WESTON
ELECTRICAL INSTRUMENTS
FOR AIRCRAFT

Weston Aircraft Instruments are supplied to the Air Ministry and to leading military and civil aircraft manufacturers throughout the world.

Sangamo Weston Ltd. are Design Approved by the Ministry of Supply, and the engineers at our Works and at our Branches are always available to discuss any problems or to give any assistance which may be required in connection with these instruments. Enquiries at any of our addresses will receive immediate attention.

MODEL S.139
ZERO READER FLIGHT DIRECTION INDICATOR

Information contained in this manual affecting safe operation, maintenance and overhaul has been verified and approved by the Air Registration Board in accordance with Chapter A6-2 of British Civil Airworthiness Requirements. 24. 5. 56.

Amendments to this publication invalidate the approval statement unless issued by the manufacturers with the concurrence of the Air Registration Board.

Date of Model Introduction 1950

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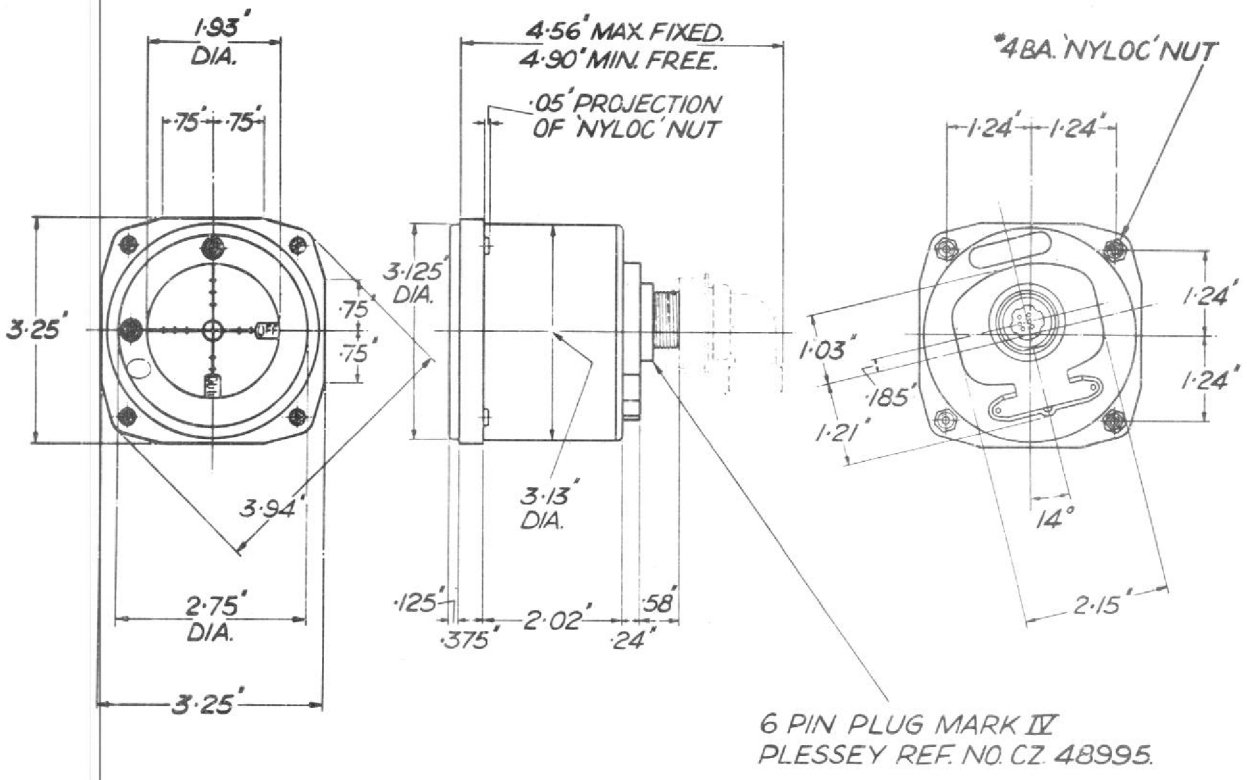
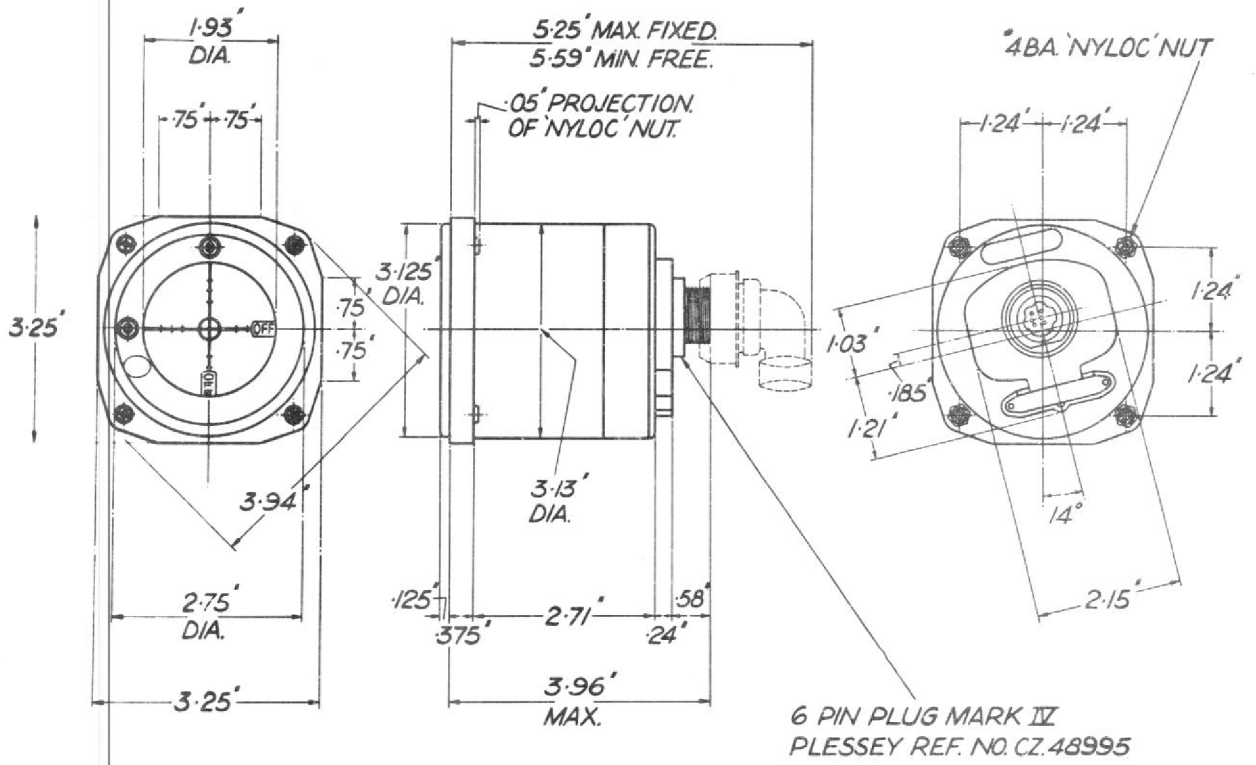
MODEL S.139
ZERO READER FLIGHT DIRECTION INDICATOR



