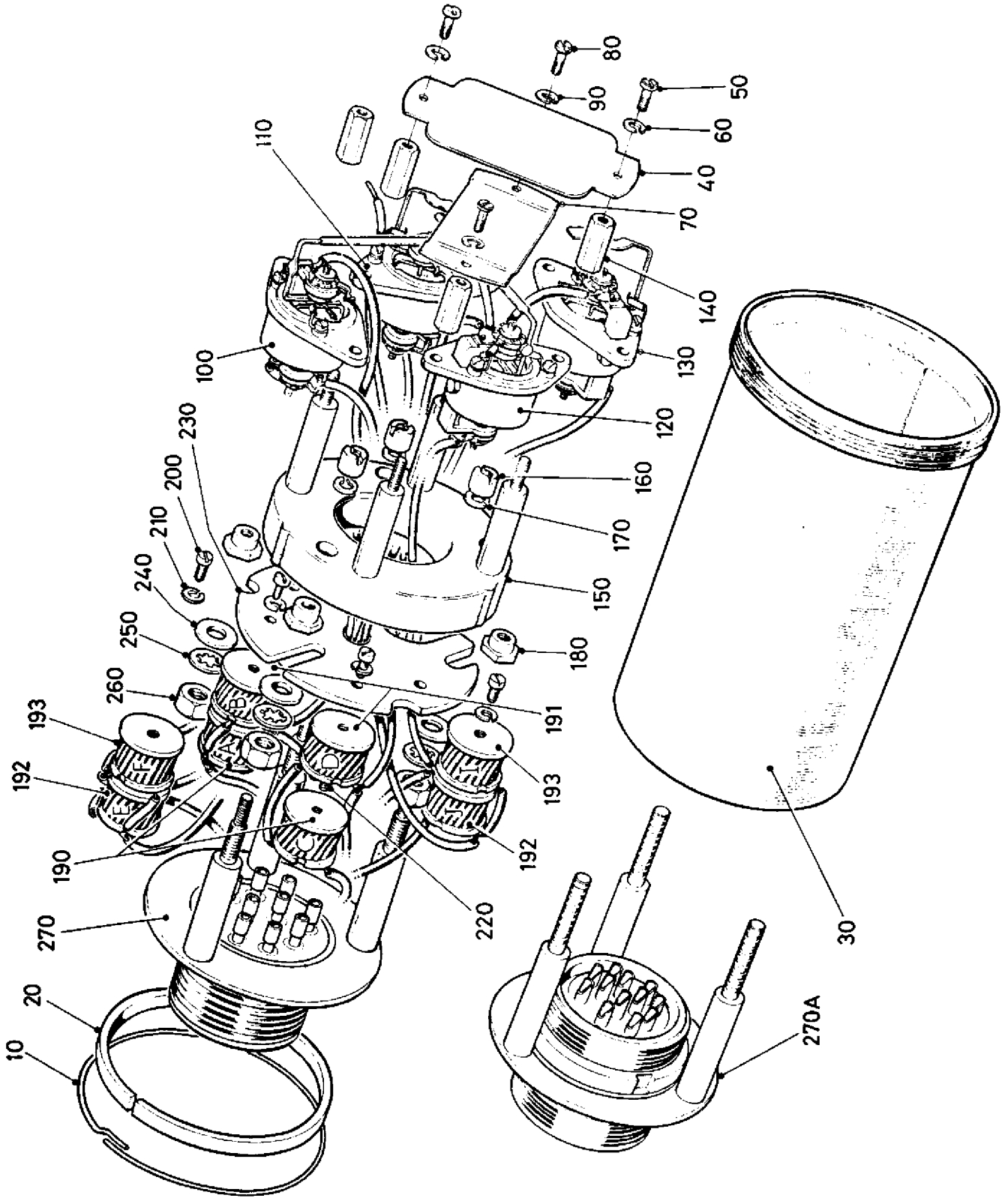
(2) The form and variant number is printed on the scale of the indicator. The variant number defines a particular application of the model and is not dependent on the Form number; a given variant number will never appear on another Form of the same model.

