SMITHS

SERVICE INSTRUCTIONS

IMPULSE TACHOMETER
(RVI.1000 SERIES)

SMITHS MOTOR ACCESSORY DIVISION

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— SERVICE —

The Service Technical Department of the Motor Accessory Division will be pleased to advise on any functional problem relating to instruments and equipment described in this brochure. All correspondence should be addressed to: SMITHS MOTOR ACCESSORY DIVISION,
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LIST OF SPECIAL TOOLS & EQUIPMENT

Description	Code No.
Speedometer Test Apparatus	SR/D.221
Adaptor (for use with Apparatus SR/D.221)	SR/D.312
OR	
Speedometer Test Apparatus	AT.9034
Adaptor (for use with Apparatus AT.9034)	SR/D.313
Ignition Pulse Simulator	SR/D.347
Generator	TV.1100/00
Bridge Spanner	SR/D.360
Bezel Fixture	SR/D.140
Bezel Spinning Tool	SR/D.269
Support Pad	SR/D.269/13
Pressure Pad	SR/D.269/14

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INPULSE TACHOMETER

GENERAL DESCRIPTION

The equipment consists of an indicator head and a pulse lead. The pulse lead, when connected in series between the vehicle ignition switch and the low tension terminal of the engine ignition coil will transmit voltage pulses to the indicator head.

The tachometer system has been designed to cover a wide range of internal combustion petrol engines using either 6V or 12V coil ignition electrical systems; positive or negative ground. This range covers 2, 3 and 4 cylinder 2 stroke engines and 4, 6 & 8 cylinder 4 stroke engines. Any one of these applications can be obtained by recalibrating the tachometer. This operation is explained in the section headed CALIBRATION INSTRUCTIONS on page S.7.

TECHNICAL DESCRIPTION .

(For Component Reference see Circuit Diagram Fig. 2 Page S.10)

The object of the circuit as shown, on Page S.10 is to provide a pulse of constant height and width to the coil of a meter every time the engine fires. The cycle of operations consists of a rest period followed by a pulse followed by a further rest period.

At rest the collector-emitter voltage of transistor TR1 is very low due to the base current flowing via resistors R8, R5 and R6. Under this condition transistor TR2 will not be conducting, since its base is effectively shorted to earth by R1 and the conducting TR1. Capacitor Cl is charged to the zener voltage with its right hand plate negative with respect to earth. No current flows through the meter M.

The primary of the triggering transformer (T) is connected in series with the primary of the engine ignition coil, so that when the contact breaker in the engine distributor closes, the current flowing to feed the ignition coil passes through the primary of the transformer energising the core. When the contact breaker opens to provide a spark to the engine, the flux in the transformer core collapses and appears as a short duration voltage pulse across the secondary of the triggering transformer.

This pulse causes TR2 to conduct, which effectively brings the right hand plate of Cl to earth potential so that the left hand plate is positive with respect to earth. Cl starts discharging through R2, R8, R5 and R6 (driving the base of TR1) positive making it non-conducting. Simultaneously, the collector voltage of TR1 switches towards the zener voltage and TR2 conducts due to the base current flowing via R4 and Rl. During this state current flows through the meter via the conducting TR2 and the temperature compensating circuit

thermistor Thl and R3. This state continues until the charge in Cl is unable to maintain the positive potential on TR1 and the circuit reverts to the stable state.

The time taken for Cl to discharge is a function of Cl, R6, R5, R8 and R2. Hence current pulses of constant charge are applied to the meter at a frequency depending on engine speed. The voltage applied to the circuit is stabilised by the zener diode Dz, C3 and R7. The capacitor C2 prevents the circuit being triggered by spurious voltages generated by auxilliary equipment or faulty contact breaker points.