Fixing Diagram
Model S139 Form 5



Fixing Diagram
Model S139 Form 7

GENERAL

This indicator is used in conjunction with Sperry Flight equipment designed to assist in the simplification of instrument flying.

DESCRIPTION

The instrument contains four moving elements. Two of these are used to indicate to the pilot what change of attitude should be made in order to correct course and height, whilst the other two are used as monitors to show whether or not the instrument is connected to a live circuit.

The change of attitude pointers are (*a*), the " Roll " pointer, which has its pivot centre at the top and indicates that the pilot must alter course right or left, and (*b*), the " Pitch " pointer which has its pivot centre at the left hand side when viewed from the front, and indicates the change of attitude required either in an up or down direction.

Both indicator pointers extend over the full span of the scale and are finished with fluorescent paint. The horizontal indicator is the nearest to the scale.

Both of the two monitor flags are inscribed " OFF " in fluorescent paint on a red background, together with a white fluorescent frame round the edge. They are mounted in such a manner that when unoperated they obscure the ends of the indicators when these are in their zero position.

When the monitor flags are operated they are carried behind the front screen of the instrument and are no longer visible. The dial when viewed from the front is convex in section and is marked with fluorescent paint on a matt black background.

The centre of the dial is marked with a circle of 0.32 inches diameter. Three short lines are marked on each side of the central circle on horizontal and vertical centre lines. These are spaced to indicate equal increments of current. The first line in each direction represents a planar deflection of 0·382 inches from zero, and a current of 250 $\pm$ 30 microamps., whilst the third line in each direction represents a planar deflection of 0·724 inches from zero, and a current of 500 $\pm$ 60 microamps.

The instrument is contained in a cylindrical black bakelite case with a front mounting flange. The cover glass is approximately flush with the panel when the instrument is in position. A magnetic external shield is moulded integral with the case.

Connections to the aircraft wiring are made through a 6 pin Mk. 4 Plessey plug.

INSTALLATION

The instrument must be mounted in the aircraft so that the scale is in the vertical plane when the aircraft is in level flight. It is recommended that an anti-vibration mounting of the type 10A/12954 is used.

TEST INSTRUCTIONS

Insulation

The internal metal parts are insulated to withstand 1,000 volts A.C. applied between the moving elements and any external metal part including a screwdriver held in the zero adjuster slot.

INDICATOR MOVEMENTS

The performance of each indicator movement should conform to the conditions given below.

Sensitivity

The current required to deflect the indicator pointer from its centre zero to the position of the mark at 0·382 inches in vertical and horizontal directions shall be 250 $\pm$ 30 microamperes, and from centre zero to the third mark in vertical and horizontal directions shall be 500 $\pm$ 60 microamperes.

Scale Characteristics

The relationships between the current in the movements and the angular deflection of the indicator pointer shall be such that increments of current shall cause equal increments of deflection.

Damping

Damping of the indicator pointers is such that they must not deflect more than 30% beyond their steady state value when operating in a circuit of 350 ohms resistance.

Response

The time taken for an indicator pointer to reach 99% of its final steady state deflection at its first movement to any part of the scale must not be less than 0·14 of a second and not greater than 0·22 of a second.

Resistance

The resistance between each indicator movement must be 1,000 $\pm$ 25 ohms. Between the vertical and horizontal monitors the resistance must be less than 2,000 ohms. These measurements must be taken at the pins of the connecting plug. The connections are as follows:—

Pins A & B: Both monitor flags in series. Pin A positive gives clockwise deflection.

