# A GENTLEMAN'S GUIDE TO *CLASSIC* SMITHS ELECTRONIC TACHOMETERS


Pictured tachometers
Top left – RVI 2631/00 Gen-2 Triumph 2.5 PI tachometer,
Top right –,RVI 1003/04 Gen-1 accessory tachometer
Bottom left – RVI5000/00B Gen-2 accessory tachometer
Lower right – RVC2611/00F Gen-4 Triumph 2500S tachometer

**Author: Alex Miller**
**Email:** **lxmiller@kinect.co.nz**

**CONTENTS:**

## PREFACE:

This document, Version 4, is less a revision but rather a strip-down and rebuild. Along with the name change to "Gentleman's Guide to **Classic** Smiths Tachometers", some re-ordering of the information has been done to make it more "user friendly".

The original intent in writing this document was to produce a guide that would provide some background to these tachometers and enable an operable Smiths tachometer to be identified and fitted to a vehicle and to get it running without removing the works from the case.

As a result of queries arising from earlier editions of this document, additional explanation has been added to correct and/or clarify the information presented. Some more technical information has also been added. This revision attempts to re-create this original intent. Most of the added technical information has now been relocated from the main body of the text to Appendix F. It is still available if wanted.

I would like to thank, particularly, Mark Olson of Accutach in California and Tom Hayden of Ohio for tips, comments made and suggestions they have provided. Thanks also to all those who contacted me with queries highlighting areas that needed clarification. Special thanks also to Phil Turnbull who provided much information for Appendix F.1 on the early pattern meters.

### GLOSSARY OF TERMS:

| | |
|---|---|
| Accessory | Here, a tachometer that is sold as an add-on device not supplied in the original vehicle model. ***Accessory tachometers have the power supply leads isolated from the instrument case.*** |
| c | "Circa" = "about" as in c[value]; an approximation to some value. e.g. c1962 means about 1962 but may have been late 1961 or early 1963. |
| fs | Full scale: The maximum value printed on an instrument's dial |
| Iron core | A critical part of the Gen-1 tachometer pulse lead assembly that couples the magnetic field generated by the electric current flowing in the pulse lead to the pick-up coil inside the tachometer. (*Refer Appendix D*) |
| mA | "milliamps": the measure of electrical current used in this document |
| OEM | Original Equipment Manufacturer. As used here, denotes a tachometer supplied by Smiths to a car manufacturer for installation in production vehicles. ***OEM in-dash tachometers always have one of the power supply connections internally connected to the instrument case.*** |
| Polarity | The sense of the electrical connections in a vehicle or devices connected to it. For a vehicle, "positive earth" and "negative earth" identify which terminal of the battery is connected to the chassis.<br>Also the electrical sense of the pulse lead in RVI tachometers. (*Refer Appendix F.3*.) |
| Pulse lead | A wire that connects a tachometer to a vehicle's ignition system. For RVI tachometers, this wire is in series with the ignition coil and carries the ignition coil current. For RVC tachometers it is a wire between the switched side of the ignition coil and the "Trigger" terminal of the tachometer. |
| RVC | Smiths prefix for the later electronic tachometers. **R**evolution counter **V**oltmeter **C**ontact breaker |
| RVI | Smiths prefix for the later electronic tachometers. **R**evolution counter **V**oltmeter **I**mpulse. |

**Note: Smiths also manufactured other tachometers – Diesel, Industrial and Marine - that are not dealt with here.**

## ERRATA:

Earlier versions of this guide stated that the RVI5000 series tachometers would operate on 6 or 12 Volts. This is incorrect. Refer section 4.2 for details.

# 1 INTRODUCTION:

Smiths Motor Accessories produced a variety of tachometers, not to mention a wide range of other automotive instruments, over the years. Many English and European cars were fitted with these devices and electronic tachometers were also sold as accessory instruments. In some cases, the original equipment instruments were branded "Jaeger" but were otherwise the same. There are three broad classes of tachometer (and speedometer) – mechanical, electrical and electronic.

**Mechanical, cable-driven tachometers were of three types:**

| Type | Identification | Approximate usage period |
|---|---|---|
| Governor | X.nnnnnn | Supplied from 1920 (or earlier) to late 1940s |
| Chronometric | RC nnnn | Supplied from 1930 to 1970s |
| Magnetic | RN nnnn<br>RSM nnnn | Supplied from 1940s to mid/late 1970s<br>RSM only used for motorcycles |

The above tachometers had the same internals as the comparable speedometer, without the odometer components, and were driven by a cable connected to the camshaft or distributor. The chronometric type was mostly found on motorcycles although chronometric instruments were frequently fitted to "competition" cars due to their excellent accuracy. ***(Some faultfinding information for cable-driven instruments is provided in appendix C to this document.)***

**Two classes of electrical tachometer are found:**

| Type | Identification | Approximate usage period |
|---|---|---|
| Voltmeter | RV nnnn (early Xnnnnn & Znnnnn) | Supplied from 1959 to late 1960s |
| Electromag | RE nnnn | Supplied from 1950s to 1970s |

RV electrical tachometers are mostly found on Jaguar/Daimler vehicles. These use a generator mounted on the engine, driven by the camshaft, and the indicator is a voltmeter that measures the voltage produced by the generator but calibrated in rpm rather than Volts. Most of these tachometers use the same style meter movement as used in the later Smiths electronic tachometers up to the early 1970s.

Electromag instruments were a hybrid electro-mechanical instrument only ever fitted to commercial vehicles, primarily Leyland, and comprised a multi-phase generator as a sensor and an electric servo-motor driving a magnetic movement to indicate speed or rpm.

Later electronic tachometers used transistors and integrated circuits to eliminate expensive transmitters and drive cables. These electronic instruments could be readily fitted to any car, either as original equipment or as an aftermarket accessory. Various types were manufactured by Smiths. The RVI and RVC types detect pulses generated by a Kettering-type ignition system. RVP and RGP diesel tachometers require a pulse generator to be fitted to the engine.

**Electronic impulse tachometers:**

| Type | Identification | Approximate usage period |
|---|---|---|
| Current sense | RVI nnnn | Supplied from mid 1960s to early 1970s<br>Two distinct types of RVI were produced but external wiring is the same for each. |
| Contact (voltage) sense | RVC nnnn | Supplied from early 1970s |
| Pulse generator | RVP nnnn<br>RGP nnnn | Used for commercial diesel vehicles and worked with an external generator similar to the RV device. Both 12V and 24V instruments are found. |

"Classic" RVC tachometers were produced into the 1990s. Larry Dalphy, from California, has advised me of a Caerbont RVC1490/00C, 4 cylinder, 7000rpm tachometer using a thick film circuit board with a production date code of March 1993 that he received for repair.

