



AP 112G-1225-1

2nd Edition Sept 1989

(Superseding 1st Edition dated
1968)

HELICOPTER TACHOMETERS (KOLLSMAN)

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

A handwritten signature in black ink, appearing to read 'Mr. G. Jones'.

Ministry of Defence

Sponsored for use in the

**ROYAL NAVY by DGA (N)
ROYAL AIR FORCE by D Air Eng (RAF)**

Publications authority: MOD (PE) Air Technical Publications Branch

Service users should send their comments through
the channel prescribed for the purpose in;
Naval Aircraft Maintenance Manual (RN)
AP 100B-01 Order 0504 (RAF)

AMENDMENT RECORD

Amdt	Incorporated by	Date
1	 DEC 90	8-3-91
2	 DEC 90	24/4/92
3		
4	A. J. Jones	26-10-95
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		

Amdt	Incorporated by	Date
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		

[illegible][illegible][illegible][illegible][illegible]

Sept 89

CONTENTS

PRELIMINARY MATERIAL

Title page
Amendment record sheet
Record of advance information leaflets (AIL)
Record of service temporary amendment leaflets (STAL)
Contents (this list)
Modification record

GENERAL AND TECHNICAL INFORMATION (-1)

Chapter

- 1 Helicopter tachometers (Kollsman)
 - 1-1 Tachometer indicator Type B31523-10-009
- 2 Standard serviceability test (using Dual Tachometer Tester Model 20317 6C/63657701)
 - 2-1 Standard serviceability test (using Dual Tachometer Tester Model 10074 6C/6598644)

Chapter 1HELICOPTER TACHOMETERS (KOLLSMAN)

CONTENTS

Para.

- 1 Introduction
- 5 Description
- 12 Operation
- 15 Installation
- 16 Servicing

Fig

- | | | | | | |
|---|---|-----|-----|-----|------|
| 1 | Sectional view of a three-pointer indicator | ... | ... | ... | Page |
| | | | | | 3 |

Introduction

1 Tachometer indicators are used on helicopters in conjunction with two or three generators to indicate engine and rotor speeds. One type of indicator has two pointers, one indicating engine speed, the other indicating rotor speed. The pointers move around one or two concentric scales on the dial. The two pointers are mounted co-axially, and should move around the scales together, thus indicating that the rotor and engine are operating together without clutch slip.

2 The type of indicator having only one scale is usually fitted to certain helicopters having a turbo-jet engine or engines. The scale indicates rotor speed only, and if the helicopter has one engine, the two pointers are marked E and R respectively. When the engine turbine and the rotor are running normally, the pointers will move around the scale together; this indicates normal operating conditions. Any divergence of the pointers will indicate abnormal conditions.

3 If the helicopter is fitted with two engines, the indicator will have three pointers labelled 1, 2 and R respectively. As with a two pointer indicator, these three pointers will move around the dial together under normal operating conditions.

4 Details of a particular type of tachometer indicator are given in the relevant appendix to this chapter.

Description

5 The tachometer indicators of the two or three pointer type are similar in construction, differing only in the number of motor assemblies, the number of plugs on the backplate, and the different gear train in the front mechanism. Figure 1 shows a sectional view of a three-pointer indicator.

6 The indicator mechanism is housed in a sealed case filled with helium gas to prolong the life of the mechanism. The case is closed at the front end by glass being soldered to the case; the rear is closed by the backplate being soldered to the case.

7 The motor assemblies are housed in the front mechanism block, and are retained by a split clamp. Each motor is connected to its respective 3-pole plug on the backplate, each plug being sealed into the backplate.

8 Each motor is of the hysteresis type, which is used in this type of indicator as it synchronises with the generator at very low speeds. Each motor consists of a three phase stator surrounding a rotor assembly consisting of a magnet free to rotate on a drive shaft, located adjacent a hysteresis rotor fixed to the drive shaft, which is free to rotate in ball bearings housed in the motor body. A pin protruding from the inner end face of the magnet engages a protruding segment of the adjacent end face of the rotor.

9 A magnetic drag assembly is mounted on an extension of the rotor shaft. This assembly consists of a four pole magnet attached to the shaft and surrounded by a magnetic shield. This shield is so positioned that a narrow air gap separates the shield and the magnet. Located in the air gap is a copper drag cup (or drum) mounted on the rear end of a handstaff.

10 Depending upon the type of indicator, there will be two or three handstaffs housed in the end face of the front mechanism casting. A hair spring is also mounted on each handstaff, together with a gear wheel. The pointer assembly consists of centre spindle carrying one pointer rotating inside one or two hollow spindles (depending whether it is a two or three pointer indicator). A gear wheel is mounted on the inner end of each pointer and this engages the gear wheel on the end of the respective handstaff. This arrangement of gears provides the required gear ratio to give the correct pointer movement.

11 The dial will have the required scale or scales engraved on it, and the dial markings and pointers can be luminised, fluorised, or plain white to suit particular installation requirements.

Operation

12 The output from the tachometer generator produces a rotating magnetic field in stator windings of the indicator; the speed of this field is controlled by the output frequency of the generator. The rotating field in the stator produces a torque in the magnet on the rotor shaft causing it to revolve in synchronism with the field. The pin on the magnet engages the protruding segment on the rotor, causing it to rotate at the same speed as the magnet.

13 Rotation of the rotor shaft spins the permanent magnet of the magnetic drag cup assembly inside the drag cup. This sets up eddy currents which rotate the drag cup against the force applied by the hairspring mounted on the handstaff. As the drag cup is secured to the handstaff, the drag cup movement is transmitted to the relevant pointer via the gear train.

14 When the speed of rotation of the tachometer decreases, the output frequency decreases. This slows down the field in the stator of the indicator, reducing the torque in the magnet and decreasing the speed of the rotor shaft. The force applied to the drag cup of the magnetic drag assembly will be less, and it will be overcome by the force applied by the hairspring. The relevant pointer will then move back towards zero, thus indicating the lower speed of rotation.

