WESTON
ELECTRICAL INSTRUMENTS
FOR AIRCRAFT

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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.144 FORM 4

"SERVO-POT"

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. 5.11.56.

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 1956

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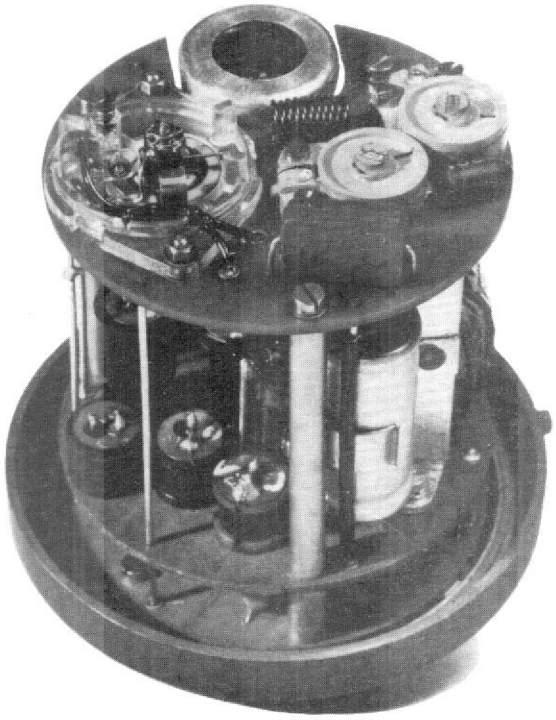
"SERVO-POT" MODEL S.144 FORM 4



INTRODUCTION

The equipment described in the following pages has been developed by this Company to meet the need for an auto-potentiometer which, with a very low power millivolt input, is capable of providing an output sufficiently large to operate several long scale accurately calibrated indicators.

Many normal instruments such as those used for temperature measurement, have been found too fragile to meet existing demands, as well as requiring temperature compensation, a factor which is not necessary with the indicator used in conjunction with this model.

The Form 4 version of the " Servo-Pot." has been designed primarily for aircraft use and will give an output which is sufficient to operate three sturdy permanent magnet milliammeters connected in series.

A typical application of this equipment is the obtaining of accurate jet pipe temperature measurements using a thermocouple to supply the input.

Heavy, large diameter compensating leads are unnecessary. The potentiometer may, if required, be mounted relatively close to the hot end of a thermocouple which can have any resistance up to 100 ohms, whilst the indicator may be positioned some distance away. The inter-connections between the " Servo-Pot." and the instrument need only be thin insulated stranded copper leads.

The standard output indicator is a circular scale milliammeter, our Model S.78 or S.149, which for use with the " Servo-Pot." has its mechanical zero at 40°C.

FUNCTIONING

Basically, the instrument comprises a balanced network of four resistance elements. One of these elements is an electronic oscillator designed to operate as a variable D.C. resistance, and consists of a Tuned Anode-Tuned Grid self biased valve oscillator working under Class C conditions.

When the oscillations in the parallel resonant circuit of the grid of the valve are damped, its bias becomes more positive. This means that the effective impedance of the valve is decreased.

An " Inductrol " is used to control the impedance of the valve. This is a conventional permanent magnet moving coil instrument in which the pointer is replaced by a vane mounted on the pointer cross arm, and a small pancake type coil takes the place of the scale. This coil is connected as an inductance in the grid parallel resonant circuit, and the approach or recession of the vane in relation to the coil controls the effective resistance of the electronic element of the bridge.

If a milliammeter is connected in series with a feedback resistor across the bridge, and the moving coil of the " Inductrol " is connected in series with a millivolt input across this resistor, then, as a few millivolts are injected, causing a current to flow through the " Inductrol " moving coil, the vane will move towards the pancake coil causing a current to flow in the feedback resistor. This current will increase until the potential difference across the resistor exactly balances the millivolt input. Under these conditions no appreciable current will flow through the " Inductrol " moving coil.

The steady state current passing through the feedback resistor and the output indicator is directly proportional to the input millivolts, and inversely proportional to the value of the feedback resistor.

DESCRIPTION

The Model S.144 Form 4 is designed primarily for use with a nominal 115 volt 400 cycle aircraft supply, and incorporates a second temperature conscious bridge.

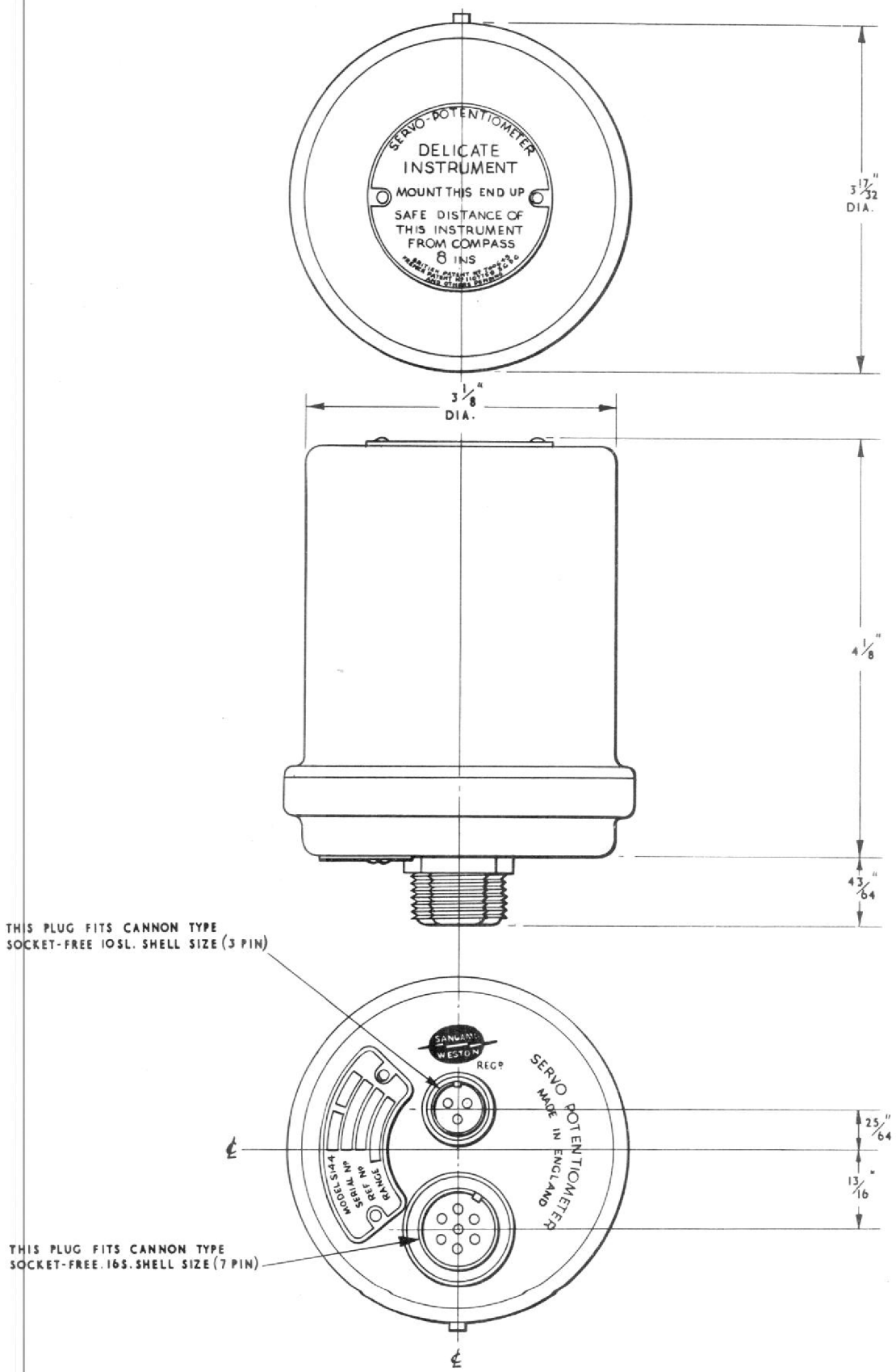
The second bridge electrically compensates for the cold-end variations of a thermocouple, and the effective thermocouple cold junction is made inside the potentiometer at the temperature sensitive element of the second bridge. By this means, any change in ambient temperature will affect both the thermocouple and the bridge equally.