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TESTING PROCEDURE

(Using Speedometer Test Apparatus SR/D.221 or AT.9034)

PREPARATION OF THE TEST EQUIPMENT

Using the appropriate adaptor SR/D.312 or SR/D.313 couple a known good generator TV.1100/00 to the speedometer test apparatus SR/D.221 or AT.9034.
Using a suitable electrical cable connect the output terminals of the generator to the two left hand terminals of the ignition pulse simulator SR/D.347.
(it is unimportant which way round these connections are made).
Refer to the white pulse lead on the tachometer and connect the lead with the red marker to the red terminal on the simulator and connect the other lead with the black marker to the black terminal on the simulator. (It is important to connect these leads in the correct order).
Connect a well stabilised D.C. supply of 12 volts to the two right hand supply terminals on the simulator marked + and -. It is imperative that the correct polarity be observed while making this connection. Wrong connections will result in the transistors used in the simulator being instantly destroyed.
Adjustment of the terminal locking nuts may also result in damage to the simulator.
Connect the tachometer to a 14.5 volt. D.C. supply, so that it is wired for a negative earth. It is important to use 14.5 volts. Voltages less than this figure can result in errors of up to 400 r.p.m. being indicated on the tachometer.

TESTING

Switch ON the supply to the ignition pulse simulator and the impulse tachometer. Wait for two minutes and allow the units to warm up. Start the speedometer test apparatus and operate the tachometer throughout its range.
Check the calibration by running the speedometer test apparatus at 3000 r.p.m., the tachometer should read as follows:

6000 r.p.m.	when calibrated	for	4 cylinder 4 stroke application
4000 r.p.m.	"	"	6
3000 r.p.m.	"	"	8

If the tachometer is found to be out of calibration it should be recalibrated as described on page S.7.
It should be noted that for all service purposes 2 cylinder 2 stroke application can be considered as being the same as 4 cylinder 4 stroke and 3 cylinder 2 stroke as 6 cylinder 4 stroke.
Set the tachometer to read 3000 r.p.m. and then switch the ignition pulse simulator OFF and ON. When the simulator is switched OFF check that the tachometer reading falls to zero and when switched ON the tachometer reads 3000 r.p.m. Finally, operate the tachometer throughout its range.
During the complete testing procedure it is most important to observe the behaviour of the pointer. The tachometer, when satisfactory, should read with little or no fluctuation between 500 r.p.m. and maximum; in this range there should be no tendency for the pointer to drop to zero.
If any unusual movement or fluctuation is observed, the tachometer should be regarded as suspect and in need of more detailed inspection.

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1 Bezel
2 Glass
3 Rubber Ring (Internal)
4 Slip Ring
5 Pointer Assembly
6 Dial Screw
7 Dial
8 Screw (Securing Circuit Board to Movement)
9 Printed Circuit Assembly
10 Movement Assembly
11 Magnet
12 Pole Bridge Piece
13 Pole Piece
14 Foam Washer
15 Base Plate
16 Terminal Stud (-6V)
17 Terminal Stud (+)
18 Terminal Stud (-6V)
19 Resistor
20 6BA Nut
21 6BA Spring Washer
22 6BA Plain Washer
23 Coil Support Assembly
24 Triggering Coil
25 Triggering Coil Cushion
26 Screw (Securing Base Plate to Movement)
27 Case
28 Rubber Ring (External)
29 Plastic Former
30 Iron Core
31 6BA Spring Washer
32 6BA Thumb Nut
33 Rubber Grommet
34 Pulse Lead
35 Marker Tag (Black)
36 Marker Tag (Red)
37 Movement Fixing Washer
38 Movement Fixing Screws
39 Terminal Block (Three Point)
40 Plain Washer (Terminal Block)
41 Shakeproof Washer (Terminal Block)
42 Fixing Nut (Terminal Block)
43 Plain Washer (Terminal Connection)
44 Spring Washer (Terminal Connection)
45 Fixing Nut (Terminal Connection)
46 Terminal Insulator
47 Fixing Strap
48 Fixing Washer
49 Fixing Thumb Nut
50 Pole Guide
A Printed Circuit Board (Complete)
B Fixing Nut (Potentiometer)
C Fixing Washer (Potentiometer)
D Resistor
E Resistor
F Resistor
G Resistor
H Resistor
I Resistor
J Resistor
K Resistor
L Potentiometer
M Capacitor
N Capacitor
O Capacitor
P Thermistor
Q Zener Diode
R Transistor