Pins D & E: " Pitch " pointer. Pin D positive gives deflection upwards.

Pins E & F: " Roll " pointer. Pin F positive gives deflection to the right.

MONITOR FLAG MOVEMENTS

The performance of the monitor flag movement must conform to the conditions given below:

Sensitivity

The monitor flags must remain in their unoperated position until a current in excess of 450 microamperes is applied. Thereafter a current of 1,050 microamperes shall be sufficient to move the monitor flags out of sight behind the mask.

MAINTENANCE AND REPAIR

The following information is given on the basis that a particular movement assembly is to be replaced and the instrument re-adjusted and tested. For this purpose the moving coil, the pointer and springs are supplied assembled and fitted to the pole piece ready for replacement assembly to the instrument.

Dismantling

(*a*) Remove the cover sealing screw and the screws which hold the instrument cover to the sub-base.

(*b*) Remove the pressure pads and springs from the two zero adjusters.

(*c*) Unscrew the four screws and washers holding the mask assembly to the scale pillars and take off the mask.

(*d*) Unscrew the two scale fixing pillars and deflect the indicator pointers by moving the long zero adjusters until the pointers are in the bottom left hand corner of the instrument.

(*e*) Withdraw the scale towards the top right hand corner of the instrument taking care not to foul the monitor pointers. Return the indicators to centre zero.

(*f*) Unsolder the connecting wires from the inner and outer bridge of each movement and move the wires so that they are clear of the movements both inside and outside.

(*g*) Take off the screws fixing the movement assembly to the mounting plate of the moving coil assembly which is to be replaced.

(*h*) With an 8 B.A. box spanner, slacken the magnet clamp on either side of this moving coil assembly.

(*j*) Unscrew the two mounting plate fixing pillars, steadying the assembly with the other hand.

(*k*) Lift the mounting plate assembly clear of the sub-mounting plate.

(*l*) The faulty movement assembly will now be free and must be carefully withdrawn from between the magnets. There will be considerable magnetic attraction opposing this removal, and due care must be taken.

NOTE: The magnets must not be removed unnecessarily, since their rearrangement will lead to considerable changes in the characteristics of the movements. Readjustment of all the movements will be necessary if the common magnetic circuit has been broken by the removal of the pole piece assembly. After the replacement of the damaged assembly and remagnetising the magnetic circuit, the movements (if not seriously disarranged) should return very closely to their original characteristics. This will facilitate the use of, if not the original spools, then very slightly adjusted original spools.

Re-assembly and Adjustment

(*a*) Replace the faulty movement assembly by sliding the replacement between the positioned magnets.

(*b*) Replace the two screws and washers which fix the movement assembly to the mounting plate, leaving the screws slack in the pole piece.

(*c*) Raise the magnets by positioning a $\frac{3}{4}$ inch diameter conductor through the centre of the assembly and passing a peak current of 10,000 amperes through it. It is essential that the system is fully saturated in order to obtain the correct dynamic characteristics of the instrument.

(*d*) Tighten all movements and magnet clamping screws.

(*e*) The magnetic circuit must now be aged to obtain a uniform flux distribution and stability. This is best achieved by placing a single conductor of $\frac{1}{2}$ inch diameter through the centre of the magnetic system and passing the current of 150 amperes at 50 cycles through it. This current must be smoothly raised to a maximum and reduced to zero within a period of 5 seconds. This process gives approximately 3% ageing to the magnet system. Saturation, correct ageing and polarity are indicated by a sensitivity check given later.

(*f*) Check the balance of the movements. The movement of the vertical indicator pointer from zero should not exceed $\pm \frac{1}{32}$ of an inch with the instrument tilted 90° to the right or left with the dial vertical. The horizontal pointer must not deflect more than $\pm \frac{1}{16}$ of an inch from zero with the instrument turned upside down and the dial still in a vertical plane.
Both pointers must not deflect more than $\frac{1}{32}$ of an inch with the instrument tilted 90° and the plug pointing downwards.

(*g*) Replace the mounting plate assembly on to the sub-mounting plate pillars, taking care not to damage the tail ends of the pointers. Locate the tails of the magnet clamps in their corresponding holes in the sub-mounting plate.

(*h*) Replace the two mounting plate fixing pillars.

(*j*) Make electrical connections to the inside and outside bridges of each movement as shown on the wiring diagram. (Fig. 1).

(*k*) Move the indicators by the long zero adjusters to the bottom left hand corner, and replace the scale from the top right hand corner. Fix the scale in position with the two scale clamp pillars and reset the zeros.

(*l*) Disconnect the spools etc. from the movement connections and arrange for the movement to be directly connected to the outside.

(*m*) Check the saturation and ageing of the magnets by testing the indicators, using a series microammeter of 0-500 microamperes and a suitable source of current.

The sensitivity to the *second* mark on the scale with the shielded cover in position must be as follows:

(i) before ageing and after saturating . . . . . 213 — 252 microamperes

(ii) after ageing . . . . . 220 — 260 microamperes

Check the polarity of magnetising as follows:

Vertical Indicator:	outer bridge connection	positive	deflection to the right.
Horizontal ,, :	,, ,,	,, positive	,, up.
Vertical Monitor :	,, ,,	,, negative	,, to the right.
Horizontal ,, :	,, ,,	,, negative	,, to the right.