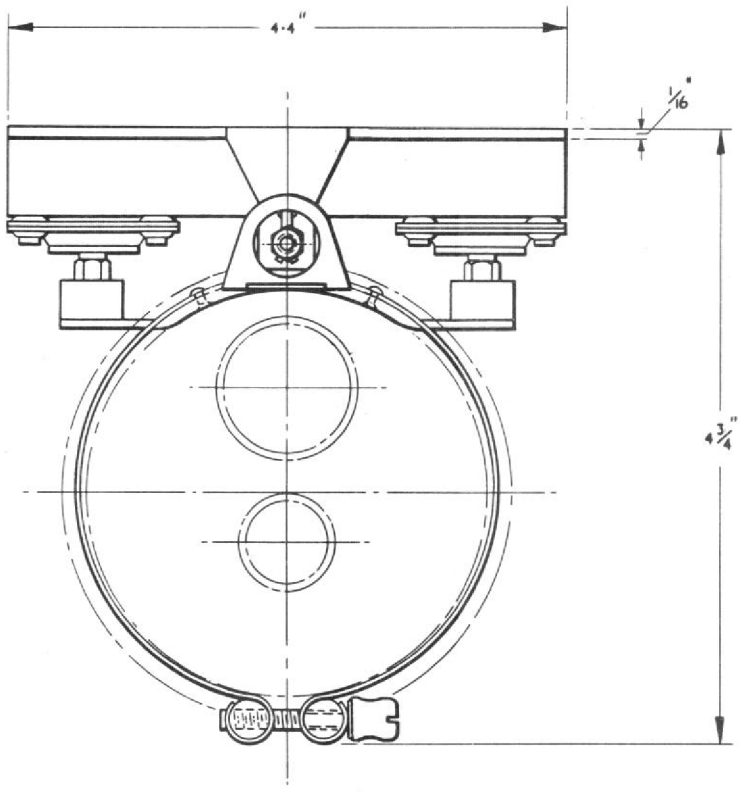
Connections are made through a fixed seven pin plug and a fixed three pin plug. These will mate with all 16S-1S and 10SL-3S Shell size " AN " type free sockets respectively.

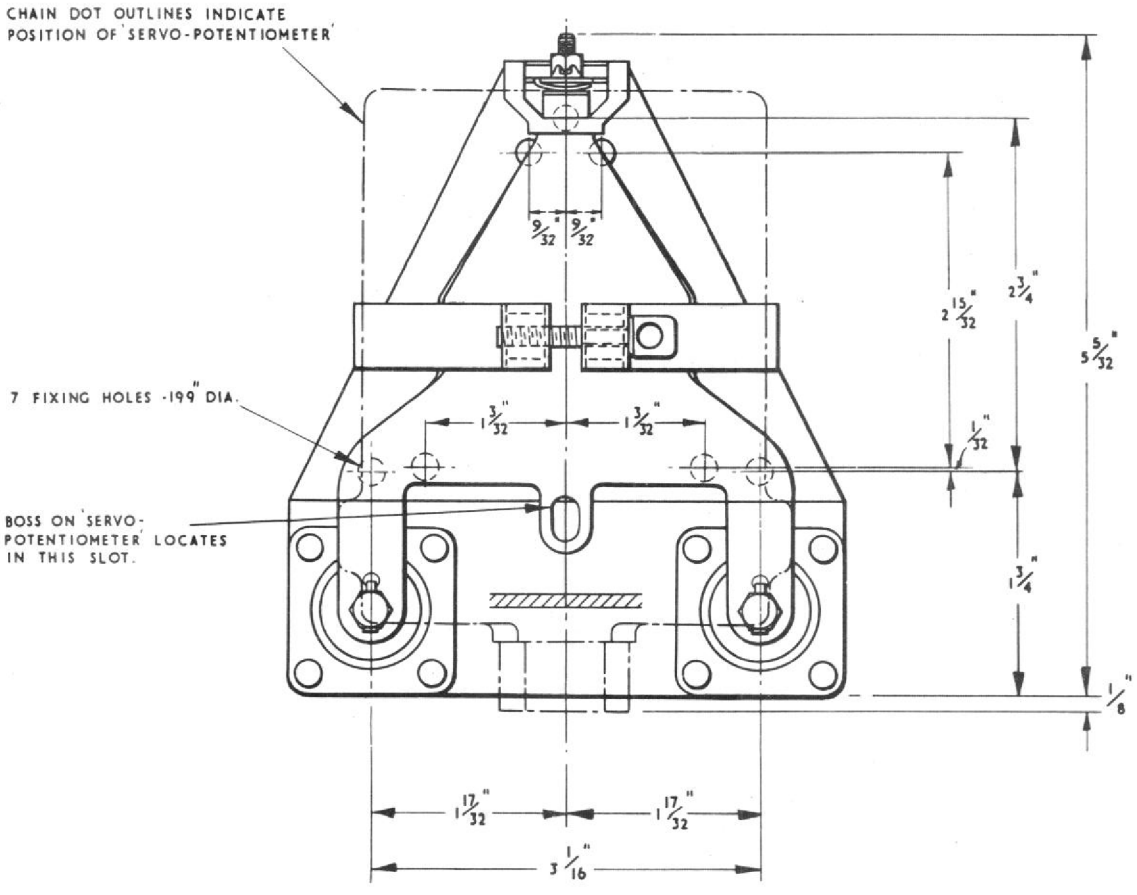
Ranges and component values are given in the tables in the rear of this publication.