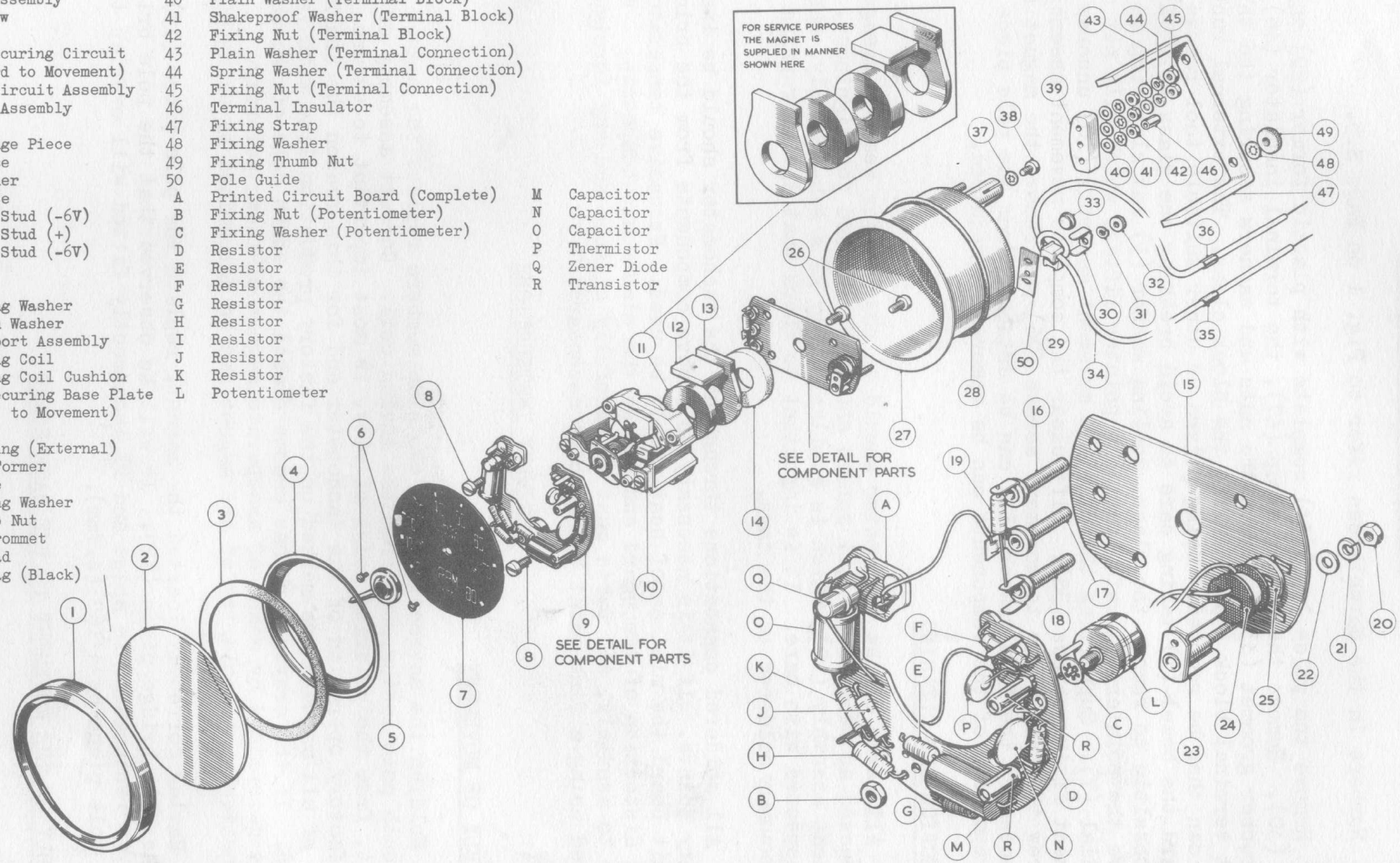

Fig.1 General Arrangement of Impulse Tachometer

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DISMANTLING INSTRUCTIONS

Numbers in the parentheses refer to Fig. 1 on Page S.5.