(3) The first group of numbers in the part number column identifies the model, form and variant as displayed on the scale, that is, the basic part number. Against each basic part number is an item identity, e.g. 1A, 1B, etc. Where a part number is applicable to all basic part numbers, the effectivity column is left blank against the part number. Part numbers not associated with all the listed basic part numbers are shown in the effectivity column and reflect the basic part number to which they are related.

(4) Each indicator, or basic part number, comprises 8 spools: 4 series spools - A,C,E and J, and 4 shunt spools - B, D, F and I. Their values are derived from the Testing procedure given in the manual, and B, D, E, F, I and J are given a range of values to cater for the variations which occur between indicators. The letters against the spools are as marked by the manufacturer Weston Instruments and have no significance in the Parts List arrangement; they are used to identify their physical position in the indicator, and also to identify their circuit relationship with the pins of the connector of the indicator.

The variants included in this Illustrated Parts List are:

	Effectivity Code
S.178-1-13	A
S.178-1-19	B
S.178-2-12	C
S.178-2-26	D



Illustrated Parts List - Model S.178 Forms 1 & 2
Figure 1

FIG. ITEM	PART NUMBER	AIRLINE PART NO.	NOMENCLATURE 1234567	EFF CODE	UNITS PER ASSY
1- 1A	S178-1-13		INDICATOR ASSY, I.L.S.	A	
-1B	S178-1-19		INDICATOR ASSY, I.L.S.	B	
-1C	S178-2-12		INDICATOR ASSY, I.L.S.	C	
-1D	S178-2-26		INDICATOR ASSY, I.L.S.	D	
10	168416		.SEALING WIRE		1
20	169908		.RING, SEATING		1
30	181441		.CASE ASSY	A,C	1
-30A	180076		.CASE ASSY	B,D	1
40	171692-178-1-13		.SCALE, FINISHED	A	1
-40A	180665-178-1-19		.SCALE, FINISHED	B	1
-40B	171692-178-2-12		.SCALE, FINISHED	C	1
-40C	171692-178-2-26		.SCALE, FINISHED	D	1
			--ATTACHING PARTS--		
50	170085		.SCREW, 10 B.A.		2
60	159306		.LOCKWASHER, 10 B.A.		2
			* * *		
70	170088		.MASK		1
			--ATTACHING PARTS--		
80	See Item No.50		.SCREW, 10 B.A.		2
90	See Item No.60		.LOCKWASHER, 10 B.A.		2
			* * *		
100	100-178-1-13		.MOVEMENT COMPLETE, VERT. POINTER	A	1
-100A	100-178-1-19		.MOVEMENT COMPLETE, VERT. POINTER	B	1
-100B	100-178-2-12		.MOVEMENT COMPLETE, VERT. POINTER	C	1
-100C	100-178-2-26		.MOVEMENT COMPLETE, VERT. POINTER	D	1
110	110-178-1-13		.MOVEMENT COMPLETE, HORIZ.MONITOR	A	1
-110A	110-178-1-19		.MOVEMENT COMPLETE, HORIZ.MONITOR	B	1
-110B	110-178-2-12		.MOVEMENT COMPLETE, HORIZ.MONITOR	C	1
-110C	110-178-2-26		.MOVEMENT COMPLETE, HORIZ.MONITOR	D	1