If all pointers deflect in a contrary direction, reverse the direction of magnetising and re-raise the magnetic circuit.

Adjustment of an indicator movement

(*n*) This adjustment is carried out with the shielded cover in position. Disconnect all spools relative to the indicator and set the indicator to centre zero. Connect a variable resistance box of 2,000 ohms maximum value across the moving coil.
From a suitable current source in series with an 0-500 microamperes instrument, apply a potential to the shunted movement and adjust the deflection of the instrument by shunting such that it deflects to the second line of the scale for a current of 375 microamperes.
Disconnect the supply, leaving the shunt box at the determined value and insert a variable resistance box of 1,000 ohms maximum in series with the shunted movement. Using a low current ohmmeter, adjust the series box to bring the terminal resistance of the shunted movement, and series to 1,000 $\pm$ 25 ohms. Note, or measure, the box value of the shunt and series resistors and adjust the spools as necessary.
The shunt spool value lies between 500-1,000 ohms and is wound with enamelled copper wire to provide temperature compensation for the movement.
The series spool value lies between 600-800 ohms and is wound with constantan, zero coefficient, material.

(*p*) Replace the adjusted spools on the spool plate and rewire the indicator circuit as shown in the wiring diagram. (Fig. 1).

(*q*) Repeat from (*n*) for the other indicator.

(*r*) Check the current sensitivity of each indicator as in (*n*). This must be 250 $\pm$ 30 microamperes to the first mark and 500 $\pm$ 60 microamperes to the third mark.

(*s*) Replace the circular mask on to the four pillars and fix down with four screws and lock washers.

Adjustment of the Monitor Movements

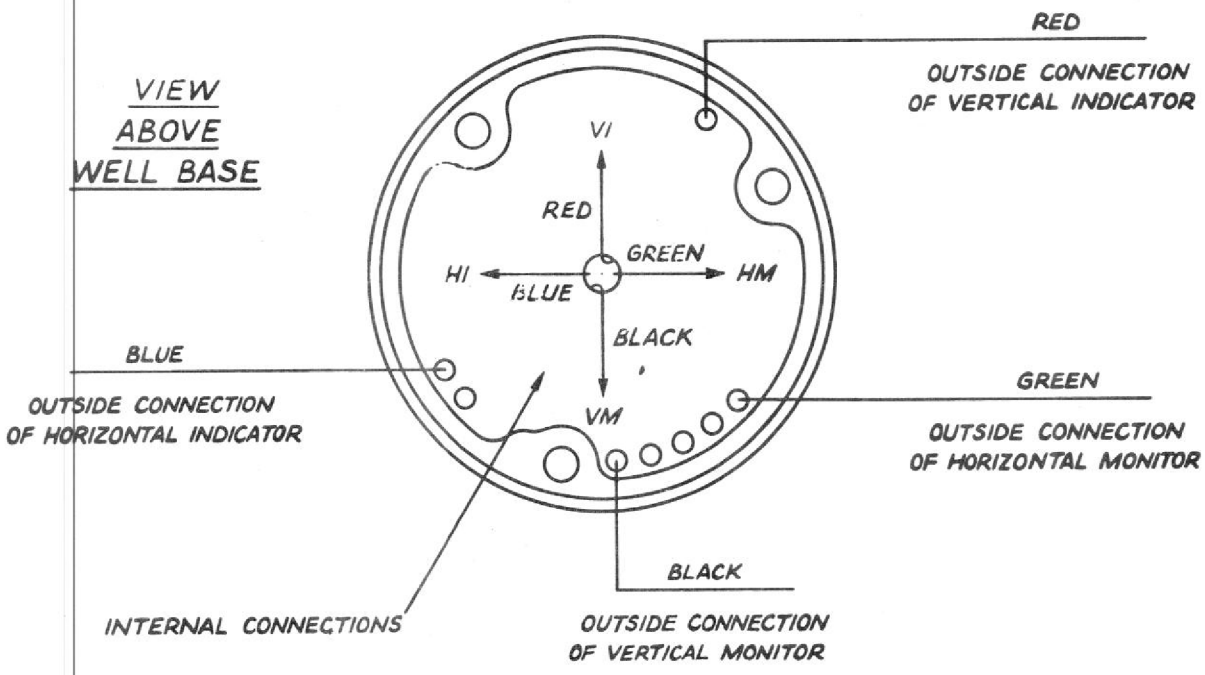
(*t*) This adjustment is carried out with the shielded cover in position. The two movements have fixed value copper shunt spools of 60 ohms. Check these spools for value and connect them in the circuit. (Earlier versions of this model include a series spool in this circuit to build out the monitor movement in series to 1,000 ohms total. This spool can be removed and the procedure detailed above followed without detriment to the instrument).

(*u*) Set each monitor pointer so that it is suppressed against the pointer stop. This position may be adjusted by moving the pointer stop as required.
NOTE: It is important that all stops are kept at right angles to the pointer at the point of contact to avoid possible sticking of the pointer on them.

(*v*) Place the monitor movements in series with a microammeter of 0-1,200 microamperes and a suitable source of current. Apply a potential so that 750 microamperes flows in the circuit. Check the balance of each monitor pointer whilst in this condition, free from suppression. Adjust the spring abutments on each monitor movement so that the monitor pointers are approximately half way between the rest position and the "disappear" position. Check that the current required to move each monitor from the stop is greater than 450 microamperes and that the current required to make each monitor pointer disappear behind the mask is 1,050 microamperes or less.