Remove the pulse lead (34) complete with plastic former (29) and iron core (30). Remove the fixing strap (47), the terminal insulator (46) and the rubber grommet (33). Remove the nuts and washers securing the three point terminal block (39) and lift the block clear. The external rubber ring (28) can then be removed. Using pliers or other suitable tool remove and discard the bezel (1) taking care to avoid breaking the glass (2). It is now possible to remove the glass, sealing washer (3) and slip ring (4). Remove the pointer (5) using suitable pointer lifters which will not damage the dial (7). Supporting the dial and movement assembly (10) unscrew the movement fixing screws (38). Lift clear the complete movement assembly and unscrew the base plate to movement screws (26) and remove the magnet (11). If necessary the foam washer (14) can be detached from the pole piece (13). The remainder of the components can be removed as required.

INSPECTION AND CLEANING

All parts of the tachometer should be checked for wear or damage and be renewed as necessary. All screws should be checked for tightness. The movement assembly (10), which is available only as a sub-assembly, should be inspected with care. It is important to check that the hairspring tails are securely soldered to the tags.

All soldered connections throughout the tachometer should be inspected for dry joints. If it is necessary to remove components from the printed circuit board the minimum of heat should be used. Excessive temperature will cause distortion of the board and damage the electronic components. Finally, prior to assembly, all parts must be carefully cleaned and any foreign matter removed using a fine paint brush where necessary.

ASSEMBLY INSTRUCTIONS

ASSEMBLY OF MOVEMENT

Holding the movement by the two side members replace the magnet with its south pole facing away from the moving coil. Correct assembly of the magnet, from the polarity point of view, is most important to ensure satisfactory operation of the tachometer and for this reason the south pole faces of all magnets are marked on the factory production line with yellow crayon. If the crayon mark has become erased the south pole of the magnet can be determined by means of a separate magnet of known polarity. Alternatively the polarity of the magnet can be determined by using a compass.

Having correctly located the magnet, replace the pole piece (13) and fit the pole bridge piece (12). It will be observed that the pole bridge piece is rectangular in shape and if incorrectly fitted will overlap the front pole piece by 3/16" (4.7mm).

ASSEMBLY OF THE MOVEMENT TO THE BASE BOARD

In a central position secure the foam washer to the rear pole piece, using Paripan Locking Varnish or a suitable equivalent. Using the base board to movement fixing screws, dipped in Paripan Locking Varnish or a suitable equivalent, secure the base board to the movement. Should any wires between the base board and movement assembly have been removed during repair or dismantling re-solder them to the correct terminals.

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RE POISING THE MOVEMENT

Replace the dial and pointer, locking the dial screws with Paripan Locking Varnish or a suitable equivalent. Fit the iron core, former and pulse lead and then proceed to poise the movement and set the basic calibration as described below.

Connect the impulse tachometer to the ignition pulse simulator and speedometer test apparatus as described in the Testing Procedure on page S.4. Switch on the supply to all these units and set the tachometer so that the pointer rests at the lower calibration mark at the 1750 r.p.m. position on the dial.

Check the poising by holding the tachometer in a vertical plane and rotating it at 90° intervals, observing the position of the pointer after each turn. In all four. positions the pointer should be within the limits of the lower calibration mark. If the pointer does not lie within the mark the movement is unbalanced and should be re-poised in the following manner.