***The remainder of this document will deal mainly with RVI and RVC electronic tachometers. Some information on other Smiths tachometers is provided in the appendices***

## 1.1 SCREW THREADS USED IN SMITHS INSTRUMENTS:

Smiths instruments, up to at least the mid 1970s, used "British Association" (BA) threads for speedometers and tachometers. Though in less common use now, they are still used in model engineering and can be frequently found at hobbyist/model engineering suppliers.

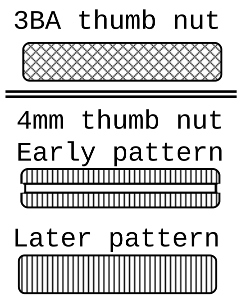
BA threads are a metric thread but dimensions are frequently given in imperial (inch) units. Sizes range from 0BA (6mm/0.2360 inch dia.) to 16BA (0.79mm/0.0310 inch dia.) Some sources list sizes down to 25BA (0.25mm/0.010 inch dia.). Odd numbers in the range are less commonly used and sizes commonly used by Smiths in their instruments are **3**, **4**, 5, **6**, 8, and **10** BA. Bold numbers are those found in electronic tachometers.

BA threads were employed up to the Gen-4 type, which used metric threads internally.

Those thread sizes used are set out below:

| **Gen-0 to Gen-3 screw threads** | | | | |
|---|---|---|---|---|
| Function | Thread diameter | Length | Notes | Location |
| Dial screws | 10BA | 8 - 10mm | Steel (coloured) | Internal |
| Circuit board to meter | 4BA | 6.4mm | Alloy or brass | Internal |
| Meter bridge screw | 8BA | 8.3mm | Special shouldered screw | Internal |
| Potentiometer mounting | 6BA | Nut | Brass | Internal |
| Meter iron core | 6BA | 9.9mm | Brass countersunk head | Internal |
| Meter to case | 4BA | 10mm | Brass | External |
| Gen-1 Terminals | 4BA | Threaded sleeve/Nut | Brass | External |
| Gen-1 pulse loop assy retaining nut | 6BA | Nut | Brass knurled thumb nut | External |
| Case clamp fixing | 3BA | Nut | Alloy Thumb nut | External |

| **Gen-4 screw threads** | | | | |
|---|---|---|---|---|
| Function | Thread diameter | Length | Notes | Location |
| Dial screw | 2mm | 5mm | Steel (coloured) | Internal |
| Meter assembly | 3mm | 14mm | Brass | Internal |
| Magnet & baseplate to frame | 3mm | 14mm | Brass | Internal |
| Meter to case | 3mm | 14mm | Brass | External |
| Case clamp fixing | 3BA | Nut | Alloy thumb nut | External |
| Case clamp fixing | 4mm | Nut | Alloy thumb nut from late 1970s | External |




Case clamp fixing thumb nuts varied between years and instruments. For electronic tachometers prior to Gen-4, 3BA threads are used. A cross-hatch knurl pattern is used on thumb nuts for most of these.

For Gen-4, 3BA threads continued to be used initially but on later instruments 4mm threads are used and thumb nuts have a shallow groove in the centre of the knurling and a ribbed pattern. The 4mm studs affixed to the case have bright plating. Later still the groove was dropped.

Unfortunately the above holds true only in *most* cases. Alloy 3 BA thumb nuts with a ribbed knurl do exist. Best idea is to keep nuts with their cases! Brass thumb nuts were used on older instruments. Ribbed knurl on these is usually 3 BA. But no guarantees!

3BA has an outside diameter of 4.11mm and 4mm shakeproof washers work well to secure the case mounting nuts.

# 2 IDENTIFYING A TACHOMETER:

Mark Olson of Accutach uses a scheme for categorising the different Smiths tachometers and I am not about to re-invent the wheel so I have used his system within this document. Mark's document can be found at https://accutach.com/smiths-tachs and it is well worth looking at. To summarise, tachometers are classed as three "generations", to which I will add three further classes, generation 0, generation 0.5 and generation 4. These generations are:

**Generation 0** (**RV**) **‡** - an electrical tachometer which required a generator producing a voltage proportional to r.p.m. Circuitry comprised a full-wave (bridge) rectifier and a wire-wound calibration resistor. These instruments are mainly found in Daimler/Jaguar cars of the 1950s to 1960s. The movement in instruments produced after c1962 is physically the same as that used in generation 1 to 3 instruments.

**Generation 0.5 (marked "RV") ‡** – This was a Smiths RV electrical tachometer head coupled with a remote sender module. (Smiths Equipment Schedules **do not** list the remote sender, implying that Smiths did not manufacture it, though the circuit is very similar to that of the Gen-1 tachometer.) This sender connected to the ignition system by a single connection to the distributor side of the ignition coil. Refer Appendix F.2.2, RV 1310/00 series tachometers fitted to early sixties Volvo sports cars".

**Generation 1** (**RVI**) the first electronic Smiths tachometer which had its electronics mounted within the tachometer head and used two transistors in a monostable multivibrator configuration. These instruments have an inductive pickup within the instrument to sense ignition current. The transformer primary connection was by way of a loop of wire in series with the ignition coil and attached to the instrument on the rear of the case.

**Generation 2** (**RVI**) – also used inductive coupling to the ignition system but used a single transistor in a blocking oscillator circuit. The transformer primary winding was inside the case and connected to the car wiring via two bullet connectors – one male, one female – mounted on the rear of the case. The meter was physically the same as used in Gen-1 & 3 but was electrically incompatible due to the very low resistance coil.

**Generation 3** (**RVC**) – sensed voltage spikes at the coil to trigger the instrument. An integrated circuit is used to drive the meter. Connection to the coil was by either a single bullet connector on the rear of the case for the OEM type or to a spade terminal for the accessory tachometer.

**Generation 4** (**RVC**) – A new meter movement but a similar circuit to the Gen-3 tachometer and using the same integrated circuit and voltage sensing. Meter mounting screws form a "Y" pattern rather than the previous rectangular pattern. The printed circuit board of the earlier tachometers was replaced with a "thick-film" board.