(*w*) Replace the back plate on to the well base and fix with a 6 B.A. sealing screw and two countersunk screws.

(*x*) Remove the cover and fit the zero stud pressure pads and springs, replace the cover and fix into position with sealing screw and two countersunk screws.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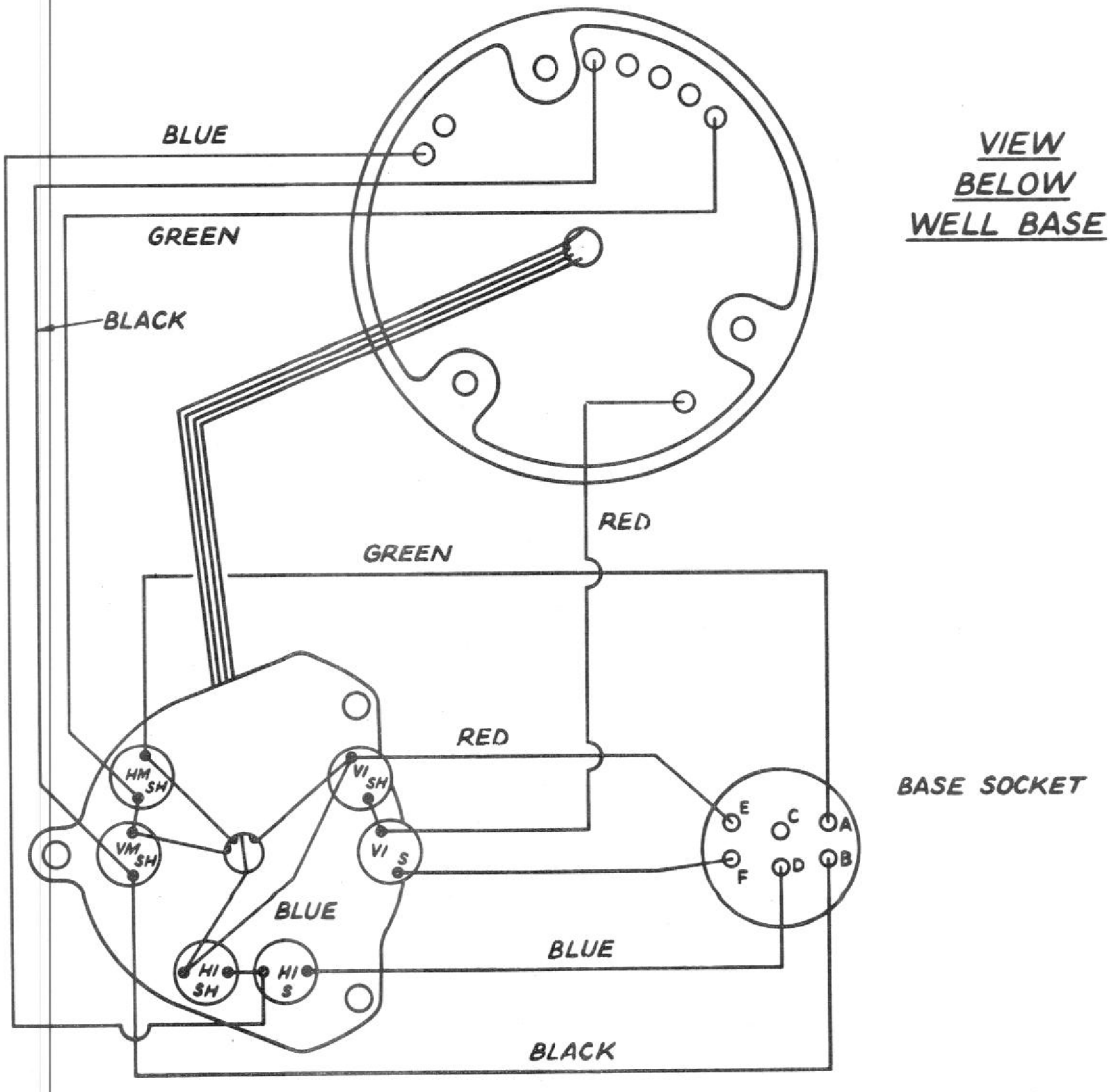
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Fig. 1

MODEL S.139 FORM 5 INSTRUMENTS

The information given in the section " Reassembly and Adjustment " applies to the Form 7 version of this instrument. The methods used in the Form 5 version are practically the same except for the changes given hereunder. The clauses are those given in the section " Reassembly and Adjustment."

(*a*) Follow the instructions to clause (*f*).

(*b*) After this proceed as follows:
Remove the spool mounting plate from the base. Move the spool plate away from the base so that the soldered connections can be reached. Disconnect the back plug connections from the spools.

Connect short lengths of wire from each pair of back plug pins. Make them long enough to reach directly to the replaced movement bridges.
Refix the spool plate on to the base and continue operations as from (*g*).

(*c*) For clause (*j*) read:
Make electrical connections to the inside and outside bridges of each movement direct from the socket to the bridge as shown in Figure 2.

(*d*) For clause (*l*) read:
Arrange for the movements to be energised via the 6 pin plug on the instrument.

(*e*) Omit clause (*p*).