INSTALLATION NOTES

The potentiometer is contained in a weatherproof cylindrical case, and should be mounted vertically. The mounting bracket, which incorporates anti-vibration suspension, is intended to be a permanent fitting in the aircraft, and the potentiometer is attached to it by a clip which permits its easy removal or replacement.




4·4"
1/16"
4 3/4"


CHAIN DOT OUTLINES INDICATE POSITION OF 'SERVO-POTENTIOMETER'
7 FIXING HOLES ·199" DIA.
BOSS ON 'SERVO-POTENTIOMETER' LOCATES IN THIS SLOT.
9/32" 9/32"
2 15/32"
2 3/4"
5 5/32"
1 3/32" 1 3/32"
1/32"
1 3/4"
1/8"
1 17/32" 1 17/32"
3 1/16"

ACCURACY

The accuracy of this Model at ambient temperatures of 15°C. to 25°C., should be within ±0·85% f.s.d. at 115 volts 400 cycles, and ±1% f.s.d. for the range 103·5 volts 380 cycles to 126·5 volts 420 cycles. The indicator should be accurate to within ±1·2% f.s.d.

LIMITING CONDITIONS AND DECLARATION REQUIRED BY BRITISH STANDARD G.100

MODEL S.144 FORM 4

Weight	2 lbs. including mounting bracket.
Maximum Storage Period without Preservation Packing	6 months.
Acceleration	Operates within limits under 1g acceleration conditions and is not damaged by 9g. A.V. mountings do not fracture under 25g crash landing conditions.
Climatic Grade	In accordance with D.T.D. 1085B.
Altitude Rating	60,000 ft.
Vibration	On its own A.V. mount, the instrument conforms to Tech. Memo. DES.1, clause 1.4 for equipment mounted in the central region.
Fire Resistance Grade	Fire Resistant.
Compass Safe Distance	8″ for 1° deflection.
C.G. Position	Approx. at intersection of vertical and horizontal centre lines.
Proofing	The instrument is flame proofed and water proofed.
Ambient Temperature Range	" Servo-Pot." —70°C. to +70°C. A.V. mounting —40°C. to +70°C.
Special Limitations	The " Servo-Pot " complies with the M.o.S. " Radio Interference " Spec. E.L.1716 Issue 1, except at a single frequency in the 60—70 Mc/s band, where the interference voltage between any line and earth may be as high as 2 mV. An aircraft radio interference check should be carried out to ensure that this is not excessive for equipment operating in this band.
Min. Withdrawal Dimensions	A space of five inches must be allowed for withdrawal purposes from the lower edge of the mounting bracket. Adequate access to the clamp fixing screw must be allowed.

MAINTENANCE AND REPAIR

CHECKING AND FAULT FINDING

The following chart gives details in tabular form of faults that may occur in the equipment. It should be read in conjunction with the circuit diagram.

Before proceeding, it is advisable to examine the equipment for any minor faults that may arise due to service conditions, such as pulled connections, frayed or otherwise damaged insulation, an improperly seating plug and so on.

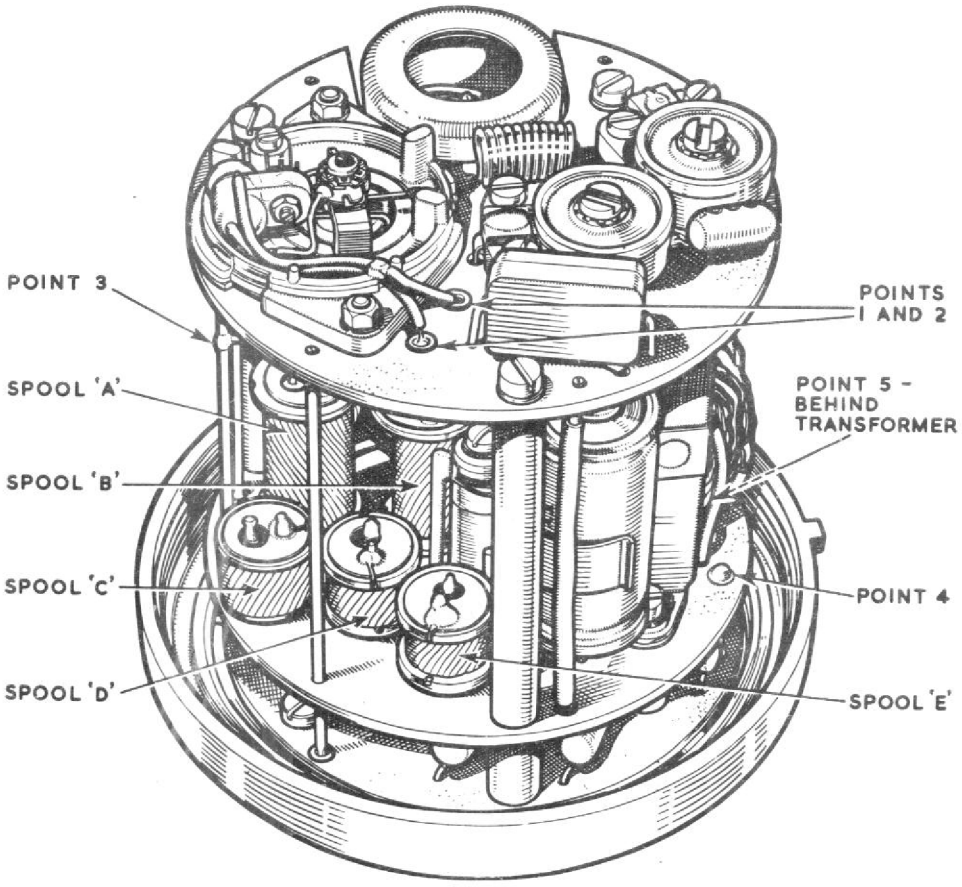


Fig. 1

Symptom	What to Check	Remedy or Further Check	Remarks
(a) Indicator pointer remains below bottom of scale after warming-up period.	1. Mechanical friction (Check that "Inductrol" is free).	Make initial check with no supplies. Inject a few millivolts into the "Inductrol" and note if the vane moves.	If there is no movement of vane, short "Inductrol" movement and check continuity between pin "C" and "A" of the three pin plug. If the resistance value is less than 200 ohms, remove the "Inductrol" for examination and repair. If open circuit, check spool "C" as in (3). If "C" is correct check continuity between spool "C" and pin "C" and pin "A" of 3 pin plug. If in either case open circuit is present, replace affected choke. (See circuit diagram).