The first thing to do when fitting these tachometers is to determine what type (Generation) of tachometer you have and, in the case of Gen-1 and Gen-2 OEM tachometers, whether it is configured for positive earth or negative earth vehicles. All cased OEM tachometers are polarised with one side of the power supply connected to the metal case. This may be marked on the dial but not always. Early OEM tachometers are configured for a set number of cylinders and with limited range of calibration adjustment. To re-configure these may require a component change on the circuit board inside the case.

Accessory, or aftermarket, type tachometers do not have the internal electronics connected to the case as do OEM instruments and thus can be readily fitted to a vehicle of either chassis polarity.

Tachometers with a part number suffix "CA" or "CB" are modern units manufactured by Caerbont Automotive Instruments and are not dealt with in this document.

***‡ Refer also to Appendix F.1. "Early pattern Gen-0 and Gen-0.5 meters".***

# 3 THE SMITHS GEN-1 RVI ELECTRONIC TACHOMETERS:

The “RVI” tachometers sensed ignition system current using a transformer to transfer pulses to the tachometer circuitry without any direct electrical connection to the ignition circuit. These tachometers are identified by the letters “RVI”, followed by numbers, printed on the dial. These identification characters are sometimes printed on the edge of the dial and may be hidden in normal use by the instrument bezel and dress plate.

As noted earlier, there are two quite different versions of the RVI tachometer. These can be differentiated as follows:

The “early” or Gen-1 type instrument has a pulse lead looped through a small nylon block and iron core (metal clip) assembly outside the case.

The “later” or Gen-2 type instrument has two bullet type connectors for the pulse loop protruding from the rear of the case.

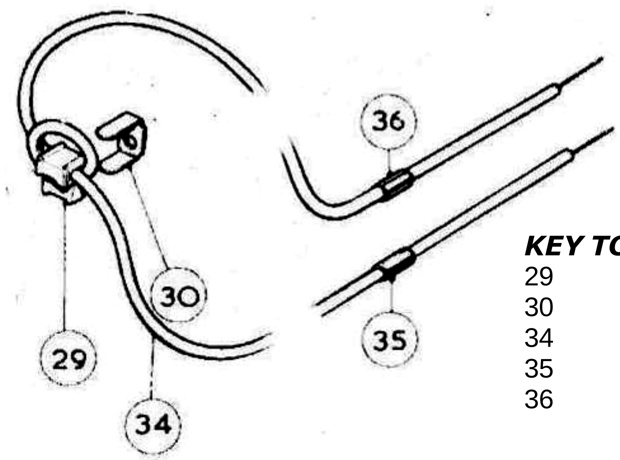
There is no difference in the external wiring between the Gen-1 and Gen-2 type tachometers. The pulse leads are placed in series with the coil, either in the coil supply lead from the ignition supply to the coil or between the coil and the distributor. The sense, or polarity, of pulse leads is critical to the operation of both types. *(Refer also Appendix F.3 “ Smiths RVI tachometer triggering”)*

There is nothing special about the Gen-1 pulse lead wire, so if in poor condition or to eliminate unnecessary joints, replace with a new length of wire to avoid later problems. Use 16 AWG/1.5 mm.

*Fig.3.1* shows the wiring for the pulse lead assembly attaching to the back of Gen-1 instruments. Accessory type instruments had coloured markers at the end of the long pulse leads when new but these markers were almost always cut off when the tachometer was fitted to a vehicle.

***Without the iron core, the Gen-1 tachometer cannot work!*** One could easily be made if required. (*See Appendix D to this document for details.)* This “little bit of tin” completes the magnetic circuit that allows the tachometer to sense ignition pulses.

The plastic former shown in *fig. 3.1* holds the pulse lead in place to prevent the wire chafing against the iron core.




***KEY TO FIGURE 4.3:***

29 Plastic former
30 Iron core
34 Pulse lead
35 Black marker - negative
36 Red marker - positive.

***FIGURE 3.1:*** Gen-1 RVI pulse lead assembly. Note how the pulse lead is threaded through the plastic former. When replacing this lead try to route the wire the same way which may save some trial and error when re-fitting. (*Drawing from Smiths service manual.)*

If you have replaced the pulse lead on a Gen-1 tachometer you may have reversed the magnetic field generated by the pulse lead/iron core assembly. This will require swapping the ends of the pulse lead. Or rethread the wire in the plastic former as in *fig.3.2*.

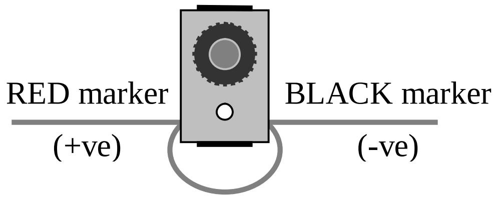



***FIGURE 3.2***: Sketch of pulse lead assembly as mounted, from rear of tachometer. Positive end of lead enters plastic former from the left through upper hole, loops and exits through lower hole at right.

## 3.1 RVI GEN-1 OEM TACHOMETER:

Early OEM and Accessory tachometers used two distinct electronic circuits. Later on, a “rationalised” movement was used in both types. In most, if not all, cases the “red-line” will be marked on the dial of an OEM tachometer and its polarity may also be marked as shown in *fig. 3.3*.

If you have a Gen-1 OEM tachometer that is marked “Positive Earth” and the number of cylinders and the part number is of the form “RVI nnnn/nn” with no following characters, then it may require internal component changes to calibrate to an engine having a different number of cylinders. It won’t hurt to try recalibrating it as it is. If this is successful then you are good to go. If however the part number ends with an alphabetic character, “A” or “B” as in “RVI nnnn/nn**A**” then the tachometer has the “rationalised” movement and recalibration for a different number of cylinders should be readily done.

Accessory instruments initially worked on 6V or 12V systems and could readily be calibrated to four, six or eight cylinder engines. The later “rationalised” OEM instruments had a wider range of calibration but internal changes in the accessory type instrument no longer accommodated 6V operation (Also refer Appendix F.3.)