(*f*) For clause (*w*) read:
Remove the movements from their mounting plate as described previously. Take off the spool mounting plate and fit the re-adjusted spools in accordance with Figure 3.
Replace the movements and connect up as Figure 2. Replace the scale and mask.

(*g*) For clause (*x*) read:
Fit the zero stud pressure pads and springs, replace the cover and fix into position with a sealing screw and two countersunk screws.

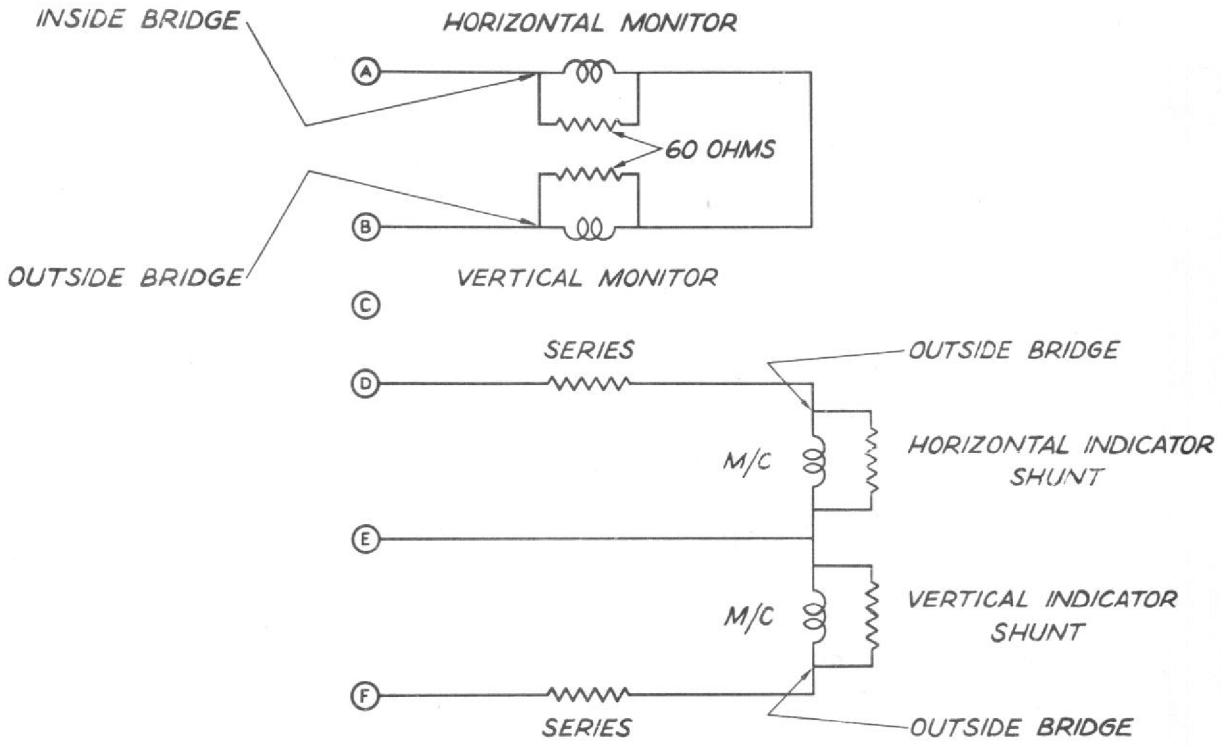
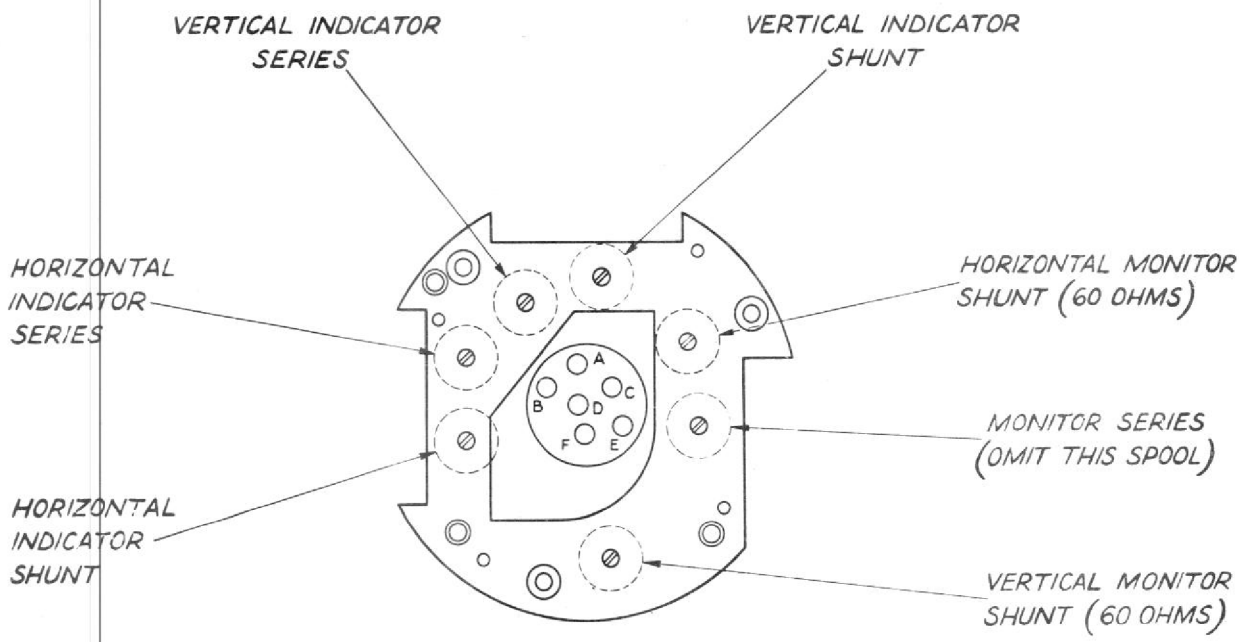


