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British Railways Board

Director of Mechanical and Electrical Engineering

Speedometers.

General Electric Co. Ltd.

Smith's Industries Ltd.

WORKSHOP OVERHAUL STANDARD SPECIFICATION



REVISION RECORD

It is intended to up-date this specification whenever experience dictates this to be necessary. Pages having amendments or additions will be issued in the form of revision letters. The amended or the additional portion of re-issued pages will be highlighted by an adjacent vertical black line.

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WORKSHOP OVERHAUL STANDARD SPECIFICATION NO. 680/1
SPEEDOMETERS

CONTENTS
SECTION 1 REPAIR PROCEDURE.

PART A. THE GENERAL ELECTRIC CO. LTD. SPEEDOMETER

1. Introduction
2. Initial Examination
3. Dismantling Examination and Repair
4. Reassembly

PART B. SMITHS INDUSTRIES LTD. SPEEDOMETER

1. Introduction
2. Initial Examination and Repair

SECTION 2 TEST SPECIFICATION

1. Testing (GEC Ltd. and Smiths Industries Ltd. Instruments)
2. Calibration Adjustments (General Electric Co. Ltd only)

SECTION 1 REPAIR PROCEDURE

PART A - The General Electric Co. Ltd. Speedometer.

1. Introduction

- 1.1 The Speedometer (the General Electric Co. Ltd.) is a 5 m.A DC FSD Moving Coil Ammeter, calibrated to read 0 - 150 MPH.
- 1.2 The Instrument has a 144mm lens of flat, toughened non reflective Glass, with a square Bezel and is mounted on the Drivers Desk in the Power Car and secured by four screws equally spaced on each corner of the Bezel.
- 1.3 The dial markings are illuminated from the underside by "Betelight" tubes and the Pointer (of parallel tapered section) is painted matt white and illuminated using a "Betelight" straight tube supported on the Pointer body.
- 1.4. Disposal and handling of broken "Betelight" tubes/strips must be in accordance with local instructions.

2. Initial Examination

- 2.1 With the Instrument removed from the Power Car carry out a dynamic check in accordance with Section 2 of this Specification. If the Instrument is functionally serviceable carry out the procedure detailed hereunder, if the item is defective proceed as per Para 3.

- 2.2 Remove the three 2BA Plain Nuts and Washers from the Studs, retaining the Instrument Case to the Base. Carefully remove the Case, tilting slightly to override and avoid the three Stud Pillars fouling the Base and Movement during removal. Lay aside Base and Movement.
- 2.3 Clean the Case using Inhibisol, and the Glass with soap and water, dry and lay aside with the Nuts and Washers. Ensure the Glass is secure and sealed in the Bezel by means of sealant and the three securing clips. To renew Glass, remove the three securing clips and push out Glass. Remove old sealant and inspect Bezel for damage. Apply new sealant to Bezel Ring, refit new Glass and resecure using the three spring clips. Lay aside Case and Glass complete.
- 2.4 On the Movement, examine the Pointer for damage. Ensure the "Betelight" strip is secure. Renew Pointer if broken or bent and renew "Betelight" strip if damaged.
- 2.5 Remove and lay aside the three 6BA Countersunk Dial securing screws and shouldered distance pieces. Remove Dial, clean as necessary and examine Scale and "Betelight" strips for damage and security. Resecure or renew items as necessary. Lay aside Dial.
- 2.6 Using a suitable camel hair brush, internally clean the Instrument.
- 2.7 Refit Dial and check Pointer for freedom of movement. Mechanically zero the Pointer by means of the zeroing adjustment and move the Instrument about its horizontal axis through increments of 90° and ascertain the Pointer returns to its original setting of zero. If necessary adjust the fine and coarse adjustment Balance Weights on the Pointer Cross and Balance Arm. After adjustment, ensure the weights are mechanically secure and are locked in position using Shellac Varnish.

Note : Care should be taken to ensure that the solvent used in the softening of the adhesive has been removed.
- 2.8 Carry out a complete physical check of the Instrument and ensure all components are undamaged and secure. If damage is found repair in accordance with Para 3.
- 2.9 Refit the Bezel and Glass to the Base, ensuring the three securing Stud Pillars do not foul the instrument Movement and Body during refitting. Refit the Plain Washers and Nuts to the three securing Studs.
- 2.10 Fit the Instrument to the Test Equipment and check in accordance with Section 2 of this Specification for correct functioning and accurate calibration.
- 2.11 Ensure the Radiation (Trefoil) symbol label is securely attached to the rear of the Instrument Case.