**<u>CAUTION:</u>**

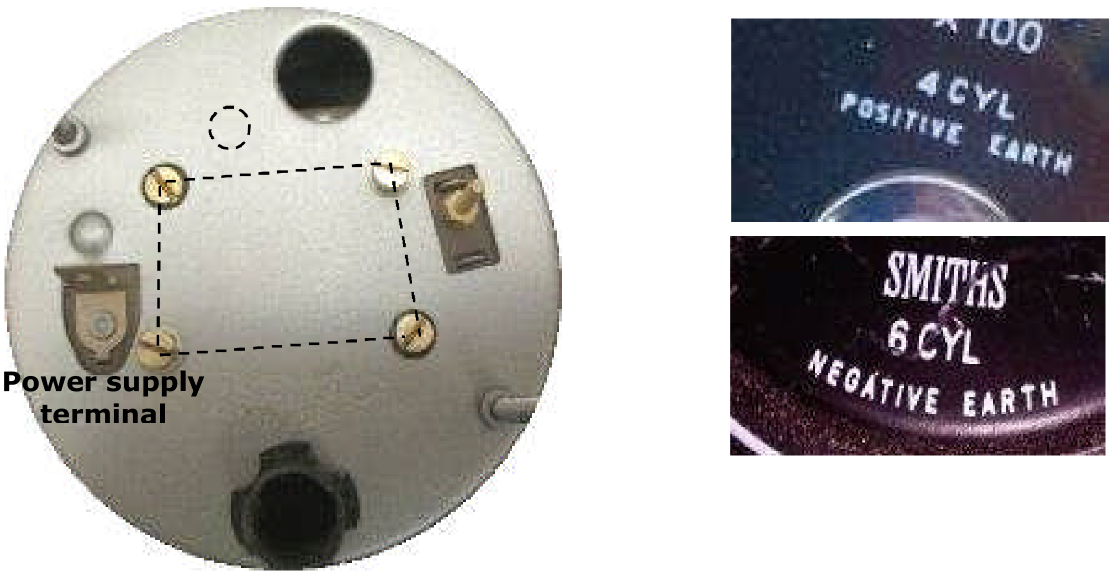



***FIGURE 3.3:*** Rear view of the Gen-1 OEM tachometer which has one of the power supply connections internally connected to the metal case. Dashed lines show the “rectangular” layout of the meter mounting screws used in all tachometers prior to Gen-4. Dashed circle shows approximately where the calibration access hole would be when provided. (*See also Appendix E.*)

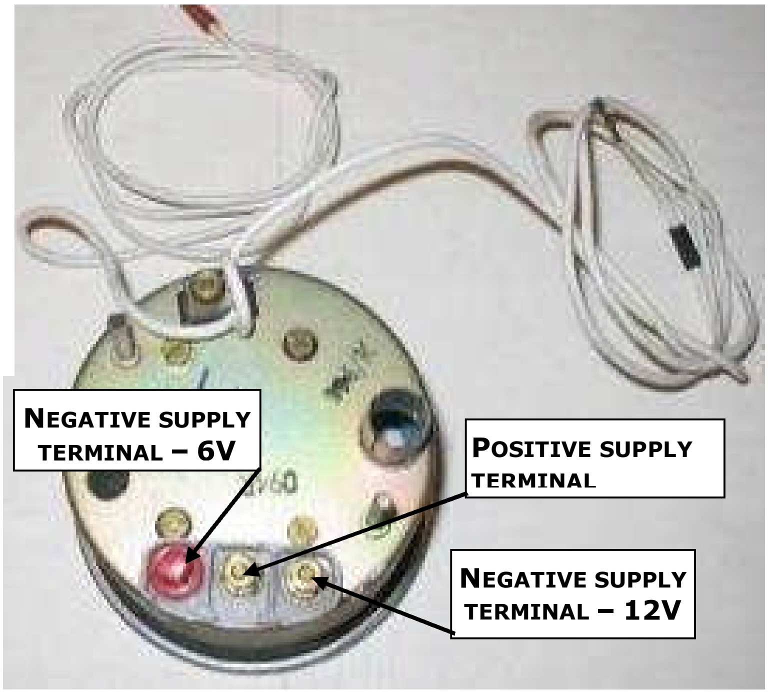
If the connections on the back of the tachometer look like those in *fig 3.3*, be very careful. This type of tachometer was produced in both positive and negative earth versions.
Some positive earth instruments may have been internally converted to negative earth. If you are buying a second-hand tachometer, marked “positive earth”, check with the seller as to the

electrical polarity of the vehicle it came from or test as set out in *Appendix B, "Checking an electronic tachometer"* later in this document

## 3.2 RVI GEN-1 ACCESSORY TACHOMETER:

Accessory tachometers, *fig. 3.4*, have no internal electrical connection to the case. Two or three terminals for power supply connection are provided as can be seen in the lower part of the picture. This particular example has two connection terminals, the third terminal, covered by a red plastic cap here, was the — 6V connection for the earlier tachometers but disconnected internally on later 12V only instruments. The centre terminal is the positive connection.

***FIGURE 3.4:*** Gen-1 accessory tachometer. 3 inch diameter instruments produced with full scale readings of 6000, 6500, 7500, 8000 and 10000 rpm.
Note that the tachometer shown below, a RVI 1000/00A (12V only), does not have the optional adjustable redline pointer that is shown on the RVI 1003/04 on the cover page. The RVI 1002/00(A) tachometer is the equivalent tachometer (8000 rpm fs) fitted with the adjustable redline pointer.

# 4 RVI GEN-2 TACHOMETERS:

Gen-2 OEM tachometers were, in the majority of cases, negative earth instruments. The RVI 2423/01 tachometer fitted to some MG vehicles is an example of a positive earth tachometer of this type. There are also "caseless" instruments, notably the RVI 2832/00A fitted to the Rover P6 3500 saloon. Refer also to Appendix F section F.6 for information on the two circuit board types used in these tachometers.

Most were produced as 4 inch diameter instruments but both 3 inch (Rover P6 2000/2200 cars) and 5 inch (Daimler/Jaguar cars) were also manufactured.

## 4.1 RVI GEN-2 OEM TACHOMETER:

The annotated photograph in *fig. 4.1* shows the connections to a later negative earth RVI tachometer.

Gen-2 tachometers have the pulse coil assembly inside the case with connections brought out to bullet connectors as shown.

Note the yellow object inside the case and labelled "Calibration adjustment". This adjustment, requiring only a small blade screwdriver, is often covered with a piece of adhesive paper or in some cases, a rubber plug. In some tachometers there may be no access hole provided.

When finally fitting the tachometer to the vehicle, replace the rubber plug or place a piece of adhesive tape over this hole to keep dust out.