Fig. 2



VIEW ABOVE SPOOL PLATE
AS SEEN ON REMOVAL OF MOVEMENTS

Fig. 3

FINAL INSPECTION TEST

Physical Tests

(*a*) All screws, nuts, etc. must be tested for tightness.

(*b*) The balance of the indicator pointers must be as stated in (*f*) " Reassembly and Adjustment."

(*c*) The indicator pointers must be mutually perpendicular with a tolerance of $\pm \frac{1}{2}°$ with reference to the upper flange holes.

(*d*) The indicator pointers must have an overtravel of approximately two pointer widths (i.e. approximately 0·06 of an inch) before contacting the stops. These pointers must not stick when a current of 600 microamperes is applied and reduced to zero.

Electrical Tests

(*e*) The internal metal parts must be insulated so that they withstand 1,000 volts A.C. applied for one minute between the movements connected together and all external metal parts including a screw driver held in the zero adjuster screw.

(*f*) The current required to deflect each indicator pointer to the first line in the scale must be 250 $\pm$ 30 microamperes, and 500 $\pm$ 60 microamperes to the third line.

(*g*) The time taken for the indicator pointers to reach 99% of their final steady state deflection on their first movement at any part of the scale when in a 350 ohms circuit must not be less than 0·14 seconds and not greater than 0·22 seconds.

(*h*) The damping of the indicator movements must be such that they do not deflect more than 30% beyond their steady state of deflection when operating in a circuit of 350 ohms resistance.

(*j*) The terminal resistance of each individual indicator circuit must be 1,000 $\pm$ 25 ohms, and the monitors less than 2,000 ohms.

(*k*) The monitor pointers in series must leave the stop for a current of not less than 450 microamperes and shall disappear behind the mask for a current not exceeding 1,050 microamperes.

(*l*) With a current of 2·5 milliamperes suddenly applied to the monitor movements the pointers must not be damaged or stick to the stops when the current is reduced below the operation current.

INSPECTION

Subsequent to satisfactory installation, the instrument should be checked visually to ensure that the glass is unbroken and that the plug and socket is tightly connected. No other maintenance is necessary for a period of 1,200 flying hours. On the completion of the period the instrument should be checked for accuracy, preferably *in situ*, as apparatus of this nature is more liable to damage from handling than from years of service. If the instrument is within permissible limits it should be passed as serviceable for a further 1,200 hours' service.

DECLARATION

INFORMATION REQUIRED BY BRITISH STANDARD G.100

MODEL S.139 FORM 5 & 7

Weight	**FORM 5:**	1 lb. 3 ozs.
	FORM 7:	1 lb. 4 ozs.
Maximum storage period without preservation packing		6 months
Acceleration Grade		1B
Climatic Grade		1
Altitude Rating		60,000 ft.
Vibration Grade		3 when mounted on instrument flight panel.
Fire Resistance Grade		Fire Resistant
Compass Safe Distance		12 inches
C. G. Position	**FORM 5:**	$1\frac{1}{4}''$ from glass *
	FORM 7:	$1\frac{3}{8}''$ from glass *