On the movement balance arm is fitted a moveable brass counter weight and at 90 to the counter weight are two extension arms on which is wired two small moveable coils. With the tachometer reading oppositethe lower calibration mark proceed to check the tachometer at 90 intervals in the vertical plane. If the pointer lies to the right or left of the calibration mark it is possible by moving the counter weight and/or a coil to bring the pointer into line. Care should be taken to avoid causing a short circuit as the adjustment is made. This procedure should be carried out until the pointer shows correct balance in each of the four positions. If it is found that correct poising cannot be obtained the magnetic circuit of the tachometer should be carefully checked for correct assembly, and if further difficulty is experienced the magnet should be changed.

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BASIC CALIBRATION

This calibration is necessary when any component affecting the electric or magnetic circuits of the impulse tachometer is altered in any way.

The figures quoted in the following instructions will only apply to instruments which have a range of 0-8,000 rpm. For instruments having alternative ranges, eg. 0-6,000 rpm or 0-10,000 rpm the values of the calibration points on the dial should be noted and the speed of the test apparatus calculated by using the following ratios:-

	Test Apparatus	Tachometer
4 cylinder engine	1	2
6 cylinder engine	3	4
8 cylinder engine	1	1

Calibration of the impulse tachometer must be carried out with the movement mounted in the instrument case. It is therefore necessary to use a dummy case with a section cut from the side to allow the bridge spanner SR/D.360 to be fitted to the anchor plate.

4 CYLINDER 4 STROKE

Connect the impulse tachometer to the ignition pulse simulator and speedometer test apparatus as previously described in the Testing Procedure on Page 4. Switch on the supply to these units and run the speedometer test apparatus at 1,500 rpm. Using the potentiometer "L" (See Fig.1. on Page S.5) set the impulse tachometer to read 3,000 rpm and wait for two minutes to allow the equipment to stabilise. Reduce the r.p.m. of the speedometer test apparatus to 875 rpm and check that the impulse tachometer reads opposite the low calibration mark 1,750 rpm. If the impulse tachometer does not read 1,750 rpm fit the bridge spanner SR/D.360 to the hairspring anchor plate and rotate the plate in the desired direction until the pointer is in line with the calibration mark. Care should be take to avoid causing an electrical short circuit during this adjustment.

After the impulse tachometer has been checked at 1,750 rpm the speedometer test apparatus should be set at 3,475 rpm and the impulse tachometer should now read 6,950 rpm. If any adjustment is necessary at this point it can be made by adjusting the potentiometer "L" (See Fig 1 on Page S.5.) in the required direction, but, any adjustment of the potentiometer will make it necessary to re-check the calibration at the 1,750 rpm position. This cross checking should be carried out until accurate calibration is obtained at both positions. Finally, set the speedometer test apparatus to read 2,300 rpm and check the mid-calibration point on the impulse tachometer. Switch off the supply and remove the iron core, former and pulse lead.

The tachometer is now calibrated for 4 cylinder 4 stroke application.

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6 CYLINDER 4 STROKE

First calibrate the instrument for 4 cylinder 4 stroke application to ensure that the movement is poised correctly and that the pointer reads opposite each of the calibration marks.

Set the speedometer test apparatus to run at 3,000 rpm and the impulse tachometer should be reading 6,000 rpm. Adjust the potentiometer "L" (See Fig. 1 on Page S.5) to reduce the speed of the impulse tachometer until it reads 4,000 rpm and then switch off the supply and remove the iron core, former and pulse lead.

The impulse tachometer is now calibrated for 6 cylinder 4 stroke application.

8 CYLINDER 4 STROKE

First calibrate the instruments for 4 cylinder 4 stroke application to ensure that the movement is poised correctly and that the pointer reads opposite each of the calibration marks.

Set the speedometer test apparatus to run at 3,000 rpm and the impulse tachometer should be reading 6,000 rpm. Adjust the potentiometer "L" (See Fig. 1 on Page S.5) to reduce the speed of the impulse tachometer until it reads 3,000 rpm and then switch off the supply and remove the iron core, former and pulse lead.

The tachometer is now calibrated for 8 cylinder 4 stroke application.