- 2.12 Ensure the two internally threaded hexagonal Terminal Studs are undamaged and their electrical polarity is clearly identified.
 - 2.13 Complete all records and fit Calibration Certificate to rear of Instrument Case.
3. Dismantling, Examination and Repair
- 3.1 Carry out procedure detailed in Paras 2.2 to 2.5 inclusive.
 - 3.2 On the Base, remove the wax sealant from the four Countersunk Screws retaining the Instrument Movement to the Base. Remove Screws and lay aside.
 - 3.3 Remove the 6BA Cheese headed Screw and Spring Washer retaining the Instrument Movement Damping Resistor. Lay aside Screw and discard Washer. Carefully move aside the Resistor former and associated leads. Using a Model 8 Avometer, check the ohmic value of the Resistor. This should be 200 ohms \pm 2%. Renew if outside tolerance.
 - 3.4 Unsolder the lead from the Bottom Hairspring Post on the Instrument Movement.
 - 3.5 Remove the 2BA x 1¹/₂ inch Hexagon Headed Screw and Spring Washer securing the negative lead eye terminals to the Instrument Frame. Lay aside Screw and discard Washer. Remove the Instrument Movement clear of the Base.
 - 3.6 Clean and examine the Base for damage, the electrical leads for serviceability and the security of eye terminals. Examine the Instrument zeroing operating pillar for security and freedom of movement. Repair as necessary. Lay aside the Base.
 - 3.7 On the Shunt Plate, remove the top 4BA Securing Screw and lay aside. Discard Spring Washer. Loosen the lower Screw and move the Shunt Plate to its lowest extremity governed by the lower Screw.
 - 3.8 Prior to removal of the Top Bracket and Core carefully mark two horizontal lines on each side of the Pillar extending each side to the Core, also mark two vertical lines on the Pillar to establish position relative to the Instrument Base. Mark the position of the Stand Off Pillar on the Top Bracket relative to the Yoke Face. These datum marks are required to ease the reassembly process.
 - 3.9 Fit a suitable Insulated spacer between the Yoke and the Core to prevent movement of the Coil Former. Place the complete Instrument Movement in the de-magnetising rig and fully de-magnetise. Remove from the rig, discard the spacer.
 - 3.10 Unsolder the Upper and Lower Hairsprings from their respective Anchor Posts.

- 3.11 Remove the two slotted 4BA Hexagon Headed Screws securing the Top Plate to the Core Pillar. Carefully remove the Top Plate ensuring no damage is incurred to the Hairspring and Pointer. Lay aside the Top Plate complete.
- 3.12 Remove the OBA x 1¹/₄ inch Hexagon Headed Bolt and Spring Washer securing the Core to the Core Pillar. Lay aside Bolt and discard Spring Washer.
- 3.13 Carefully remove Core, Coil Former and Hairspring Assemblies complete from the Yoke. Remove the Coil Former and Hairspring from the Yoke. Lay aside the Yoke after examining for damage.
- 3.14 Examine the Coil and Hairspring Assembly for damage, after cleaning with Inhibisol and Camel Hair Brush. Ensure that :-
- (a) Upper and Lower Hairsprings are flat, undistorted with no overlapping of turns.
 - (b) Pointer Assembly is securely attached to the Centre Post and it is undamaged. Renew Pointer if broken or distorted.
 - (c) Insulating Mica Washer between Upper Hairspring and Pointer Securing Bracket is undamaged, renew as necessary.
 - (d) Pointer Cross, Balance Arm and associated weights are undamaged and secure, renew all damaged items.
 - (e) Coil Former is undamaged and secure to the Centre Pillar. Using a Model 8 Avometer check the Coil on the Coil Former for continuity. The ohmic reading should be 230 ohms \pm 10%.
 - (f) Upper and Lower Pivots are undamaged. Remove and renew if defective.

Note : If the Pivots are changed, the corresponding Bearing Jewels must also be renewed.

- 3.15 Upon completion of examination/repair, lay aside the complete assembly.
- 3.16 Clean the Top Plate as required and examine for damage, ensure the Hairspring Post Star Wheel is secure and the Jewel Screw 6BA Locknut is tight.

Note : If required to change the Upper Jewel remove the 6BA Jewel Screw Locknut, lay aside, note position of Star Wheel and length of protusion of Jewel Screw. Unscrew Jewel Screw and discard. Refit new Jewel Screw. Unscrew Jewel Screw and discard. Refit new Jewel Screw into Star Wheel to obtain same protusion as original. Refit Locknut, reposition Star Wheel and finally tighten Locknut.