Symptom	What to Check	Remedy or Further Check	Remarks
	*2. Check continuity of H.T. from top of 1 mf. Condenser next to transformer to valve pin "1".	If open circuit, check soldered joints of anode coil	—
	*3. Check continuity of spool "C" between the pins on top of spool.	If replacement is necessary refer to section "Maintenance and Repair".	—
	*4. Check continuity of spool "D" between the pins on top of spool.	If replacement is necessary refer to section "Maintenance and Repair".	—
	*5. Check continuity of spool "E" between the pins on top of spool.	If replacement is necessary refer to section "Maintenance and Repair".	—
(b) Indicator pointer "Slams" beyond full scale deflection after warming-up period.	1. Check continuity of grid pancake coil between points "1" and "2" (Figure 1).	—	—
	2. Check continuity of spool "E".	—	—
	3. Check continuity of spool "A".	—	As a direct continuity test of spool "A" is impossible at this stage, connect "Servo-Pot." to test circuit as shown in Figure 2. Note that under these conditions with the output disconnected, the vane should not "slam".
(c) Spurious indication.	1. Check output Indicator.	Refer to section dealing with indicator.	Open circuit on indicator moving coil causes instrument to read 40°C. permanently.
	*2. Inspect "Inductrol". vane for correct alignment.	Correct and rebalance. If necessary, refer to section "Adjustment of the 'Servo-Pot.'"	—
	*3. Check continuity of "Inductrol" moving coil. Inject a *maximum* of ½ range millivolts across pins "D" and "G", and note whether vane moves.	If necessary to replace moving coil, refer to section "Maintenance and Repair".	—
	4. Suspect short circuit in "Inductrol" moving coil. Check for electrical balance, and, if necessary, rebalance as detailed in "Balancing the Movement".	If the "Inductrol" refuses to balance, the moving coil must be replaced. Refer to section "Maintenance and Repair".	As test circuit.
(d) Indicator reads 40°C. permanently.	1. Check that valve heater is glowing.	With the supply switched off, check continuity between valve pins "4" and "5" and also continuity between valve base pins "4" and "5".	If either the valve or transformer is faulty, replace.
	2. Check D.C. volts across the 1 mf. condenser. The value obtained should be approximately 80 volts.	If there are no volts present, remove the valve and check the A.C. volts between valve pin "6" and bottom of condenser. The value obtained should be 75 volts approx.	If these values are not reached replace the transformer.
	*3. With the valve removed, check continuity between valve pin "3" and pin "D" of seven pin plug.	If open circuit, replace choke.	—
	*4. Check continuity between pin "E" of seven pin plug and bottom bridge connection of "Inductrol". (Point "3", Figure 1).	—	—
	5. Check continuity between pins "A" and "B" of 7 pin plug.	If open circuit is present, check continuity of transformer primary between points "4" and "5".	If open circuit is revealed, replace transformer. If there is no open circuit, check chokes.

* Disconnect "Servo-Pot." from supply.

CHECKING " INDUCTROL "

Should a fault occur in the " Inductrol " remove it from the " Servo-Pot." by unsoldering at points 1, 2 and 3 and at the lead on the top bridge where it is joined to the printed circuit. Ascertain first whether the failure is caused by a damaged spring or ligament. If these appear satisfactory, inject a *maximum* of 20 millivolts into the " Inductrol " and note whether or not the vane moves. No response from this part indicates that the fault lies in the moving coil.

The following procedure should be adopted where it is necessary to replace a moving coil. Read carefully through the following instructions before starting operations.

Remove the screw which holds the pancake coil former housing. Also remove the screws which hold the return ring to the housing, whereupon the movement and the return ring may be extracted from the housing.

Take out the retaining screw which holds the movement to the return ring, thereby enabling the movement to be extracted from the return ring. Unsolder the spring and the ligament, slacken off the jewel screw and remove the coil assembly from the movement assembly. Undo the top pivot nut, remove the spring and vane, undo the bottom pivot nut and remove the ligament.

Replace the new coil in a sequence of operations in a reverse order to those already quoted but solder the coil end of the ligament into position before the movement is reassembled.

The coil must be centred longitudinally so that the gaps between it and the top and bottom plates are equal.

JEWEL ADJUSTMENT

Carry out jewel adjustment by turning the jewel screw clockwise in small increments until cross arm " flop " just disappears, (" flop " is the movement of the cross-arm due to the pivots being able to move laterally in the jewels). Back off the jewel screw by an amount 1/10th to 1/8th turn until a definite cross-arm " flop " is apparent.

RAISING THE MAGNET

A single turn raising bar must be positioned through the diametric centre of the raising yoke, and a current of approximately 10,000 amperes passed through it to saturate the magnet.

The magnet should be raised so that when a positive potential is applied to the bridge carrying the spring, the vane moves towards the pancake coil.

BALANCING THE MOVEMENT

With the instrument in a horizontal position, allow the vane to come to rest. Now turn it to a vertical position with the vane arm horizontal and adjust the large weight opposite the vane.

When the movement is balanced in this position, turn the instrument through 90° and, if necessary, adjust the two smaller weights.

CHECKING EFFICIENCY OF MAGNET RAISING

With the instrument completely assembled, the current sensitivity should be not more than 10 mic.A. for 30° vane deflection.

STABILISING PROCEDURE

The complete " Inductrol " replaced in the " Servo-Pot." must be baked at a temperature of 70°C. (158°F.) for a period of not less than 24 hours.

REPLACEMENT OF DEFECTIVE COMPONENTS

Before any repair is attempted to the " Servo-Pot." it is necessary to remove the valve.

If a faulty component is located entirely on the top deck it should be removed and replaced.

Replacement of any component located on either of the other two decks will necessitate the complete stripping of the " Servo-Pot.". In order to do this, first cut all interconnections between top and middle decks. Remove the screws holding the top deck to the pillars, and when removing top deck unsolder the connection between the 1 mf. condenser and the top deck.

Remove the three pillars and the screw holding the centre deck to the base and the bottom deck. Cut all interconnections between the bottom and centre decks and unsolder the joint between the copper spool and the constantan interconnector. Now remove the centre deck. Unsolder the connections to the plugs, undo the retaining studs and screws on the base. Remove the bottom deck.

It is now possible to replace the faulty component, but before doing so, remove the remains of the interconnection leads from all decks and clear all holes of solder. Replace the new interconnecting leads, being extremely careful not to overheat the copper on the printed circuit. Re-assemble in a sequence of operations in a reverse order to those already quoted.

ADJUSTMENT OF " SERVO-POT."