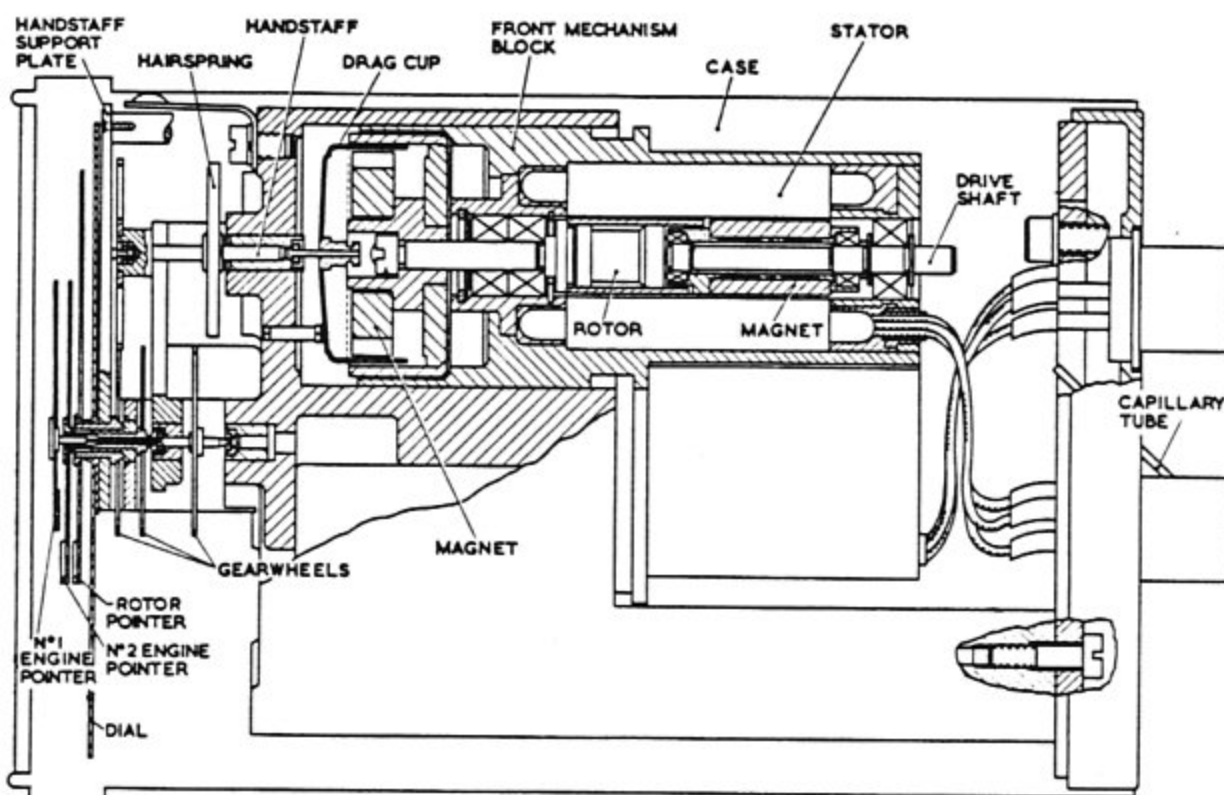


Fig.1 Sectional view of a three-pointer tachometer indicator

Installation

15 The mechanism case had a mounting flange at its front end, the flange being provided with four holes to accommodate the mounting screws. The electrical connections will vary between the different types of indicator, and reference should be made to the relevant chapter for information on the electrical connections of a particular indicator.

Servicing

16 As these indicators have a sealed case, the only routine servicing permitted is a visual examination for damage. If the serviceability of the instrument is suspect, it is to be tested as detailed in Chapter 2.

Chapter 1-1TACHOMETER INDICATOR, TYPE B31523-10-009

CONTENTS

Para.

- 1 Description
- 6 Servicing
- 7 Test tolerances

Table

1	Test tolerances	...	...	...	...	...	...	...	Page
									2

Fig

1	Dial presentation	...	...	...	...	...	...	Page
								2
2	Details of the electrical connections	...	...	...	...	...	...	Page
								2

Description

1 The tachometer indicator Type B31523-10-009 (Ref. No. 6A/7547) as shown in figures 1 & 2, is used to indicate directly the rotor speed of a helicopter together with the relevant speed of each engine. This indicator has only one scale marked on the front face, this indicates rotor speed, and its range is 50-260 rpm.

2 The instrument has three co-axial pointers labelled R, 1 and 2 respectively, and under normal operating conditions, these three pointers will move around the dial together. The R will indicate the rotor speed, and the fact that pointers 1 and 2 are aligned with it indicate that the relative engine revolutions necessary to rotate the rotor at that speed are being maintained. Any divergence between the R pointer and either pointer 1 or 2 indicates abnormal conditions.

3 The dial markings and pointers are painted white, and the dial background is black. As shown in fig.2, the electrical connections are via three, 3 pole plugs located on the rear of the case.

4 The engine-rotor and generator drive ratios are as follows:

4.1 Engine/rotor ratio:

4.1.1 Engine generator drive ratio - 0.05462 of engine speed.

4.1.2 Rotor generator drive ratio - 5.68 x rotor speed.

5 Number 1 & 2 engine generators are both Type B16206A two pole machines. Rotor generator Type KGA 0202 is a four pole machine.

Servicing

6 If the serviceability of the instrument is suspect, it is to be tested as detailed in Chapter 2.

Test tolerances

7 The test tolerances for this indicator are given in Table 1 below.

TABLE 1 TEST TOLERANCES

Test Bench Speed (RPM)	No 1 & No 2 Indicated Engine Speed (RPM)	Test Bench Speed (RPM)	Indicated Rotor Speed (RPM)
1000 - 4600	± 2.5	800-2800	± 2.5



Fig.1 Dial presentation

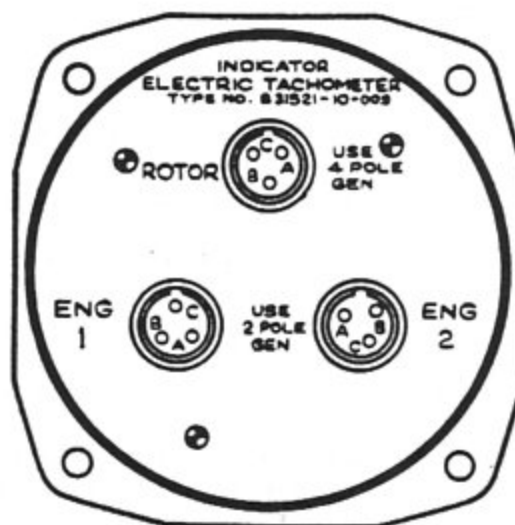


Fig.2 Details of the electrical connections

Chapter 2STANDARD SERVICEABILITY TEST

(USING DUAL TACHOMETER TESTER 6C/6365770)

CONTENTS

Para.