FINAL ASSEMBLY

Carefully remove all dust particles from the assembled movement and base board, then place this sub assembly into the case securing it in position with the shakeproof washers and screws. Replace the three point terminal block, terminal insulator and rubber grommet. Carefully clean the dial, replace the slip ring and sealing washer and then fit a clean dial glass. Over the glass place a replacement bezel and spin in the manner described below.

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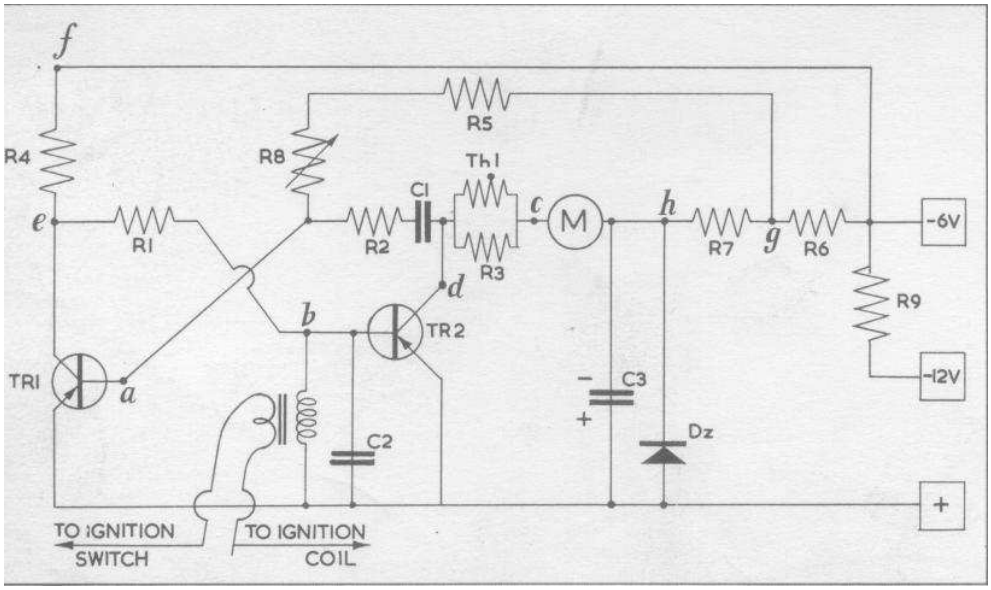
INSTRUCTIONS FOR SPINNING THE BEZEL

Set up the bezel fixture SR/D.140 on a bench with the steel plate and rubber pad to suit the tachometer; fitted in the ratchet table. Slacken the centre clamp screw and fit the wooden block over the back of the instrument. Place the instrument face down on the rubber pad, ensuring that the V bezel is seating down in the groove. The centre clamp screw can now be tightened down, so that the instrument is gripped firmly.
Set the ratchet to turn the table clockwise and loosely assemble the spinning attachment to the left hand pillar.
Slacken the feed screw right back and adjust the height of the spinning attachment, the wheel should be just above the level of the case flange.
Clamp the spinning attachment tightly to the support, so that the wheel is almost touching the bezel.
Turn the table by means of the ratchet arm, slowly tightening the feed screw at the same time. This should be continued until the bezel has been spun over, if necessary adjusting the height of the spinning attachment.
Slacken the feed screw and centre clamp screw, then remove the instrument. After spinning proceed to complete the assembly of the tachometer.

FITTING THE PULSE LEAD

Particular care should be taken when fitting the pulse lead assembly. It is essential that a good electrical connection be obtained at the iron core. Poor connection is liable to result in intermittent operation of the tachometer, particularly during high speed motoring when the tachometer is subject to increased vibration.