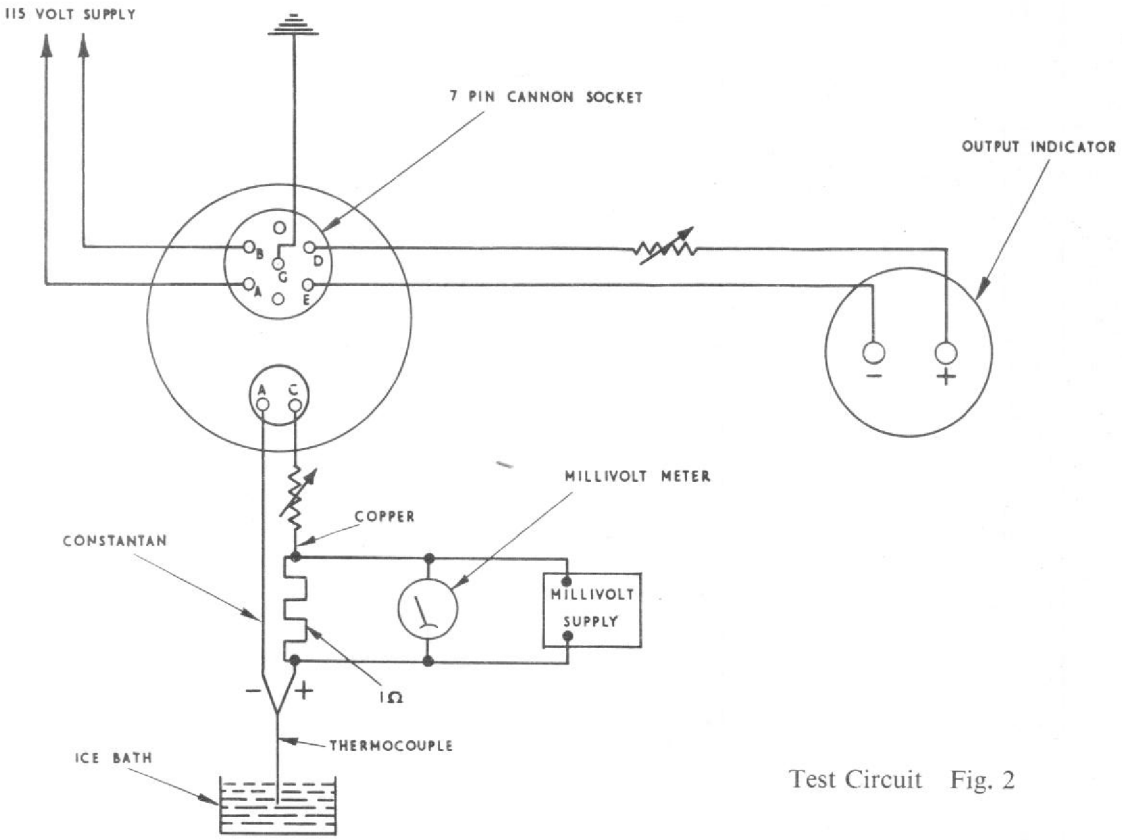
Connect the " Servo-Pot." as shown in the test circuit. The Resistance Boxes in the circuit should be set to zero.

Check that when a maximum of 20 millivolts is injected into the thermocouple circuit the " Inductrol " vane moves up to its pancake coil. Now switch on the 115 volt 400 cycle supply and allow the valve to warm up. Carry out the following adjustment with both trimmer condensers set to their maximum value, that is, when the black marks are coincident. All the following adjustments should be carried out with a test cover on the " Servo-Pot.". This test cover is made from a normal cover with the top removed. Detune the grid trimmer connected to the " Inductrol " pancake coil (i.e. the one farthest from the edge). This should cause the vane to start its controlling action and the output indicator should read approximately 0°C. By a slight adjustment to both trimmers adjust the vane so that it is 0·020″ from the face of its pancake coil.

Insert 1,000 ohms in series with the output indicator, and 100 ohms in series with the thermocouple lead. Inject full-scale millivolts across a 1 ohm shunt which is also in series with the thermocouple. The output indicator should now read full-scale deflection. Insert a further 2,000 ohms into the output circuit, making a total of 3,500 ohms, and the indicator should still read full-scale deflection. On the insertion of a further 1,000 ohms, the output indicator should read downscale. Adjust both trimmers until this state is reached.

Reset the resistance in the output side to 1,000 ohms, and with no millivolts injected, the " Inductrol " vane should still be approximately 0·020″ from the face of its pancake coil.

Insert 5,000 ohms in the thermocouple circuit, and adjust the spring abutment on the " Inductrol " to bring the output indicator back to zero deflection.



Test Circuit Fig. 2

ELECTRICAL BALANCE OF " INDUCTROL "

Use the test circuit as shown and with 100 ohms in the input, and a total of 1,500 ohms in the output, place the " Servo-Pot." with its major axis vertical.

Inject sufficient millivolts for indicator to read half-scale deflection, and turn the " Servo-Pot." so that its major axis is horizontal. Now slowly rotate the potentiometer, and note that the error shown on the output indicator does not exceed $\pm\frac{1}{2}\%$ of full-scale deflection for 0-800°C. and 0-1,000°C. instruments employing a chromel/alumel thermocouple, and $\pm 1\%$ of full-scale deflection for 0-350°C. instruments using a copper/constantan thermocouple.

Should the " Inductrol " be outside these limits, it may be corrected by adjusting the balance weights.

INSPECTION

Every 1,200 flying hours the " Servo-Pot." must be checked in accordance with the instructions given in this manual.

The valve must be checked and replaced as required by the established procedure of the operator.

ALTERNATIVE METHOD OF TEST

It should be stressed at the outset that the preferred method of testing involves the use of an Ice Bath as detailed in the section " Adjustment of Servo-Pot.". Failing this, test equipment should be used, employing the same circuit diagram as shown in the above mentioned section. All ranges given in this publication show calibration figures with the thermocouple junction at 0°C., that is, in the Ice Bath.

Where no Ice Bath is available, a suitable correction may be made if the thermocouple junction temperature is known. The thermocouple may be placed in a suitable liquid, for example, water or oil, or alternatively a metal block may be used and the temperature measured by a mercury-in-glass thermometer of known accuracy, or by a similar method.

Failing all these methods the engine thermocouples may be used provided that their temperature is known accurately. Owing to the usual difficulty of access to these thermocouples, this method should only be used in extreme cases.

For any methods not using an Ice Bath, a correction must be applied to the calibration tables given in this publication to take into account any difference between the thermocouple temperatures and 0°C. Examples showing how this may be done are given below.

It should be noted that the correction figures given in the accompanying tables should have their sign changed before they are applied. An example may help to make this point clear.

Assume that the instrument is being checked in an ambient temperature of +15°C. Reference to the correction tables for chromel/alumel thermocouples will show that 0.6mV is already being injected into the circuit due to ambient conditions. This amount must, therefore, be *subtracted* from the calibration figures to give the correct 0°C. thermocouple junction reference figure.

The converse also applies. At an ambient temperature of —25°C., a correction of 0.95mV must be *added* to bring the calibration figures to their correct value.

Make absolutely certain that the indicator has been correctly set to zero by disconnecting it and setting it to 40°C. This need not be done when the system errors are adjusted at the critical operating temperatures.

Example 1. 0-800°C. Indicator Thermocouple temperature —10°C.