- 1 Introduction
- 2 Test equipment
- 3 Preparation
- 4 Insulation resistance test - room temperature
- 5 Ranging test
- 6 Pointer interference
- 7 Insulation resistance test - hot

Table

- | | | | | |
|---|---|-----|-----|------|
| 1 | Indicator ranging test figures and tolerances | ... | ... | Page |
| | | | | 3 |

Fig

- | | | | | | |
|---|---|-----|-----|-----|------|
| 1 | Triple tachometer indicator test circuit | ... | ... | ... | Page |
| | | | | | 4 |
| 2 | Wessex triple tachometer indicator test box | ... | ... | ... | 5/6 |

Introduction

1 The tests detailed in this chapter must be applied whenever serviceability of the instrument is suspect.

Test Equipment

2 The following items of test equipment are required:

- | | | |
|-----|---|--------------------------|
| 2.1 | Dual tachometer tester part no 20317 (AP 112T-0110-1) | 6C/6365770 |
| 2.2 | Counter/timer part no 9523 | 6C/6625-99-6205835 |
| 2.3 | Test Box, locally manufactured to fig.1 | Drg No.CSDE/WES/ETE/1002 |
| 2.4 | Multi-range insulation tester BM8 Mk 2 | 5G/6626-99-6505337 |
| 2.5 | Tachometer Generator, Engine B16206/A | 6A/6401535 |
| 2.6 | Tachometer Generator, Rotor KGA 0202 | 6A/4333052 |
| | or | |
| | KGA 0701 | 6A/1035655 |
| 2.7 | Overspeed Trip Unit Adapter 20268 | 6A/1981834 |

Preparation

3 Prepare the items of test equipment as follows:

- 3.1 Set up the Dual Tachometer Tester as detailed in AP 112T-0110-1.

3.2 Mount and secure Drive 1530 and Gearbox 1388, 1 to 2 ratio, to the left-hand locating ring of the tester. Fit and secure Engine Tachometer Generator B16206/A to the adapter.

3.3 Mount and secure the Overspeed Trip Adapter 20268 to the right-hand locating ring of the tester. Fit and secure Rotor Tachometer Generator KGA 0202 or KGA 0701 to the adapter.

3.4 Connect the generators to the test box as shown in fig.2.

3.5 Connect the Counter/Timer to the Overspeed Trip Unit Adapter.

Insulation resistance test at room temperature

4 Using the Multi-range Insulation Tester, set to the 250 V range, measure the insulation resistance between each pin of the three connectors and the indicator body. The resistance in each instance shall not be less than 20 Megohms.

Ranging Test

5 Perform the ranging test as follows:

CAUTION ...

When switching the tester motors ON ensure the tachometer generators are rotating in the correct direction by slowly adjusting the appropriate SPEED CONTROL and observing the indicator pointers move 'up scale'.

5.1 Connect the indicator to the test box flying leads and set the ENG 1 and ENG 2 switches to ON.

5.2 Set the Counter/Timer power switch to ON.

5.3 Set the test bench directional switches for clockwise rotation.

5.4 Set the test bench left-hand ON/OFF switch to ON and slowly adjust the SPEED CONTROL until pointers 1 & 2 indicate 220 rpm.

5.5 Set the test bench right-hand ON/OFF switch to ON and slowly adjust the SPEED CONTROL until pointer R indicates 220 rpm.

NOTE

A ten minute 'warm up' period must now elapse before proceeding with any tests.

5.6 Slowly adjust the left-hand SPEED CONTROL until pointers 1 and 2 indicate $60 \text{ rpm} \pm 2.5 \text{ rpm}$. Light tapping of the indicator is permitted throughout the test.

5.7 Slowly adjust the right-hand SPEED CONTROL until pointer R indicates $70 \text{ rpm} \pm 2.5 \text{ rpm}$.

5.8 Slowly adjust the left-hand and then the right-hand SPEED CONTROLS to check the indicator pointers at all speeds listed in Table 1 columns (1) and (3), ensuring the indications listed in columns (2) and (4) are within the tolerance specified in column (5).

5.9 Slowly adjust the right-hand SPEED CONTROL until pointer R indicates 220 rpm.

TABLE 1 INDICATOR RANGING TEST FIGURES AND TOLERANCES

Test Bench Speed (rpm)	No 1 & 2 Indicated Engine Speeds	Test Bench Speed (rpm)	Indicated Rotor Speed	Pointer Tolerance $\pm$ rpm
(1)	(2)	(3)	(4)	(5)
1098	60	800	70	2.5
1464	80	1200	106	2.5
2013	110	1600	141	2.5
2379	130	2000	176	2.5
2928	160	2400	211	2.5
3477	190	2450	215.1	2.5
4026	220	2500	220	2.5
4392	240	2550	224.5	2.5
4574	250	2600	229	2.5
		2650	233.5	2.5
		2800	247	2.5

Pointer Interference

6 Check that the indicator pointers do not foul each other, the glass or the dial whilst carrying out the following operations:

6.1 Adjust the left hand SPEED CONTROL until pointers 1 & 2 indicate 240 rpm.

6.2 Set ENG 1 switch to OFF and check that pointer 1 moves smoothly 'down scale'. Adjust the left-hand SPEED CONTROL to minimum.

6.3 Set ENG 1 switch to ON and adjust the left-hand SPEED CONTROL until pointers 1 & 2 indicate 240 rpm.

6.4 Set ENG 2 switch to OFF and check that pointer 2 moves smoothly 'down scale'. Adjust the left-hand SPEED CONTROL to minimum.

6.5 Set ENG 2 switch to ON and adjust the left-hand SPEED CONTROL until pointers 1 & 2 indicate 240 rpm.

6.6 Adjust the right-hand SPEED CONTROL until pointer R indicates 260 rpm. Adjust the right-hand SPEED CONTROL to minimum and check that pointer R moves smoothly 'down scale'.

6.7 Set the right-hand motor ON/OFF switch to OFF.

6.8 Adjust the left-hand SPEED CONTROL to minimum and set the left-hand motor ON/OFF switch to OFF.

6.9 Switch the counter/Timer power off and disconnect the indicator from the test box.

Insulation resistance test - hot

7 Using the Multi-range Insulation Tester, set to the 250 V range, measure the insulation resistance between each pin of the three connectors and the indicator body. The resistance in each instance must not be less than 5 megohms.