- 3.17 Clean and examine the Yoke and Frame Assembly for damage. Renew items as necessary.

Note : If required to change the Lower Jewel, loosen the Jewel Screw Locknut and unscrew the Jewel Screw noting the number of thread turns required to effect complete removal from the Base Plate. Remove Jewel Screw and discard. Remove Pointer Zero Adjusting Arm, Tension Washers and Locknut. Refit new Jewel Screw into Base Plate and reassemble Zero Adjusting Arm assembly to obtain correct tension for ease of movement of the adjuster.

4. Reassembly

- 4.1 Refit the Coil Former and Hairspring Assembly into the Core.
- 4.2 Apply the thinnest possible film of approved Clock Oil to the Upper and Lower Jewels prior to the assembly of the Instrument.
- 4.3 Refit the Core (complete) into the Yoke and carefully refit the Lower Pivot into the Lower Jewel.
- 4.4 Position the Core on to the Core Pillar and loosely refit the Securing Bolt with a new Spring Washer and carefully realign the Core to the Core Pillar with the datum lines marked in accordance with Para 3.8. To ensure re-alignment and to assist in obtaining correct orientation of the Core insert a non-metallic wedge between Core and Yoke. When correct alignment has been obtained finally tighten securing Bolt. Remove and discard wedges.
- 4.5 Refit the Top Plate, ensuring correct physical positioning and fitting of the Upper Pivot in the Jewel. Refit the two securing Screws loosely, position the Top Plate Pillar to its correct position on the Yoke. Partially tighten Securing Screw.
- 4.6 Ensure correct positioning of the Zero Adjuster, adjust Upper Jewel Screw to obtain correct and free movement of the Coil. Check the Zero Adjuster for freedom of movement. Tighten the two Top Plate Securing Screws. Tighten the Upper Jewel Screw Locknut.
- 4.7 Resolder in turn the Upper and Lower Hairsprings to their respective Spring Posts. Check the Springs for flatness, distortion or over-lapping of turns. Ensure the Pointer moves freely.
- 4.8 Using the three 6BA Screws, refit the Dial to the Top Plate.
- 4.9 Mechanically zero the Pointer using the Zero Adjuster, and check that the Instrument is in balance by rotating with the Dial vertical. The Pointer should come to rest in its original position. If required adjust the Balance Weights on the Pointer Cross and Balance Arm. Ensure weights are mechanically secure and are locked in position using Shellac Varnish.

Note : Care should be taken to ensure that all solvent used in the softening of the adhesive has been removed.

- 4.10 Remove Dial from the Top Plate and lay aside.
- 4.11 Raise the Shunt Plate to its previous position. Refit Securing Screw with new 4BA Spring Washer. Fully tighten both 4BA Securing Screws.
- 4.12 Re-magnetise the magnet by placing the whole Movement in the Magnetiser Test Rig to saturate. Use a magnetising current approximately equal to the full scale value of the Instrument. Remove from Test Rig.
- 4.13 Refit the 2BA x 1¹/₂ inch Screw with new Spring Washer to secure the two negative lead eye terminals to the Instrument Movement.
- 4.14 Offer the Base Plate to the Instrument Movement and correctly locate the remote Pointer Zeroing Mechanism with the Zero Adjuster on the Instrument Frame. Refit the four Base Plate securing screws. Reseal screw heads with wax.
- 4.15 Refit the Damping Resistor Former and secure to the Instrument Frame using the Securing Screw and new Spring Washer.
- 4.16 Resolder the lead to the Lower hairspring Post.
- 4.17 Refit the Dial to the Top Plate.
- 4.18 Refit the Instrument Case to the Base and secure using the three 2BA Nuts and Plain Washers.
- 4.19 Mechanically Zero the Pointer.
- 4.20 Carry out a Dynamic Test and Calibration Check in accordance with Section 2 of this Specification. Adjustments to be made in accordance with Section 3 of this Specification.
- 4.21 Carry out operations 2.11 to 2.13 inclusive.

PART B - Smiths Industries Ltd Speedometer.

1. Introduction

- 1.1 The Speedometer (Smiths Industries Ltd) is a 5m/A DC FSD Moving Coil Ammeter, calibrated to read 0-150 MPH.
- 1.2 See Paras 1.2 to 1.4 inclusive. (Part A)

2. Initial Examination and Repair

- 2.1 With the Instrument removed from the Power Car carry out a dynamic check in accordance with Section 2.