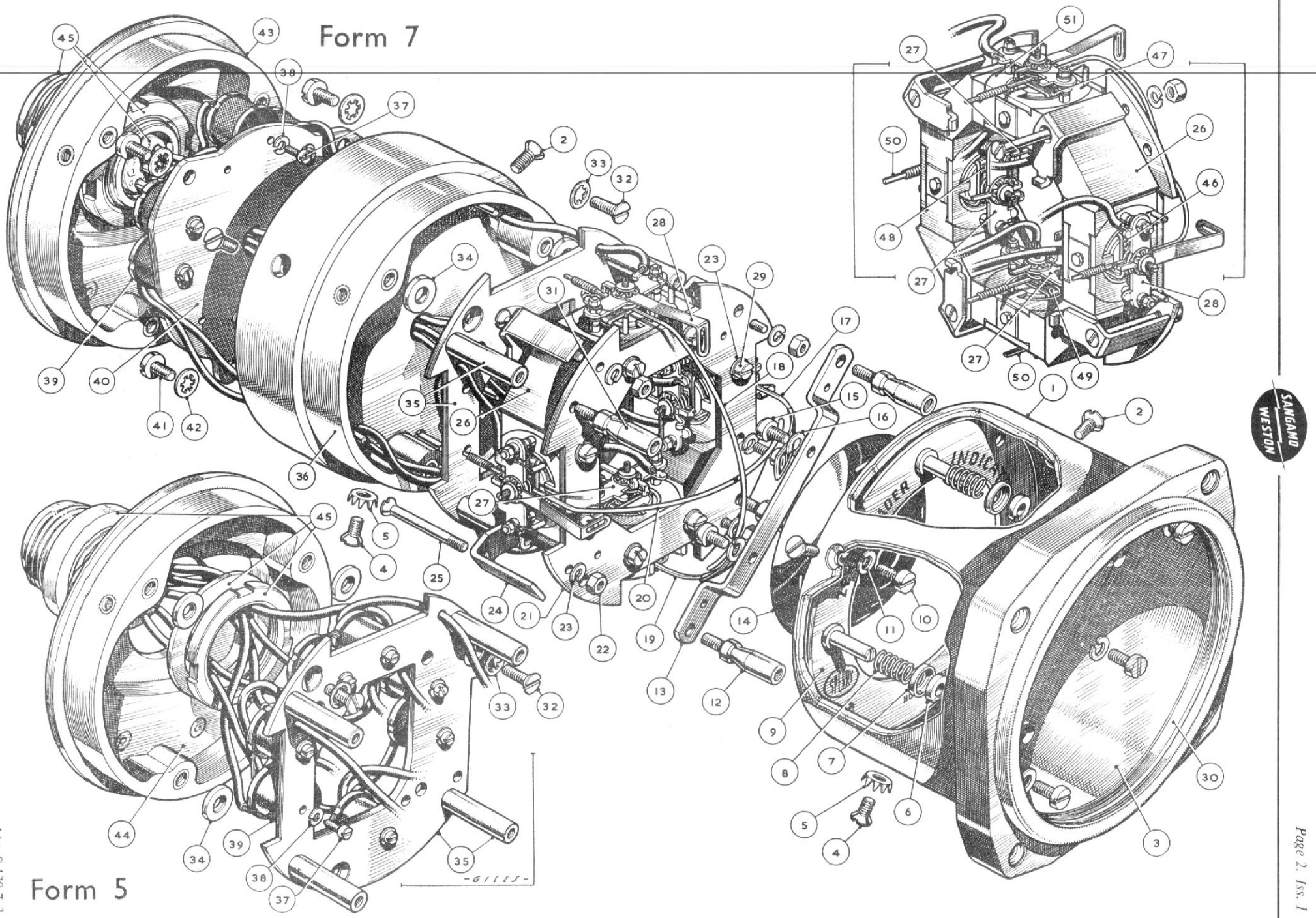
* Measured along geometric centre

MODEL S.139

PARTS LIST

Reference	Description	Part No.	No. Off per Instrument
1	Cover Assembled	167880	1
2	Cover Fixing Screw, 4 off Form 7, 2 off Form 5	150146	As stated
3	Glass Drilled	167808	1
4	Sealing Screw, 2 off Form 7, 1 off Form 5	168862	As stated
5	Sealing Cup	168013	2
6	Rubber Washer	167914	2
7	Cupped Washer	167913	2
8	Spring	167915	2
9	Mask Assembly	167909	1
10	6 B.A. Screw × $\frac{7}{32}$″	167920	4
11	6 B.A. Lock Washer	158805	4
12	Pillar (Mask and Scale)	167916	2
13	Dial Mounting Bracket	167889	1
14	Dial Finished	167887	1
15	6 B.A. Screw × $\frac{3}{16}$″	92478	2
16	6 B.A. Lock Washer	156976	2
17	R.H. Flag Finished	167902	1
18	Vertical Pointer	167899	1
19	Lower Flag Finished	167904	1
20	Horizontal Pointer	167900	1
21	Movement Mounting Plate	167890	1
22	8 B.A. Nut	160168	4
23	8 B.A. Lock Washer	103854	12
24	Magnet Clamp	167918	4
25	8 B.A. Screw × $\frac{7}{8}$″ csk.	167921	4
26	Magnet	167809	4
27	Bottom Bridge Assembly	167896	4
28	Top Bridge Assembly (Pointers, vertical and horizontal)	167894	2
29	8 B.A. Screw × $\frac{1}{4}$″	167919	8
30	Bezel Ring	166781	1
31	Pillar (Mask)	167917	2
32	6 B.A. Screw × $\frac{5}{16}$″ csk.	155128	3
33	6 B.A. Shakeproof Washer	150376	3
34	Spacer	167886	3
35	Sub Mounting Plate Assembled	167883	1
36	Base (well type) Form 7 only	168804	1
37	10 B.A. Screw × $\frac{3}{16}$″ (spool fixing)	150330	7
38	10 B.A. Lock Washer	153367	7
39	Spools	Specify Code No.	
40	Well Mounting Panel Form 7 only	168616	1
41	6 B.A. Screw × $\frac{3}{16}$″ Form 7 only	156671	3
42	6 B.A. Shakeproof Washer Form 7 only	150376	3
43	Base Printed Form 7 only	168806	1
44	Base Printed Form 5 only	167882	1
45	6 Pin Plessey Mark IV Plug	168069	1
46	Horizontal Moving Coil Assembly with pointer, springs and pivots	—	1
47	Vertical Moving Coil Assembly, with pointer, springs and pivots	—	1
48	R.H. Flag Moving Coil Assembly, with pointer, springs and pivots	—	1
49	Lower Flag Moving Coil Assembly, with pointer, springs and pivots	—	1
50	Top Bridge Assembly (Flags R.H. and Lower)	164694	2
51	Pole Piece Assembly	167891	4

NOTE: SANGAMO WESTON Code Number appears on front of Dial.


Form 7
Form 5
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