**On negative earth instruments the male pulse lead connector here goes to the power supply, the female connector connects to the coil.**

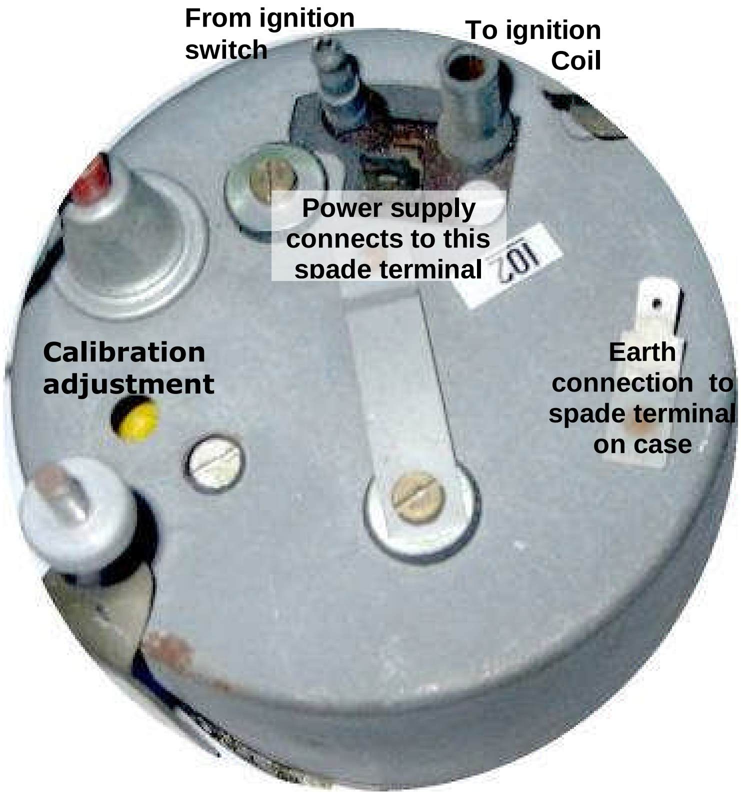



***FIGURE 4.1:*** Typical Gen-2 OEM tachometer.

***FIGURE 4.2:*** Example of a 3 inch diameter Gen-2 OEM tachometer as fitted to some Rover P6, Series 1 and Series 2 2000/2200 cars fitted with the Smiths "Ribbon" ("strip") speedometer.

This particular example, RVI 1050/06A, has the early production circuit board fitted so could be configured for positive or negative earth, though this requires that the works are removed from the case. (*For more detail refer to section "F.6 Gen-2 circuit board types" in Appendix F.*)

Rover P6 2000/2200 cars to early 1966 are positive earth vehicles.

## 4.2 RVI GEN-2 ACCESSORY TACHOMETER:

Smiths produced a plastic cased "pod-style" instrument in the Gen-2 range. This was the RVI 5000 series accessory tachometer and is shown in *fig. 4.3* at right. ***Contrary to what was written in earlier versions of this guide, this tachometer is only suitable for use on vehicles with 12 Volt electrical systems***.

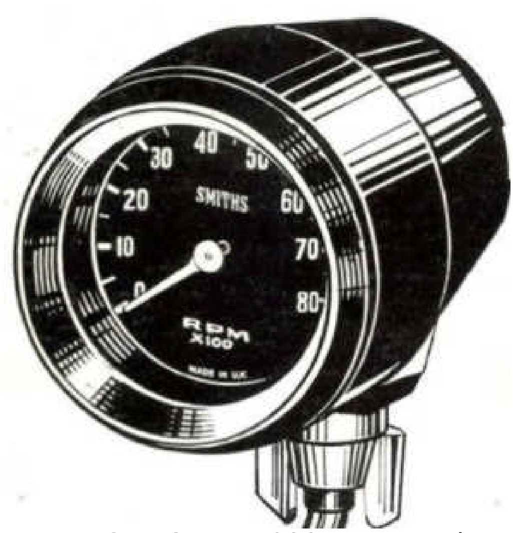



***FIGURE 4.3:*** Gen-2 RVI 5000 series tachometer

Tachometer mounting requires a 12mm diameter hole is drilled into the dashboard or mounting panel.

Bezels may be of black plastic only or fitted with matt or bright chrome dress rings.

Pulse leads are white and, when new, are marked with short red and black sleeves near the end of the wires. The red marked pulse lead should connect (for a negative earthed vehicle) to the ignition supply or the coil "CB" or distributor terminal. Accessory types are designed for 12V supplies.

Isolation of the internals from the vehicle chassis allowed these to be fitted to both positive and negative earth vehicles. These tachometers were also fitted to some Volvo vehicles as standard equipment and marked RVI 541n/nn. (There may be additional part numbers for OEM. series 5000 tachometers.) The differences between the accessory and OEM versions are the provision of an additional connection for use with 8 cylinder engines (marked "8 CYL") at the rear of the accessory tachometer, omitted in the OEM instruments as shown in *fig.4.4*.

The rear case cover simply pops off to provide access.

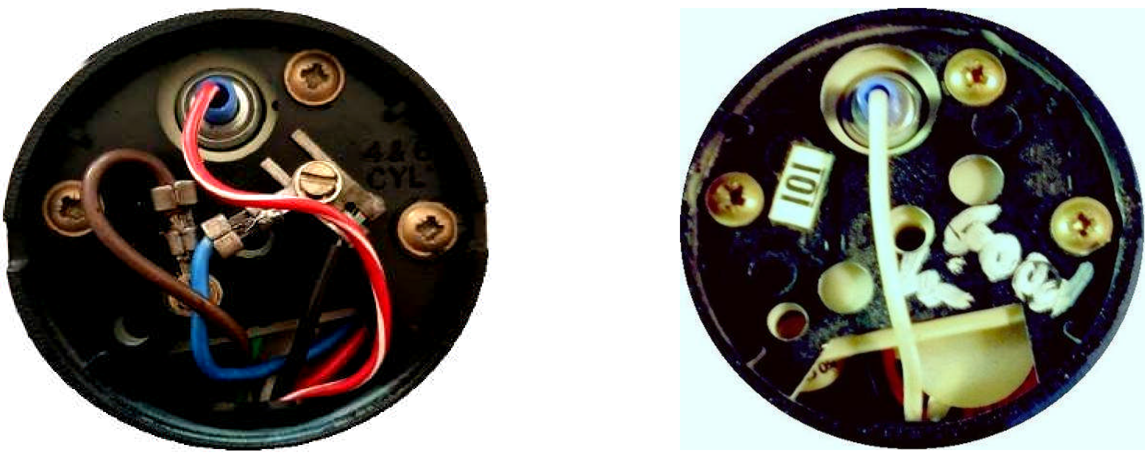



***FIGURE 4.4***: RVI 5000 series tachometer. At left is the rear view of an accessory tachometer, with the rear cover removed and showing the cylinder select terminals. **The blue wire is the -12V connection for 4 & 6 cylinder engines, the brown wire for 8 cylinders. Not, as previously written, for voltage selection!** The black wire is the lead to the vehicle's earth connection and internally connects only to the barrel of the lamp holder. Ensure that the connectors on the Blue and Brown wires do not move and short together! The internals are electrically isolated from the car and a green wire is provided as a dedicated earth for the light and is to be connected to the car's chassis.