Req'd. Temp. Reading	mV from Table (T/C at 0°C.)	Correction	Injected mV across ballast
0°C.	0	+0·39	+0·39
100°C.	4·10	+0·39	+4·49
600°C.	24·91	+0·39	+25·30

Example 2. 0-800°C. Indicator Thermocouple temperature +20°C.

Req'd. Temp. Reading	mV from Table (T/C at 0°C.)	Correction	Injected mV across ballast
0°C.	0	—0·80	—0·80
100°C.	4·10	—0·80	+3·30
600°C.	24·91	—0·80	+24·11

Example 3. 0-800°C. Indicator Thermocouple temperature +50°C.

Req'd. Temp. Reading	mV from Table (T/C at 0°C.)	Correction	Injected mV across ballast
0°C.	0	—2·02	—2·02
100°C.	4·10	—2·02	+2·08
600°C.	24·91	—2·02	+22·89

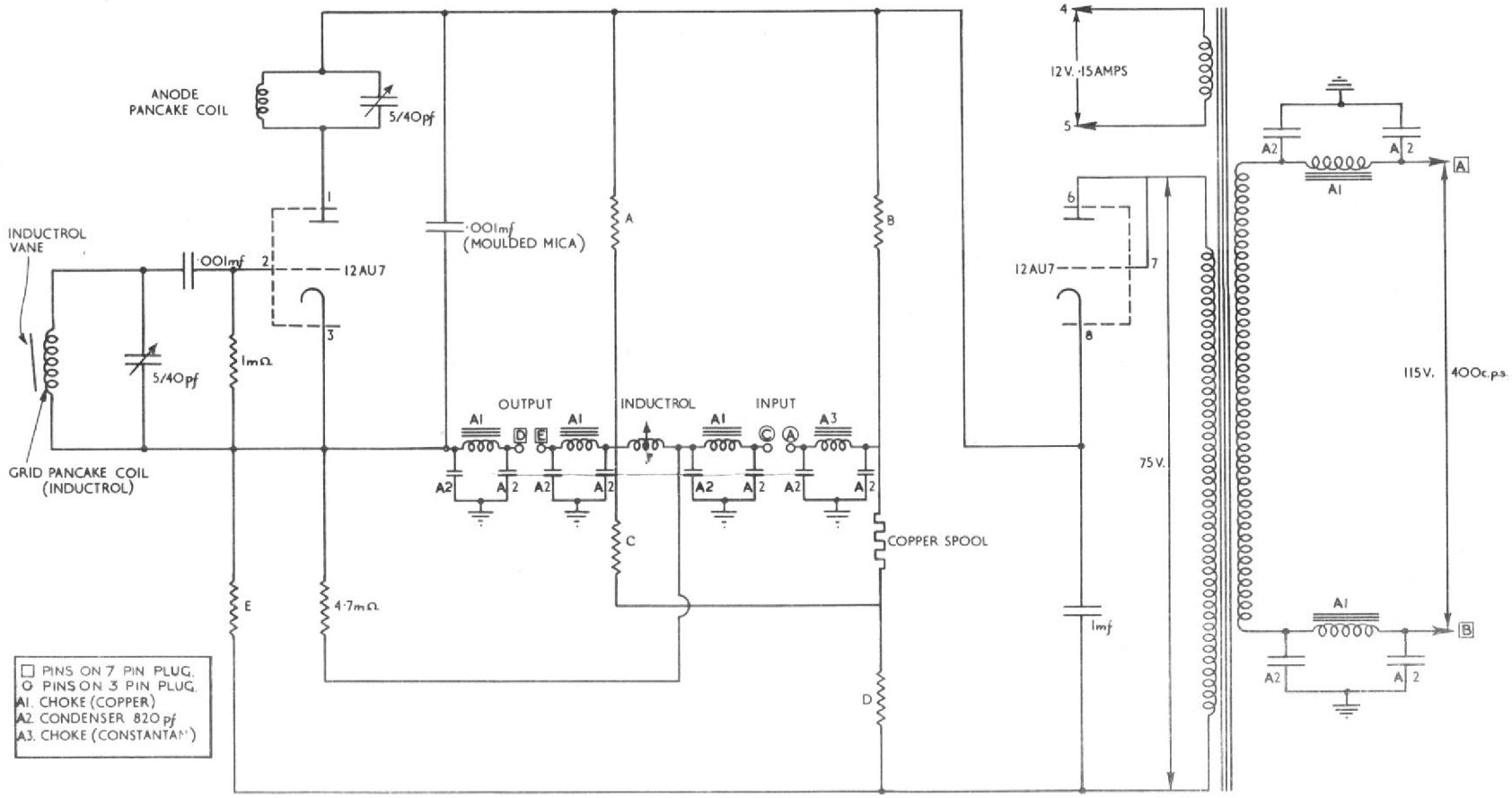
CORRECTION TABLES

EXTRACT FROM B.S.1827—1952
CHROMEL/ALUMEL THERMOCOUPLES (T1/T2)
EMF(mV)/Temp. °C.

°C.	0	1	2	3	4	5	6	7	8	9	10
					mV						
—40	—1·50	—1·54	—1·57	—1·61	—1·64	—1·68	—1·72	—1·75	—1·79	—1·82	—1·86
—30	—1·14	—1·17	—1·21	—1·25	—1·28	—1·32	—1·36	—1·39	—1·43	—1·47	—1·50
—20	—0·77	—0·80	—0·84	—0·88	—0·92	—0·95	—0·99	—1·03	—1·06	—1·10	—1·14
—10	—0·39	—0·42	—0·46	—0·50	—0·54	—0·58	—0·62	—0·66	—0·69	—0·73	—0·77
— 0	—0·00	—0·04	—0·08	—0·12	—0·16	—0·19	—0·23	—0·27	—0·31	—0·35	—0·39
+ 0	0·00	0·04	0·08	0·12	0·16	0·20	0·24	0·28	0·32	0·36	0·40
10	0·40	0·44	0·48	0·52	0·56	0·60	0·64	0·68	0·72	0·76	0·80
20	0·80	0·84	0·88	0·92	0·96	1·00	1·04	1·08	1·12	1·16	1·20
30	1·20	1·24	1·28	1·32	1·36	1·40	1·44	1·49	1·53	1·57	1·61
40	1·61	. .1·65	1·69	1·73	1·77	1·81	1·85	1·90	1·94	1·98	2·02
50	2·02	2·06	2·10	2·14	2·18	2·23	2·27	2·31	2·35	2·39	2·43
60	2·43	2·47	2·51	2·56	2·60	2·64	2·68	2·72	2·76	2·80	2·85

EMF(mV)/Temp. °C.
COPPER/CONSTANTAN THERMOCOUPLES
(REF. B.S. G.116)