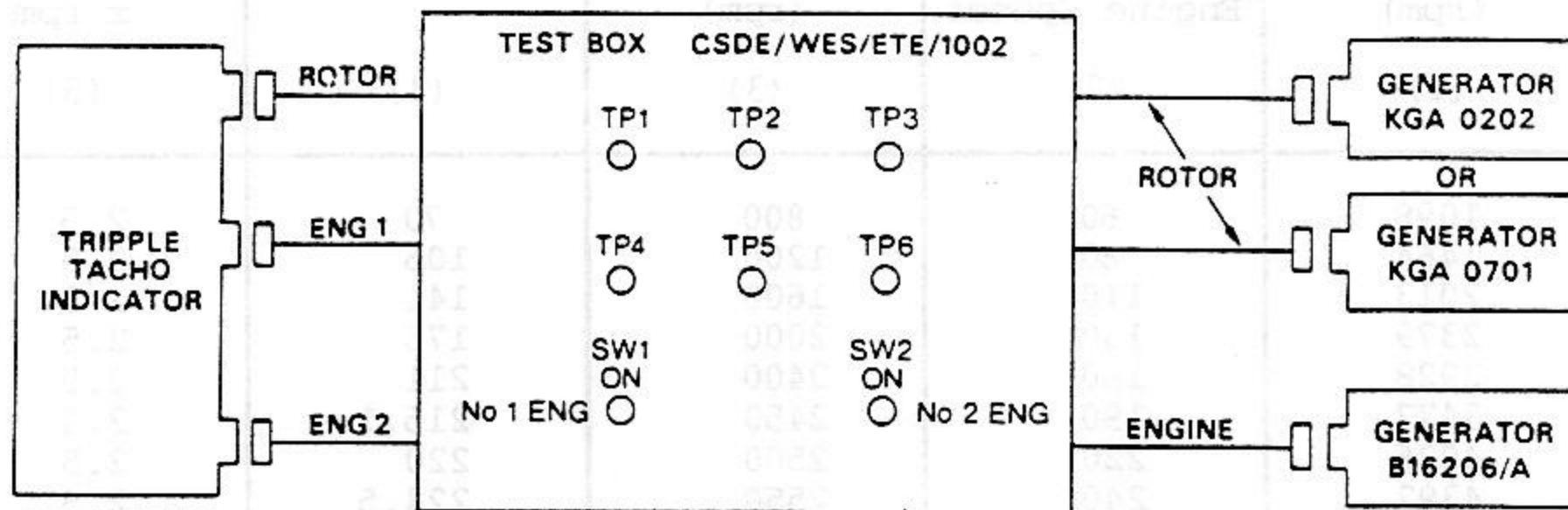


Fig.1 Triple tachometer indicator test circuit

TABLE 2 KEY TO FIG.2

Item (1)	Description (2)	Sect/Ref NSN (3)	Part Number (4)	Quantity (5)
1	Connector	5935-99-7147928	PTO6E 8 3s	2
2	Connector	5935-99-2213497	466-8-98SW	1
3	Connector	5935-99-1063515	508/2/11360	1
4	Connector	5935-99-1095342	3108E-10SL-3S	1
5	Switch	10F 1089797		2
6	Switch cover	1730-99-2062734		2
7	Test socket	5935-99-6466327		6
8	Terminal block	5940-99-6462027		1
9	Termination	5X 1051675		8
10	Adhesive clamp	5340-99-6424108		AR
11	Tywrap	5970-00-7275153		AR
12	Cable (3 core)	5E 1116722		AR
13	Stuffing gland	LPO	Sarel SG 12 ISO	6
14	Small enclosure	LPO	Sarel Code 356	1
15	Connector	5935-99-2221586	HBS06E-8-3SX	1

NOTE

LPO items 13 & 14 from: Walsall Conduits Ltd
Oak Street
Norwich Tel 0603 626242.