The right-hand picture shows the same view of an OEM instrument without the cylinder select option. (*Right-hand photo supplied by Mark Olson*)

# 5 SMITHS RVI NEGATIVE EARTH TACHOMETER WIRING:

While there are significant internal differences between the Gen-1 and Gen-2 tachometers, they connect to the vehicle in the same way and the terms "OEM" and "accessory" are used to differentiate between the wiring configurations usually used in each case. These two wiring configurations are shown in *figs 5.1 and 5.2* below. Irrespective of which wiring option is used, the current drawn by the ignition coil, ***and only the current drawn by the ignition coil***, must pass through the pulse lead.

***Any ignition system that does not permit the RVI tachometer's triggering transformer to fully magnetically energise, or to "de-energise" will adversely affect operation.***

Both the power supply to the tachometer and the pulse lead sense are polarity sensitive. ***Connecting the tachometer supply with the wrong supply polarity will damage the tachometer, so make absolutely certain that it is connected correctly before powering up.***

Connecting the pulse lead with the wrong polarity will not damage the tachometer but it will not work. If an RVI tachometer is known to be good and does not operate when installed in a vehicle then swap the pulse lead connections. The tachometer should now work.

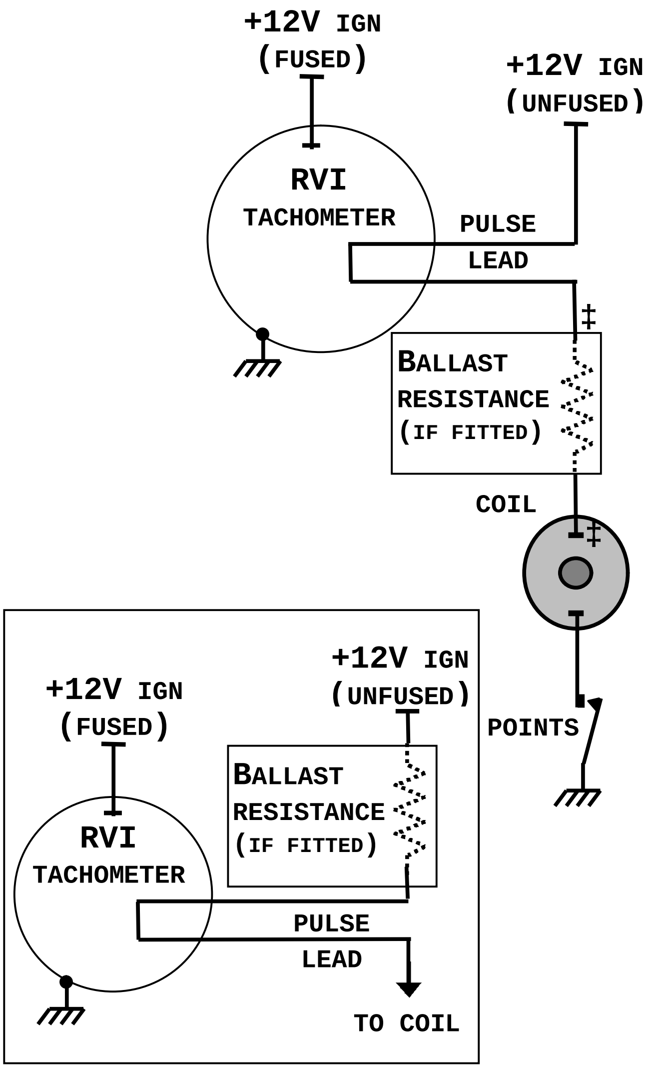



*FIGURE 5.1:* **OEM-STYLE WIRING: (NEGATIVE EARTH)**

The pulse lead is connected in the supply to the ignition coil. Ignition coil supply is taken from the (un-fused) "Ign" terminal on the ignition switch or electrically equivalent location.

An alternative wiring method for a ballasted ignition system is shown inset at lower left

Tachometer supply is taken from an ignition-controlled source through a fuse.

This wiring configuration is used where tachometers are fitted to a vehicle by the manufacturer and may not be easily duplicated for an aftermarket tachometer where existing wires may be joined within the vehicle's wiring loom.

Do not use the coil supply terminal or the ballast resistor terminal, marked "‡" on the diagram, to connect any other accessory circuits. This will almost certainly prevent an RVI type tachometer from working!

***For an accessory type tachometer, the earth connection will be to a terminal on the tachometer and not to the case as shown here.***