°C.	0	1	2	3	4	5	6	7	8	9	10
					mV						
—40	—1·49	—1·52	—1·56	—1·59	—1·63	—1·66	—1·70	—1·73	—1·77	—1·81	—1·84
—30	—1·13	—1·16	—1·20	—1·24	—1·27	—1·31	—1·34	—1·38	—1·42	—1·45	—1·49
—20	—0·76	—0·80	—0·83	—0·87	—0·91	—0·94	—0·98	—1·02	—1·05	—1·09	—1·13
—10	—0·38	—0·42	—0·46	—0·50	—0·53	—0·57	—0·61	—0·65	—0·68	—0·72	—0·76
— 0	—0·00	—0·04	—0·08	—0·12	—0·15	—0·19	—0·23	—0·27	—0·31	—0·35	—0·38
+ 0	0·00	0·04	0·08	0·12	0·16	0·20	0·23	0·27	0·31	0·35	0·39
10	0·39	0·43	0·47	0·51	0·55	0·59	0·63	0·67	0·71	0·75	0·79
20	0·79	0·83	0·87	0·91	0·95	0·99	1·03	1·07	1·11	1·16	1·20
30	1·20	1·24	1·28	1·32	1·36	1·40	1·44	1·49	1·53	1·57	1·61
40	1·61	1·65	1·69	1·74	1·78	1·82	1·86	1·90	1·95	1·99	2·03
50	2·03	2·07	2·12	2·16	2·20	2·24	2·29	2·33	2·37	2·42	2·46
60	2·46	2·50	2·54	2·59	2·63	2·68	2·72	2·76	2·81	2·85	2·89



SANGAMO WESTON

RANGE SHEET "A"

0°C.-350°C.

(COPPER-CONSTANTAN THERMOCOUPLE)

CALIBRATION

The " Servo-Pot." should give the following milliampere outputs for the specified temperature and E.M.F. input values.

Temp. °C.	Input (mV.)	Output (mA.)	Temp. °C.	Input (mV.)	Output (mA.)
350	17·65	0·910	100	4·24	0·149
300	14·70	0·742	50	2·03	0·024
250	11·90	0·583	40	1·61	0
200	9·20	0·430	0	0	–0·091
150	6·65	0·286			

All tests should be carried out with a 100 ohms resistance in the input side, and 1,000 ohms in series with the output indicator.

SPOOL DATA

(Refer to Circuit Diagram)

Spool	Value (ohms)	Spool	Value (ohms)
A	124,100±550	D	300±3
B	11,172—11,628	E	2,000±20
C	17·59±0·04		

RANGE SHEET "B"

0°C.-800°C.

(CHROMEL-ALUMEL THERMOCOUPLE)

CALIBRATION

The "Servo-Pot." should give the following milliampere outputs for the specified temperature and E.M.F. input values.

Temp. °C.	Input (mV.)	Output (mA.)	Temp. °C.	Input (mV.)	Output (mA.)
800	33·30	0·952	300	12·21	0·319
700	29·14	0·827	200	8·13	0·196
600	24·91	0·700	100	4·10	0·075
500	20·64	0·572	40	1·61	0
400	16·40	0·444	0	0	–0·048

All tests should be carried out with a 100 ohm resistance in the input side, and 1,000 ohms in series with the output indicator.

SPOOL DATA

(Refer to Circuit Diagram)

Spool	Value (ohms)	Spool	Value (ohms)
A	234,500±1,100	D	300± 3
B	11,172—11,628	E	2,000±20
C	33·24±0·05	E*	4,000±40

*S144.4.50 and S144.4.51 ONLY.

RANGE SHEET "C"

0°C.-1,000°C.

(CHROMEL-ALUMEL THERMOCOUPLE)

CALIBRATION

The "Servo-Pot." should give the following milliampere outputs for the specified temperature and E.M.F. input values.

Temp. °C.	Input (mV.)	Output (mA.)	Temp. °C.	Input (mV.)	Output (mA.)
1,000	41·31	0·961	400	16·4	0·358
900	37·36	0·865	300	12·21	0·257
800	33·30	0·768	200	8·13	0·158
700	29·14	0·666	100	4·10	0·060
600	24·91	0·564	40	1·61	0
500	20·64	0·461	0	0	–0·039

All tests should be carried out with a 100 ohm resistance in the input side, and 1,000 ohms in series with the output indicator.

SPOOL DATA

(Refer to Circuit Diagram)

Spool	Value (ohms)	Spool	Value (ohms)
A	291,000± 1,400	D	300± 3
B	11,172—11,628	E	2,000±20
C	41·25±0·05	E*	4,000±40

*S144.4.50 and S144.4.51 ONLY.

PARTS LIST

MODEL S.144 FORM 4

It should be noted that repairs made to this instrument will be much easier if the repairer uses complete plate assemblies rather than replacing individual components.

Ref. No.	Description	Part No.	No. Off	Estimated requirements for 100 instruments
1	Cover	169848	1	1
2	Rubber Gasket	169847	1	5
3	Base	171081	1	1
4	Upper Mounting Plate Assembly (13D3 Valve)	172349	1	5
—	Upper Mounting Plate Assembly (12AU7 Valve)	171085	1	5
5	Anode Coil	171153	1	5
6	Screw 8 B.A. × $\frac{5}{16}$″ Ch. Hd.	96646	4	10
7	Trimmer Condenser 5·0-40 μμF	171442	2	2
8	Condenser 1,000 pfd	171157	1	5
9	Connection Strip	171443	1	2
10	Condenser 0·001 mfd.	163987/0·001 mfd.	1	5
11	Inductrol	172472	1	5
12	Screw 8 B.A. × $\frac{3}{16}$″	159195	2	5
14	Movement Mounting Stud	171121	2	—
15	Lock Nut 8 B.A.	150178	4	10
16	Shakeproof Washer 8 B.A.	94469	8	20
17	Centre Mounting Plate Assembly	171089	1	5
18	Screening Can	171152	1	2
19	Type B9A Valve Holder for Printed Circuits	171151	1	2
20	Erie Carbon Resistor 1 Megohm	169306/1MΩ	1	2
22	Voltage Transformer	171096	1	2
23	Dubilier Type Condenser 1 μF/150V	164967	1	2
24	Inter-Connection Wire—Copper	171126	3	30
25	Inter-Connection Wire—Copper	171127	1	10
26	Compensating Coil Complete	171101	1	5
27	Shakeproof Washer 8 B.A.	94469	1	2
28	Screw 8 B.A. × $\frac{13}{16}$″ Ch. Hd.	155373	1	2
29	Lower Mounting Plate Assembly	171093	1	5
30	Inter-Connection Wire—Copper	171128	2	20
31	Choke—Copper	170977	5	10
32	Condenser 820 pfd	170979	12	24
33	Inter-Connection Wire—Constantan	171155	1	10
34	Choke—Constantan	170978	1	2
36	Inter-Connection Wire—Copper	171125	3	30
37	Erie Carbon Resistor 4·7 Megohms	169306/4·7MΩ	1	2
38	Lower Mounting Pillar	171122	4	—
39	Upper Mounting Pillar 2·07″ Long	171123	2	—
40	Upper Mounting Pillar 1·97″ Long	171124	1	—
41	Shakeproof Washer 6 B.A.	150376	5	—
42	Screw 6 B.A. × $\frac{1}{4}$″ Ch. Hd.	150136	4	—
43	Cover (Inductrol) NOT SHOWN	171114	1	5
44	Housing (Inductrol)	171112	1	—
45	Oscillator Coil Assembly	171107	1	2
46	Movement Bracket Assembly	172190	1	—
47	Clamp Screw NOT SHOWN	170076	1	—
48	Return Ring	171115	1	—
49	Spools. Quote Letter and Code Number	Specify Code No.	5	25 sets
50	Ligament Top and Bottom: Phos. Bronze 0·0001″ × 0·002″ × $\frac{3}{4}$″ NOT SHOWN	—	2	2 ft.
51	Vane Assembly	171158	1	5
52	Stop for Vane	171156	1	10
53	Balance Weights	Specify Code No. 158012	As required	As required
54	Screw 10 B.A. × $\frac{1}{8}$″ C'sk NOT SHOWN	158320	3	5
55	Screw 10 B.A. × $\frac{3}{16}$″ Ch. Hd. NOT SHOWN	150330	1	5
56	Screw 10 B.A. × $\frac{1}{8}$″ Ch. Hd.	150321	1	5
57	Spring Terminal (Ligament) NOT SHOWN	154735	2	10