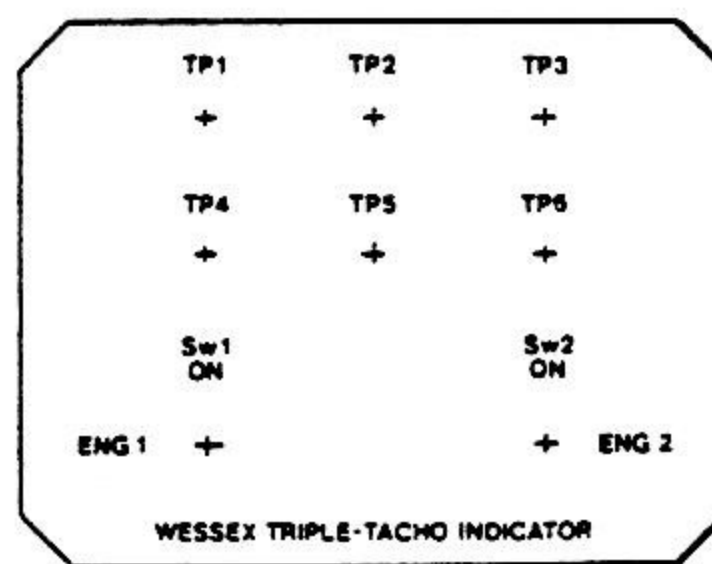
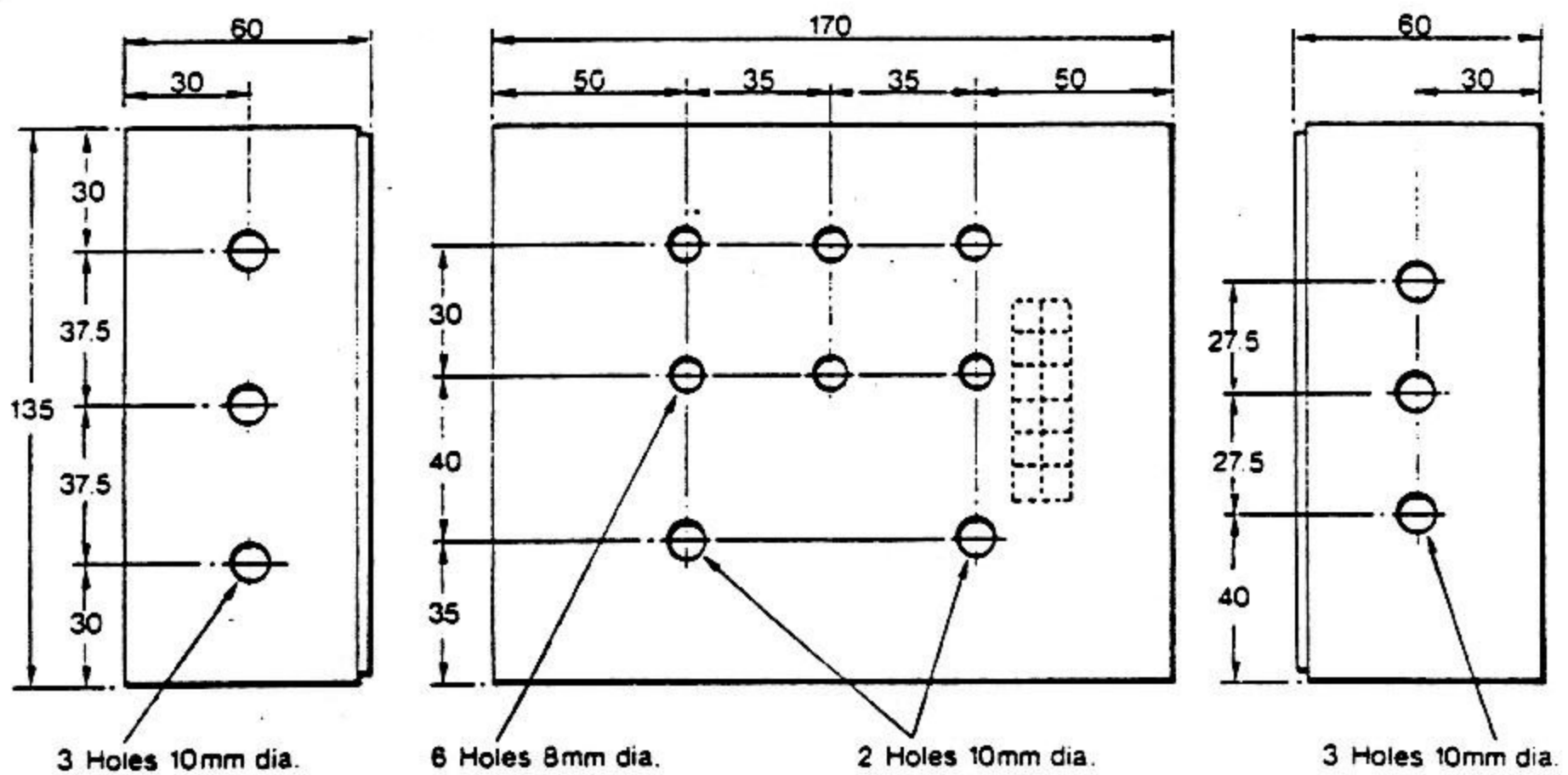
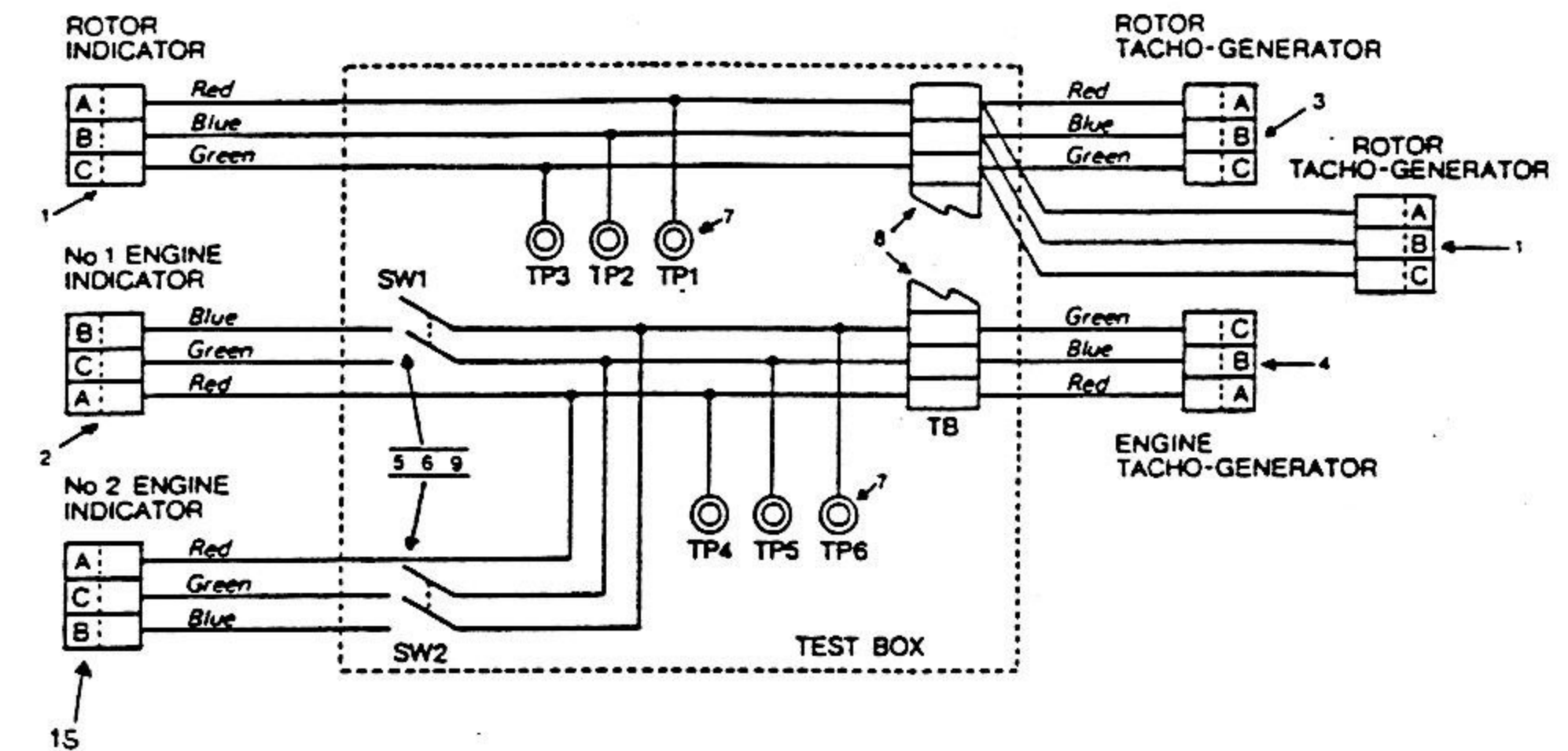


Fig.2 Wessex triple tachometer indicator test box

Chapter 2-1

STANDARD SERVICEABILITY TEST(USING DUAL TACHOMETER TESTER 6C/6598644)

CONTENTS

Para.