R. Resistor

C. Capacitor

TR. Transistor

Th. Thermistor

Dz. Zener Diode

M. Meter

a–e Reference Points

Fig.2 Circuit Diagram of Impulse Tachometer

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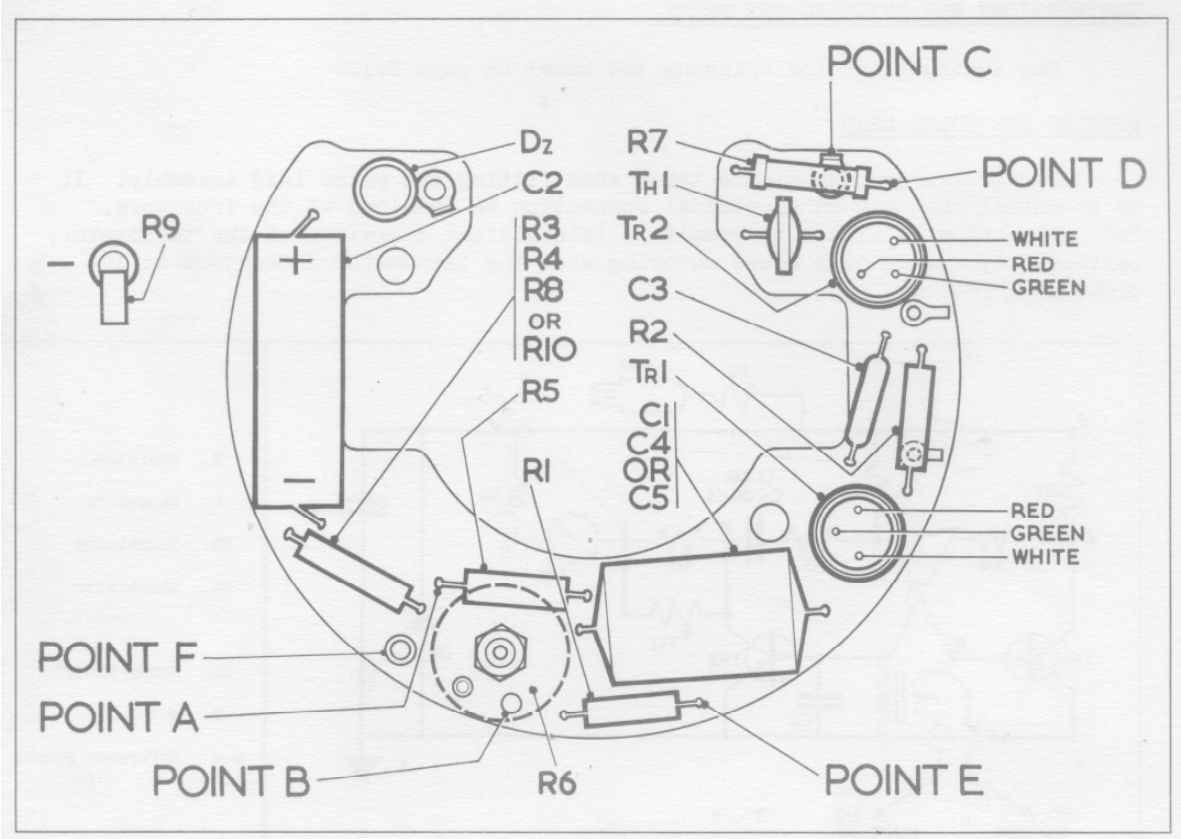

Fig.3 Printed Circuit Board Diagram

Fig.4 Ignition Pulse Simulator SR/D.347

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SYMPTOMS, FAULTS AND TREATMENT

It is possible by using these instructions to eliminate any single defective component in the Tachometer. To assist this a schematic circuit diagram showing points letter A - H is shown.

In addition to the special recalibrating equipment a good quality voltmeter suitable for reading voltage and resistance values will be necessary to locate most faults. When taking voltage checks, always take them with respect to the positive line.