- Items not illustrated

continued

FIG. ITEM	PART NUMBER	AIRLINE PART NO.	NOMENCLATURE 1234567	EFF CODE	UNITS PER ASSY
1					
120	120-178-1-13		.MOVEMENT COMPLETE, HORIZ.POINTER	A	1
-120A	120-178-1-19		.MOVEMENT COMPLETE, HORIZ.POINTER	B	1
-120B	120-178-2-12		.MOVEMENT COMPLETE, HORIZ.POINTER	C	1
-120C	120-178-2-26		.MOVEMENT COMPLETE, HORIZ.POINTER	D	1
130	130-178-1-13		.MOVEMENT COMPLETE, VERT. MONITOR	A	1
-130A	130-178-1-19		.MOVEMENT COMPLETE, VERT. MONITOR	B	1
-130B	130-178-2-12		.MOVEMENT COMPLETE, VERT. MONITOR	C	1
-130C	130-178-2-26		.MOVEMENT COMPLETE, VERT. MONITOR	D	1
			--ATTACHING PARTS--		
140	170084		.PILLAR, SCALE		4
			* * *		
150	170079		.RING, MOULDED		1
			--ATTACHING PARTS--		
160	92356		.NUT, 6 B.A. ROUND		3
170	156976		.LOCKWASHER, 6 B.A.		3
			* * *		
180	170056		.NUT, 6 B.A., SPECIAL		3
190	159781-680-40J		.SPOOL, SERIES (A & C), 680Ω MAX.		2
191	159781-580-47C		.SPOOL, SHUNT (B & D), 580Ω MAX.		AR
-191A	159781-610-47C		.SPOOL, SHUNT (B & D), 610Ω MAX.		AR
-191B	159781-640-47C		.SPOOL, SHUNT (B & D), 640Ω MAX.		AR
-191C	159781-670-47C		.SPOOL, SHUNT (B & D), 670Ω MAX.		AR
-191D	159781-700-47C		.SPOOL, SHUNT (B & D), 700Ω MAX.		AR
192	158363-139-37J		.SPOOL, SERIES (E & J), 139Ω MAX.		AR
-192A	158363-159-37J		.SPOOL, SERIES (E & J), 159Ω MAX.		AR
-192B	158363-179-37J		.SPOOL, SERIES (E & J), 179Ω MAX.		AR
-192C	158363-199-37J		.SPOOL, SERIES (E & J), 199Ω MAX.		AR
-192D	158363-220-37J		.SPOOL, SERIES (E & J), 220Ω MAX.		AR

- Items not illustrated

continued

FIG. ITEM	PART NUMBER	AIRLINE PART NO.	NOMENCLATURE 1234567 *******	EFF CODE	UNITS PER ASSY
1					
193	159781-1810-43J		.SPOOL, SHUNT (F & I), 1810Ω MAX.		AR
-193A	159781-2190-43J		.SPOOL, SHUNT (F & I), 2190Ω MAX.		AR
-193B	159781-2650-44J		.SPOOL, SHUNT (F & I), 2650Ω MAX.		AR
-193C	159781-3200-44J		.SPOOL, SHUNT (F & I), 3200Ω MAX.		AR
-193D	159781-3870-45J		.SPOOL, SHUNT (F & I), 3870Ω MAX.		AR
-193E	159781-4690-45J		.SPOOL, SHUNT (F & I), 4690Ω MAX.		AR
-193F	159781-5680-46J		.SPOOL, SHUNT (F & I), 5680Ω MAX.		AR
-193G	159781-6880-46J		.SPOOL, SHUNT (F & I), 6880Ω MAX.		AR
-193H	159781-8000-46J		.SPOOL, SHUNT (F & I), 8000Ω MAX.		AR
			--ATTACHING PARTS--		
200	167699		.SCREW, 10 B.A.		4
210	153367		.LOCKWASHER, 10 B.A.		4
220	166476		.STUD, 10 B.A.		4
			* * *		
230	171580		.PLATE, SPOOL MOUNTING		1
240	90296		.WASHER, 6 B.A. PLAIN		3
250	150376		.WASHER, 6 B.A. SHAKEPROOF		3
260	112243		.NUT, 6 B.A.		3
270	170865		.PLATE, END	A,B	1
270A	170109		.PLATE, END	C,D	1

- Items not illustrated