- 1 Introduction
- 2 Test equipment
- 3 Preparation
- 4 Insulation resistance test - room temperature
- 5 Ranging test
- 6 Pointer interference
- 7 Insulation resistance test - hot

Table

- | | | | | | |
|---|---|-----|-----|-----|------|
| 1 | Indicator ranging test figures and tolerances | ... | ... | ... | Page |
| | | | | | 3 |

Fig.

- | | | | | | |
|---|---|------|-----|-----|------|
| 1 | Triple tachometer indicator test circuit | | ... | ... | Page |
| | | | | | 4 |
| 2 | Wessex triple tachometer indicator test box | ... | ... | ... | Page |
| | | | | | 5 |

Introduction

1 The tests detailed in this chapter must be applied whenever serviceability of the instrument is suspect.

2 The following items of test equipment are required:

- ▶ 2.1 Dual tachometer tester part no 10074, (AP 112G-01121) 6C/6598644
- 2.2 Test Box, locally manufactured to Fig.1 Drg No.CSDE/WES/ETE/1002
- 2.3 Multi-range insulation tester BM8 Mk 2 5G/6626-99-6505337
- 2.4 Tachometer Generator, Engine B16206/A 6A/6401535
- 2.5 Tachometer Generator, Rotor KGA 202 6A/4333052
- or
- KGA 0701 6A/1035655

3 Prepare the items of test equipment as follows:

- 3.1 Set up the Dual Tachometer Tester as detailed in AP 112T-0110-1.
- ▶ 3.2 Mount and secure Drive 1530 and Gearbox 10094, 1 to 2 ratio, to the left-hand locating ring of the tester. Fit and secure Engine Tachometer Generator B16206/A to the adapter.
- 3.3 Mount and secure adapter 10095 and Gearbox 10095, 1 to 1 ratio, to the right-hand locating ring of the tester. Fit and secure Rotor Tachometer Generator KGA 0202 or KGA 0701 to the adapter.
- 3.4 Connect the generators to the test box as shown in fig.2.

Insulation resistance test at room temperature

4 Using the Multi-range Insulation Tester, set to the 250 V range, measure the insulation resistance between each pin of the three connectors and the indicator body. The resistance in each instance shall not be less than 20 Megohms.

Ranging Test

5 Perform the ranging test as follows:

CAUTION ...

When switching the tester motors ON ensure the tachometer generators are rotating in the correct direction by slowly adjusting the appropriate SPEED CONTROL and observing the indicator pointers move 'upscale'.

5.1 Connect the indicator to the test box flying leads and set the ENG 1 and ENG 2 switches to ON.

5.2 Set the test bench directional switches for clockwise rotation.

5.3 Set the test bench left-hand ON/OFF switch to ON and slowly adjust the SPEED CONTROL until the left-hand digital display indicates 2013 with pointers 1 & 2 indicating 220 rpm.

5.4 Set the test bench right-hand ON/OFF switch to ON and slowly adjust the SPEED CONTROL until the right-hand digital display indicates 1250 with pointer R indicating 220 rpm.

NOTE

A ten minute 'warm up' period must now elapse before proceeding with any tests.

5.5 Slowly adjust the left-hand SPEED CONTROL until the left-hand display indicates 549 and pointers 1 and 2 indicate $60 \text{ rpm} \pm 2.5 \text{ rpm}$. Light tapping of the indicator is permitted throughout the test.

5.6 Slowly adjust the right-hand SPEED CONTROL until the right-hand display indicates 398 and pointer R indicates $70 \text{ rpm} \pm 2.5 \text{ rpm}$.

5.7 Slowly adjust the left-hand and then the right-hand SPEED CONTROLS to check the indicator pointers at all speeds listed in Table 1 columns (1) and (3), ensuring the indications listed in columns (2) and (4) are within the tolerance specified in column (5).

5.8 Slowly adjust the right-hand SPEED CONTROL until pointer R indicates 220 rpm.

Pointer Interference

6 Check that the indicator pointers do not foul each other, the glass or the dial whilst carrying out the following operations:

6.1 Adjust the left hand SPEED CONTROL until pointers 1 & 2 indicate 240 rpm.

TABLE 1 INDICATOR RANGING TEST FIGURES AND TOLERANCES

Test Bench Speed (rpm)	No 1 & 2 Indicated Engine Speeds	Test Bench Speed (rpm)	Indicated Rotor Speed	Pointer Tolerance $\pm$ rpm
(1)	(2)	(3)	(4)	(5)
549	60	398	70	2.5
732	80	600	106	2.5
1006	110	800	141	2.5
1188	130	1000	176	2.5
1464	160	1200	211	2.5
1738	190	1225	215.1	2.5
2013	220	1250	220	2.5
2196	240	1275	224.5	2.5
2287	250	1300	229	2.5
		1325	233.5	2.5
		1400	247	2.5

6.2 Set ENG 1 switch to OFF and check that pointer 1 moves smoothly 'down scale'. Adjust the left-hand SPEED CONTROL to minimum.

6.3 Set ENG 1 switch to ON and adjust the left-hand SPEED CONTROL until pointers 1 & 2 indicate 240 rpm.

6.4 Set ENG 2 switch to OFF and check that pointer 2 moves smoothly 'down scale'. Adjust the left-hand SPEED CONTROL to minimum.

6.5 Set ENG 2 switch to ON and adjust the left-hand SPEED CONTROL until pointers 1 & 2 indicate 240 rpm.

6.6 Adjust the right-hand SPEED CONTROL until pointer R indicates 260 rpm. Adjust the left-hand SPEED CONTROL to minimum and check that pointer R moves smoothly 'down scale'.

6.7 Set the right-hand motor ON/OFF switch to OFF.

6.8 Adjust the left-hand SPEED CONTROL to minimum and set the left-hand motor ON/OFF switch to OFF.

6.9 Disconnect the indicator from the test box.

7 Using the Multi-range Insulation Tester, set to the 250 V range, measure the insulation resistance between each pin of the three connectors and the indicator body. The resistance in each instance must not be less than 5 Megohms.