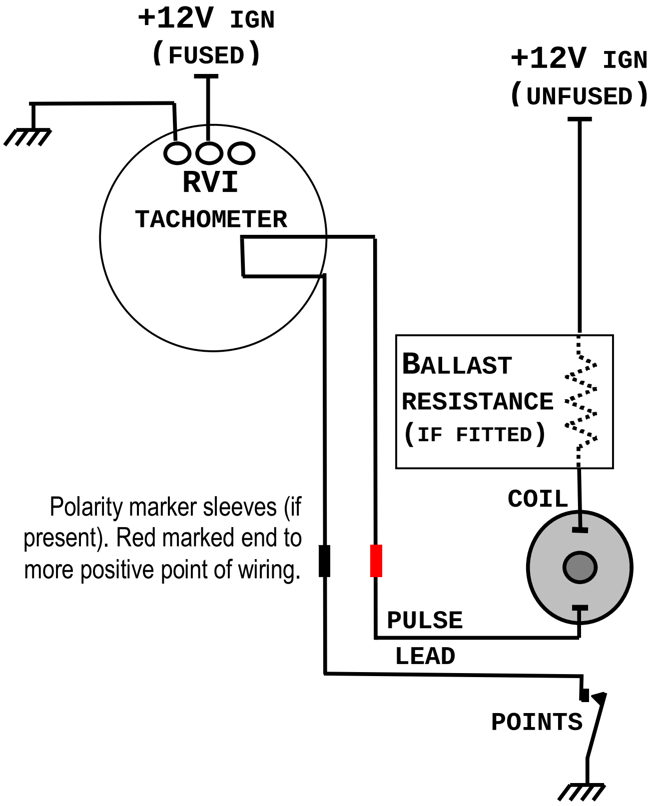



*FIGURE 5.2:* **ACCESSORY-STYLE WIRING.**

The pulse lead is connected between the coil and the distributor, replacing the existing wire. This configuration guarantees that only the coil current passes through the pulse lead so tachometer operation is not affected by additional electrical loads connected to the coil supply terminal.

Tachometer supply is again taken from an ignition-controlled source through a fuse. If no fuses are fitted in the vehicle, then fit an in-line fuse to supply the tachometer.

***For an OEM type tachometer, the earth connection will be to the case and not to a terminal as shown here.***

**NOTE:** If the car is fitted with a ballasted ignition coil then the ballast resistor must be left in circuit as shown. The tachometer will still work. The system may use a ballast resistor or a resistance wire, often yellow or pink, embedded in the wiring loom. A ballasted system has a lower voltage coil with a series resistance (ballast) to limit current. At a continuous 12V, this coil is unlikely to last long. So if making modifications to the wiring a vehicle, make sure that you do not unintentionally bypass a ballast resistor.

Where points have been replaced by a solid-state switch (TAI), these tachometers will still work. They will not work with capacitor discharge systems or similar ignition systems that drive the coil directly.

To wire accessory tachometers for a positive earth vehicle, simply swap the power supply leads and also swap the pulse lead connections.

**INSTALLATION WHERE A RADIO IS FITTED TO A VEHICLE:**

In the document "SMITHS_Industries_Supplementary_Instruments_Fitting_Instructions" Ref. No. S.6089, from about 1970, the following advice was provided.

> *"Where a radio is fitted it is recommended that, in order to achieve maximum radio suppression, the lead connecting the CB terminal on the coil to the contact breaker terminal on the distributor is left intact. Instead the lead to the SW terminal from the ignition switch should be disconnected at the coil end and the pulse lead with the black market connected to it. The pulse lead with the red marker should then be taken to the SW terminal on the ignition coil. For negative earth application the pulse leads should be reversed."*

This change describes the "OEM" style wiring as set out in *fig. 5.1* previously.

## 6 THE SMITHS RVC ELECTRONIC TACHOMETERS:

Where the RVI tachometer senses current in the ignition circuit, the RVC type senses voltage pulses at the coil. RVC tachometers will work with most ignition systems. The pulse sensing is via a single wire connected to the distributor side of the ignition coil and requires no further modification of the cars wiring beyond providing power and light to the unit. The current loop of the RVI instruments is no more. All OEM. RVC instruments are negative earth.

Internally these instruments are very different to RVI instrument. An integrated circuit is used rather than the discrete transistors used previously. There are also significant internal differences between Gen-3 and Gen-4 instruments though external connections were the same.

### 6.1 RVC GEN-3 OEM TACHOMETER:

The Gen-3 instruments retained the same style meter as previous models. Pointers and dials could be swapped between Gen-3 and the earlier instruments if desired. This ability permitted the works and case from a Gen-3 RVC tachometer to replace an earlier RVI tachometer.

The early model RVC tachometer, with meter mounting holes in a rectangular pattern, is known to have been fitted to MG and Jaguar vehicles in the early 1970s. The "MGB-style" shown in *fig. 6.1* looks almost identical to the Gen-2 RVI model except that the dial is marked "RVCnnnn/nn" and the female pulse lead bullet connector is replaced with a rubber plug. OEM instruments retained the bullet style connector for the pulse lead in most cases.

Jaguar vehicles used this same model tachometer with the pulse and supply leads brought out to a 4-pin connector with a white wire looped between two of the pins as in *fig. 6.2*.This arrangement allowed the later tachometer to be fitted with minimal wiring changes.

Note that caseless instruments of this type were also manufactured. The later Rover P6 3500 cars are fitted with the RVC 2812/00 caseless tachometer.

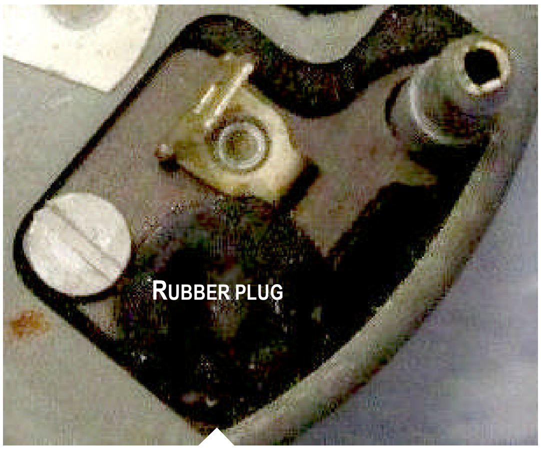



***FIGURE 6.1:*** Rubber blanking plug here in lieu of female bullet connector on the RVI tachometer.


***FIGURE 6.2:*** Jaguar Gen-3 RVC tachometer. *Photograph courtesy of Mark Olson, Accutach.*

### 6.2 RVC GEN-3 ACCESSORY TACHOMETER:

A cylinder select switch was provided and accessed via a hole in the back of the tachometer case.

Power and trigger connections were by way of three spade terminals having the same configuration and wiring as for the later Gen-4 instrument.

## 6.3 RVC GEN-4 TACHOMETER:

The Gen-4 instrument was the last of the "classic" Smiths tachometers. Electronics were now effectively a single component and a new type of meter (for Smiths) was used. The mounting screws for the meter were now of a "Y" pattern rather than the rectangular pattern of earlier instruments. There were also changes to the taper on the meter spindle and the positioning of the dial mounting screws. You cannot readily fit an earlier dial or pointer to a Gen-4 tachometer.

These tachometers were calibrated at production and no provision for user re-calibration was provided. The internal construction was such that slight changes in calibration only were possible to allow for manufacturing tolerances when replacing the electronics board.