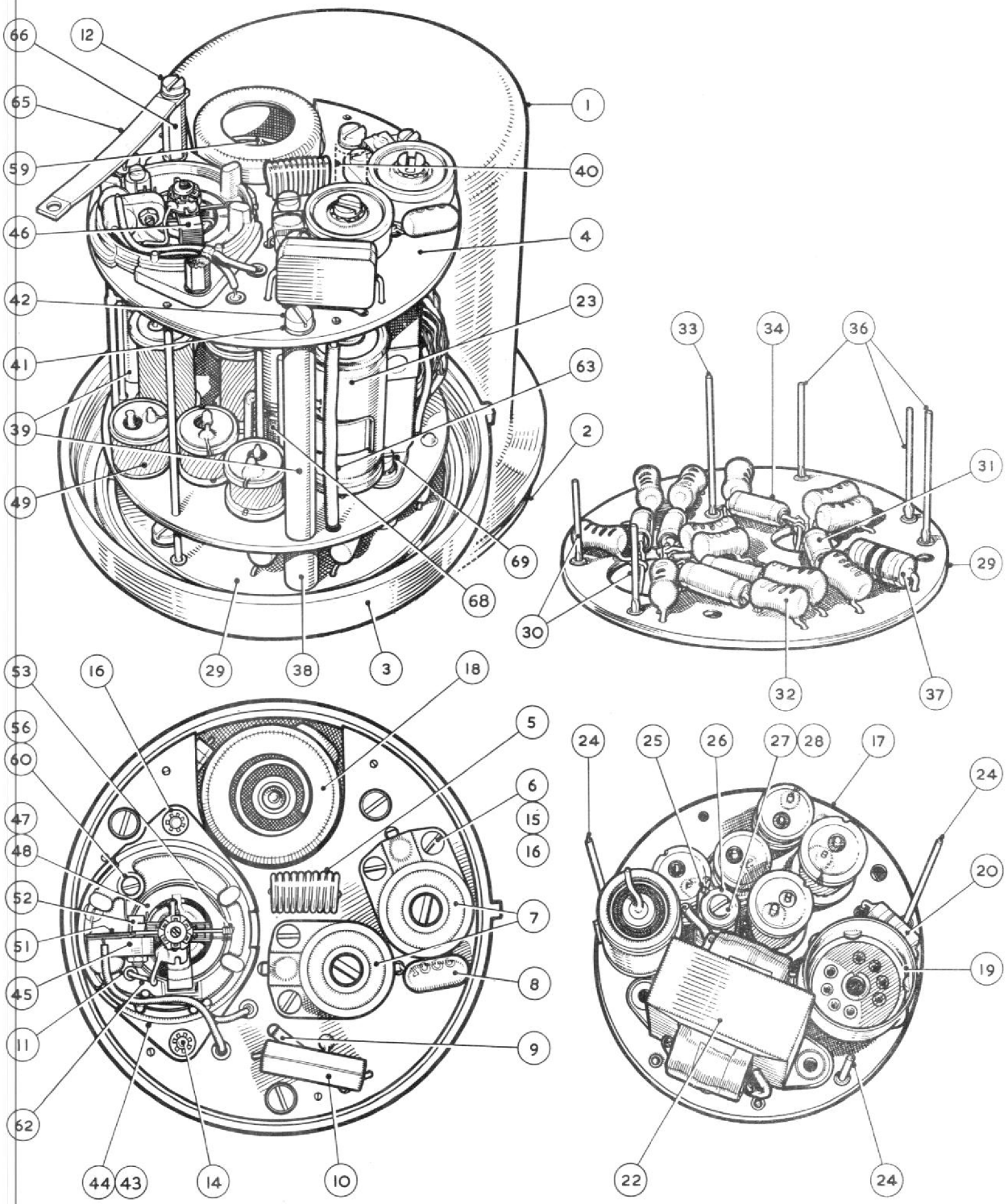
Continued

PARTS LIST (*Continued*)

Ref. No.	Description	Part No.	No. Off	Estimated requirements for 100 instruments
58	Nameplate .. .. NOT SHOWN	171359	1	—
59	Valve 13D3 ANR	172185	1	10
—	Valve (Brimar) Type 12AU7 (CV4003)	171150	1	10
60	Lockwasher 10 B.A.	153367	2	10
61	Nameplate .. .. NOT SHOWN	Specify Code No. 171160	1	—
62	Connecting Wire for Top Bridge	171162	1	—
63	Symite Sleeve 1½ m/m × 1$\frac{15}{16}$″ Long	171429	1	—
64	Anti-Vibration Bracket .. .. NOT SHOWN	171887	1	5
65	Retaining Spring for Inductrol Cover	171920	1	5
66	Pillar for Inductrol Cover	171921	2	10
67	Erie Resistor 0·2 Megohms ± 20% ¼ Watt .. .. used with 13D3 ANR Valve NOT SHOWN	169306/0·2MΩ	1	2
68	Compensating Coil Spacer	172337	1	—
69	Screw 6 B.A. × ⅜″ Ch.Hd.	150336	1	—

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

The items printed in blue should be stocked by the customer in order to cater for conditions arising due to careless handling or accidental damage. They are quoted for this purpose only and do not form part of a normal overhaul requirement.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