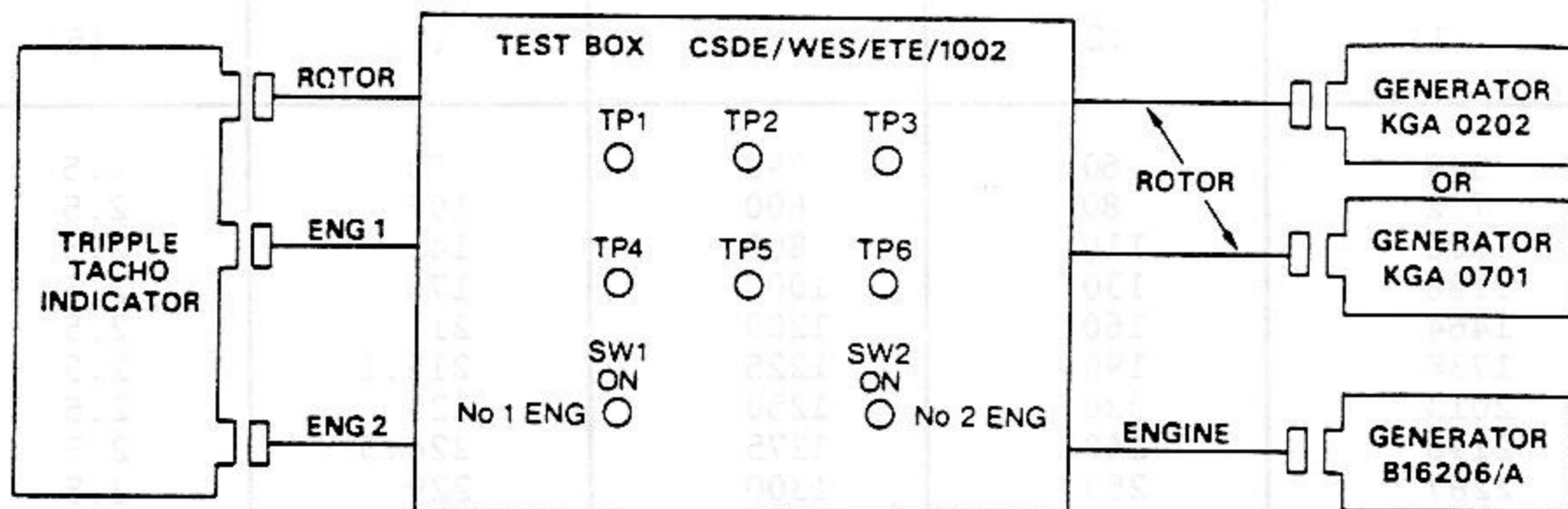


Fig.1 Triple tachometer indicator test circuit

TABLE 2 KEY TO FIG.2

Item (1)	Description (2)	Sect/Ref NSN (3)	Part Number (4)	Quantity (5)
1	Connector	5935-99-7147928	PTO6E 8 3S	2
2	Connector	5935-99-2213497	466-8-98SW	1
3	Connector	5935-99-1063515	508/2/11360	1
4	Connector	5935-99-1095342	3108E-10SL-3S	1
5	Switch	10F 1089797		2
6	Switch cover	1730-99-2062734		2
7	Test socket	5935-99-6466327		6
8	Terminal block	5940-99-6462027		1
9	Termination	5X 1051675		8
10	Adhesive clamp	5340-99-6424108		AR
11	Tywrap	5970-00-7275153		AR
12	Cable (3 core)	5E 1116722		AR
13	Stuffing gland	LPO	Sarel SG 12 ISO	6
14	Small enclosure	LPO	Sarel Code 356	1
15	Connector	5935-99-2221586	HBS06E-8-3SX	1

NOTE

LPO items 13 & 14 from : Walsall Conduits Ltd
Oak Street
Norwich Tel 0603 626242.