SYMPTOM	FAULTS	TREATMENT
Incorrect Reading	Poor Connections	Check all connections for dry joints and also the pulse lead and iron core assembly.
	Incorrect Calibration	Check the calibration of the Tachometer as described under calibration instructions on Page S.7.
	Out of Poise	Check poising as described on Page S.7.
	Pointer Sticking	Check positioning of pointer on movement spindle and refit if necessary. Poise and recalibrate.
	Movement Assembly	Remove suspect movement and replace with a good one and check the Tachometer. Poise and recalibrate.
	C2 Faulty	If C2 has a low capacitance replace component.
No Reading	Poor Connections	Check all connections and in particular the pulse lead and iron core assembly.
	Pointer Loose	Refit the pointer. Poise and recalibrate the movement.
	Component defective R9, C3, DZ, R5, R8, R7, R6, TR1, TR2, R3, R2, Cl, C2.	Switch on the supply to the Tachometer but do not feed in a pulse. Check the voltage across DZ and if it is between 4.7V and 5.1V the meter circuit is satisfactory. If voltage is more than 5.1V replace DZ and check the Tachometer again. If the voltage is less than 4.7V check the rest of the components.

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SYMPTOM	FAULTS	TREATMENT
	Resistor R9	With the supply OFF check resistance value -6v and -12v terminals. This should be 82 ohms.
	Capacitor C3	Disconnect one side of C3 and switch the supply ON. If the voltage across Dz is between 4.7V and 5.1V, C3 is faulty. If the voltage is still less than 4.7V, reconnect and test Dz.
	Diode Dz	Disconnect one side of Dz and switch the supply ON. Measure the voltage across C3. If it is more than 4.7V change Dz, if not proceed to test R5, R8, C1, R2, R7 and R6.
	R5 and R8	With the supply OFF check the resistance between A & G. On adjusting R8 the resistance should vary between 6K and 22K. The value of R5 should read 5K.
	C1	With the supply ON check the voltage across C1. This should be at zener potential approximately.
No Reading (contd.)	C2	Check for short circuit. Replace if necessary.
	R2	With the supply OFF check the resistance between A and the left hand of C1. This should be 1320 ohms – 1080 ohms.
	R7	With the supply OFF check R7 between H & G. Resistance should be 3.3 ohms.
	R6	With the supply OFF check R6 between G & 6v terminal. The resistance should be 18 ohms.
	Component defective M, Th1, R3, TR1, TR2	With the supply ON and D shorted to earth. The Tachometer should read 8000 r.p.m. If it does the components are satisfactory, if not proceed as follows:
	Meter M	With the supply ON, short point C to earth. If the meter reads, it is satisfactory and the fault lies in R3 and it should be replaced.

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SYMPTOM	FAULTS	TREATMENT
Permanent reading on tachometer without a pulse being fed in.	Transistors TR1 & TR2	With the supply ON short point D to earth and check that the meter reads. The meter should not read when point A is shorted to earth. When A is earthed measure the voltage at E. If it is less than 1.5V change T11, if more than 1.5V change TR2.
	Triggering Coil T	Measure resistance of the coil between + terminal and B. The correct value is 120 ohms. If Correct proceed to Rl.
	Resistor R1	With the supply OFF check the resistance between E & B. Should be between 517 ohms and 423 ohms.
	TR1, R4, R5, R6 and R8	With the supply ON measure the voltage at E. If the voltage is less than 0.2 volts proceed to check TR2. If it is greater than 0.2V the fault lies in TR1, R4, R5, R6 or R8.
	R4	With the supply OFF check the resistance between E & -6V terminal. This should be 750 -900 ohms.
	R8 & R5	With the supply OFF check the resistance between A & G. On adjusting the potentiometer the resistance should vary between 6K and 22K. The value of R5 should. read 5.1K.
	R6	With the supply OFF check resistance between G & -6V terminal. This should be between 16 ohms and 20 ohms. If R4, R5, R6 and R8 are satisfactory change TR1.
	TR2	With the supply ON short B to earth. If the meter still reads, replace TR2 and then check that the meter reading falls to zero. If after shorting B to earth the meter does not fall to zero, recheck TR1, R4, R8, R5 and R6.

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