If the item fails this test, change the Movement Body Para 2.6 refers.
- 2.2 Remove the eight 4BA Countersunk Screws and lay aside. Remove the Instrument Face (Bezel and Glass). Clean the Glass, using soap and water. Dry and lay aside.
- 2.3 Remove the four Round Head Screws securing the Case to the Base. Lay aside Screws, clean the Case using Inhibisol, if undamaged lay aside.
- 2.4 Remove the Pointer securing screw and retain. Remove Pointer and ensure the "Betelight" strip is secure. If undamaged lay aside. Renew if defective.
- 2.5 Remove the Dial securing screws and lay aside. Remove Dial, examine for damage and lay aside. Renew all "Betelight" strips if damaged.
- 2.6 Clean the Movement Body and examine for damage. If necessary, change the Movement Body.

Note : Due to the unique construction of this instrument no further dismantling is possible. Do not use solvents for cleaning.
- 2.7 Refit Dial and the securing screws.
- 2.8 Refit Pointer and secure by means of the securing screw.
- 2.9 Refit the Case and secure with the four Round Headed Screws.
- 2.10 Refit the Instrument Face and secure with the eight 4BA Screws.
- 2.11 Fit the complete instrument to the Test Equipment and check in accordance with Section 2 of this specification for correct functioning and correct calibration. If no faults are indicated remove the item from the Test Equipment.
- 2.12 Carry out operations Part A, 2.11 to 2.13 inclusive.

Section 2. Test Specification

1. Testing (GEC Ltd. and Smiths Industries Ltd. Instruments)

1.1 Test Equipment

Variable Stabilised DC Power Supply.
Precision Grade Milliammeter.

1.2 Dynamic Test and Calibration Check

1.2.1 Connect the Instrument under test in series with the Precision Grade Milliammeter and the Stabilised Power Supply.

1.2.2 Slowly raise the Stabilised Voltage from zero to 5m/A and back to zero on the Precision Grade Milliammeter and check the Instrument under test for smooth and free movement over the full range of the Scale. Check the Pointer for sticking and Pivot wear by tapping the Case lightly whilst slowly increasing the reading from zero to full scale and back again whilst tapping the Case, observe the Pointer for lateral movement indicating worn Pivots.

1.2.3 Check and record the calibration of the Instrument under test at all 10 MPH points from 10 MPH to 150 MPH with both rising and falling supply voltages. Check the indicated speed on the Speedometer against the indicated readings on the Milliammeter as per the following table :-

MPH	m/A
10	0.333
20	0.666
30	1.0
40	1.333
50	1.666
60	2.0
70	2.333
80	2.666
90	3.0
100	3.333
110	3.666
120	4.0
125	4.16
130	4.333
140	4.666
150	5.0

The permissible error at any indicated point must be within $\pm 1\%$ of the full scale deflection.

2. Calibration Adjustments (General Electric Co. Ltd Instruments only)

- 2.1 Remove the Speedometer from the Test Equipment and withdraw the complete Instrument Movement from the Case.
- 2.2 Insert the Movement in the Magnetising Test Rig, reset the test rig to "Set Back" the magnet to a value equivalent to 125 MPH (4.16 m/A) Allow a compensating factor equivalent to 2 MPH as all readings indicated without the instrument case will be slightly high. (the case will act as a Mu-Metal Screen thus causing a reduction in value of readings). Remove the Movement from the Test Rig.
- 2.3 Connect the Movement to the Test Equipment as described in Section 2 Para 1.2.1 and carry out a Dynamic Test and Calibration check in accordance with Paras 1.2.2 and 1.2.3. Record results and carry out adjustments as required.
- 2.4 Coarse adjustment to the calibration of the Instrument may be affected by adjusting the Shunt Plate. This will give a variation of up to ± 3 MPH on both the lower and higher ends of the Scale.
- 2.5 Fine adjustment to the centre range of the Scale is carried out by means of the Front and Side Core Adjusting Screws.

Note : Before attempting mechanical adjustment loosen off the Core Pillar securing screw and retighten on completion of adjustments.
- 2.6 Upon completion of all adjustments to bring the Scale readings to within permissible limits in accordance with Para 1.2.3 of this Specification, remove the Instrument Movement from test equipment.
- 2.7 Refit the Case to the Instrument Movement and Base. Secure in accordance with Para 2.9 Section 1.
- 2.8 Refit the Speedometer to the Test Equipment and carry out a final Dynamic and Calibration check of the instrument in accordance with Para 1.2. If no faults are indicated, remove the item from the Test Equipment.
- 2.9 Carry an Insulation Resistance Check using a 250 v Insulation Tester between Instrument Case (or earth terminal if fitted) and each Terminal Stud. The readings should be infinity.