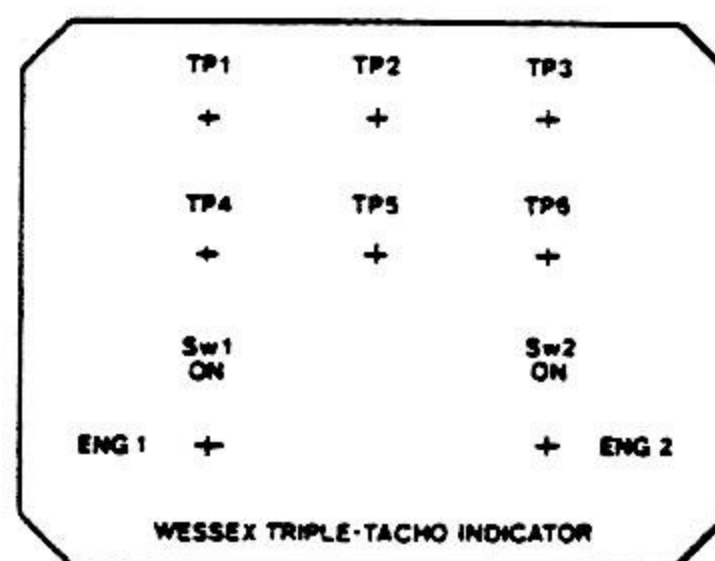
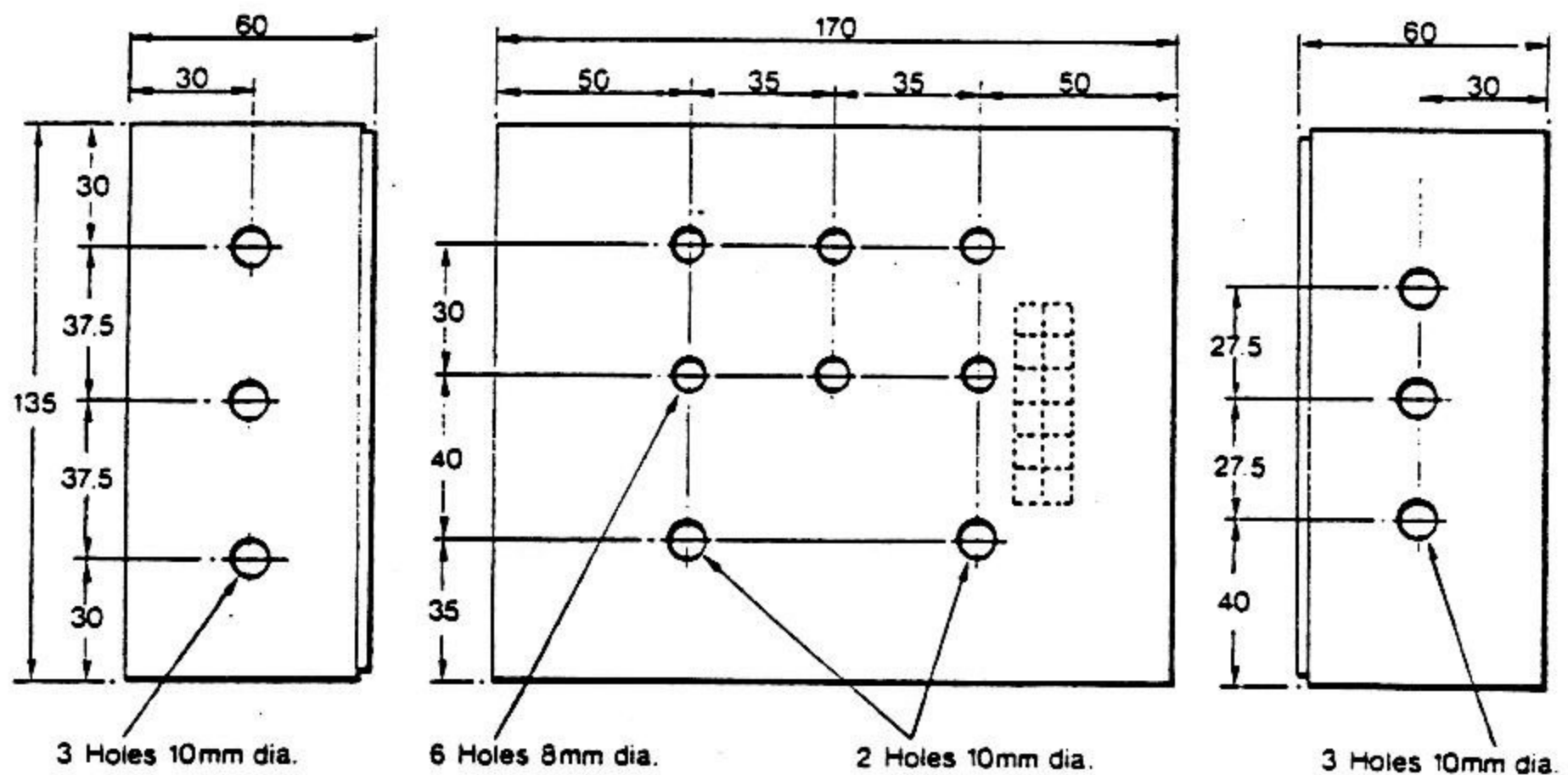
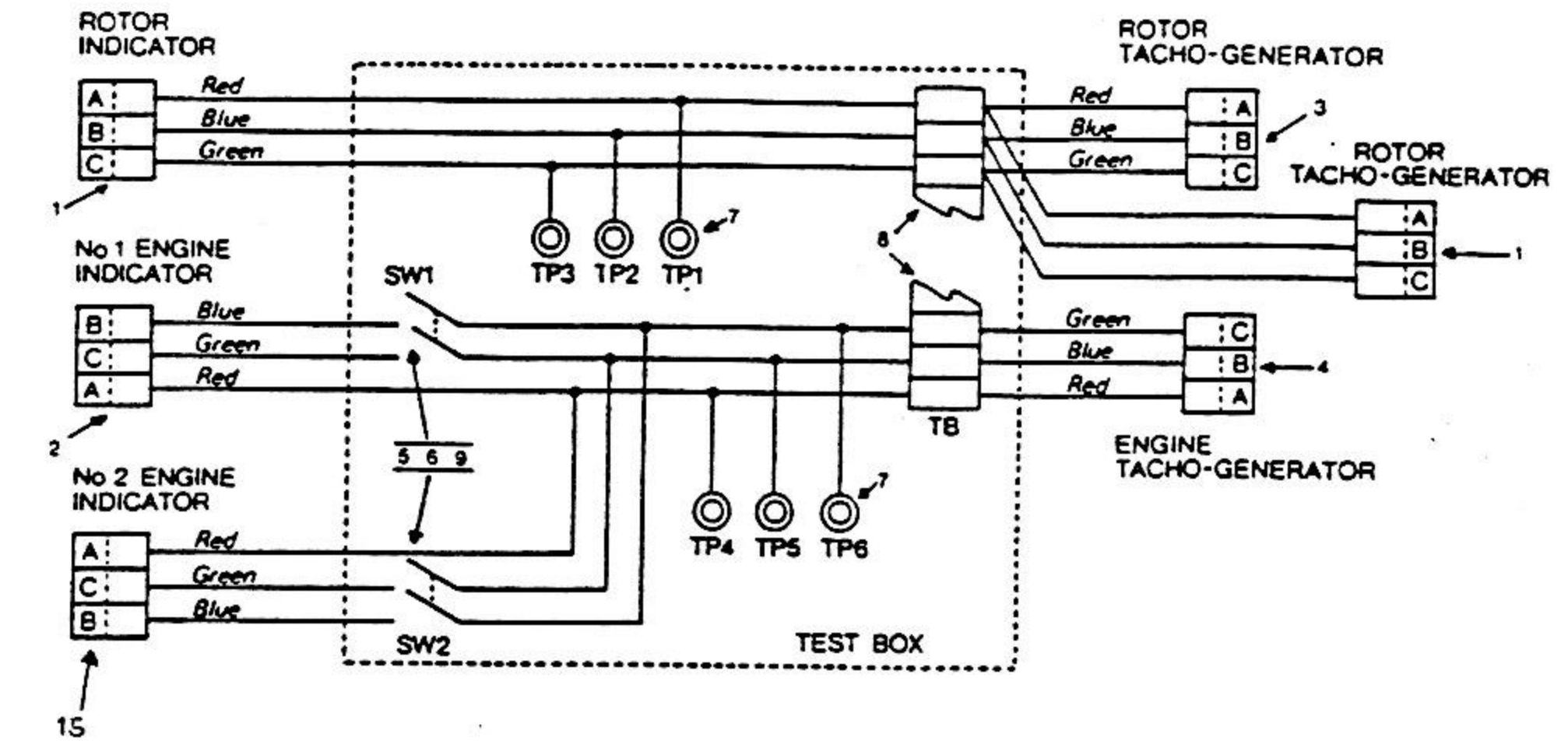


Fig.2 Wessex triple tachometer test box