## 6.4 RVC GEN-4 OEM TACHOMETER:

Connections in a late model RVC OEM device consist of a blade connector for power supply, a smaller blade connector spot-welded to the case for negative (earth) connection and a single "bullet" type connector for the pulse lead as shown in *fig. 6.3* at right. The "Y" mounting screw layout of the Gen-4 instrument is plain to see here (dashed lines).

There were also caseless versions of the Gen-4 instruments manufactured. Gen-4 caseless instruments, e.g. RVC 6419/00F, were fitted to Triumph TR7/TR8 cars.

Gen-4 OEM tachometers cannot readily be recalibrated. Circuitry is mounted on a thick-film board and is specific to the number of cylinders and tachometer full-scale value.

Two different meters were used in the Gen-4 tachometer. Construction of the meter was changed as was the resistance of the meter coils.

Fig. 6.4 below shows the two styles of meter fitted to Gen-4 instruments.

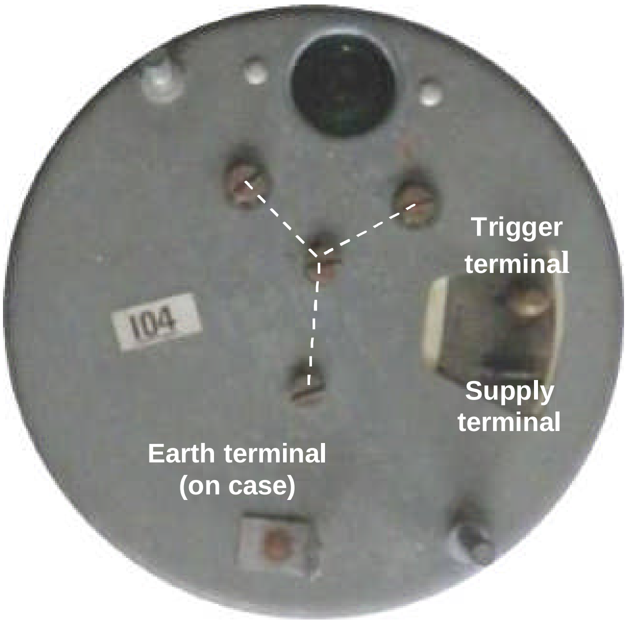



***FIGURE 6.3:*** Gen-4 OEM tachometer showing terminals. Dashed lines show "Y" shape of the meter mounting screw pattern.
The screw at the centre of the Y does not need to be removed when removing the internal works from the case.

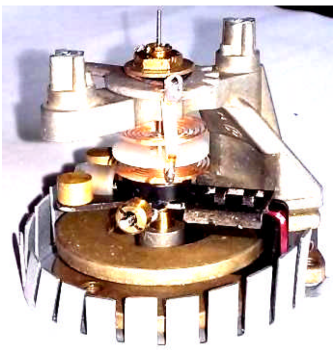
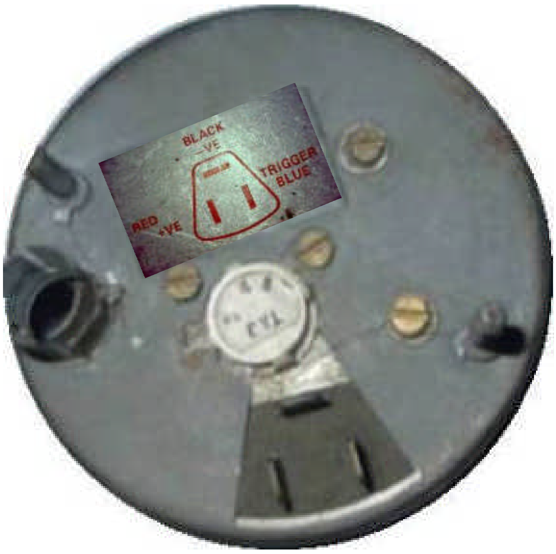


***FIGURE 6.4:*** Gen-4 meter showing difference in the field plate between the earlier style at left and the later at right. Early coil has a resistance of c155 Ohms; the later coil is c205 Ohms.
Balance of the early style meter is adjusted by threaded weights. The later meters have balance weights crimped in place and cannot be adjusted.
The early Gen-4 tachometers are marked "RVC nnnn/nn**F**". The later, "RVC nnnn/nn**AF**".

## 6.5 RVC Gen-4 Accessory Tachometer:

*Fig. 6.5* below shows the rear of the "accessory" type Gen-4 tachometer. As with earlier accessory instruments, the electronics inside are electrically isolated from the case.




Note the white selector switch next to the terminals. This selector switch is only found on Gen-4 instruments, Gen-3 RVC tachometers used a switch accessed through a hole in the rear of the case.

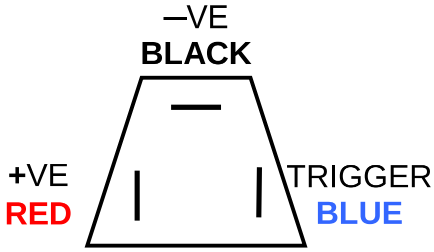



***Figure 6.5:*** Rear view of Gen-4 accessory tachometer. Terminals at bottom with white cylinder select switch above. Wiring of terminals redrawn at right.

*Fig.6.6* shows the RVC range's answer to the RVI 5000 series instruments. This comprises a small indicator head designed to be mounted on a dashboard with adhesive pads fitted to the base. Four wires (2 for meter, 2 for lighting) lead from the underside of the indicator head through a hole cut in the dashboard. All the electronics are housed in a rectangular metal case which is intended to be hidden behind the dashboard. Power and pulse connections are made at the electronics unit and are the same as those shown for the Gen-4 accessory tachometer above. A two-pin Cinch socket for connection to the indicator pod meter is provided and located in the hole above "SMITHS".


***Figure 6.6:*** Gen-4 pod style tachometer comprising FVG 1021 head unit and separate FVG 1022 electronics module for mounting under dashboard.

A document describing the internal construction, electronic circuit and re-calibration of the Gen-4 tachometer can currently be found on the Accutach website. An internet search for: "Smiths_Gen-4_Tach_thick-film_circuit_boards.pdf" should find it.

# 7 SMITHS RVC TACHOMETER WIRING:

Wiring RVC ***accessory*** tachometers is relatively straightforward. Connect power and connect the trigger terminal to the distributor side of the coil.

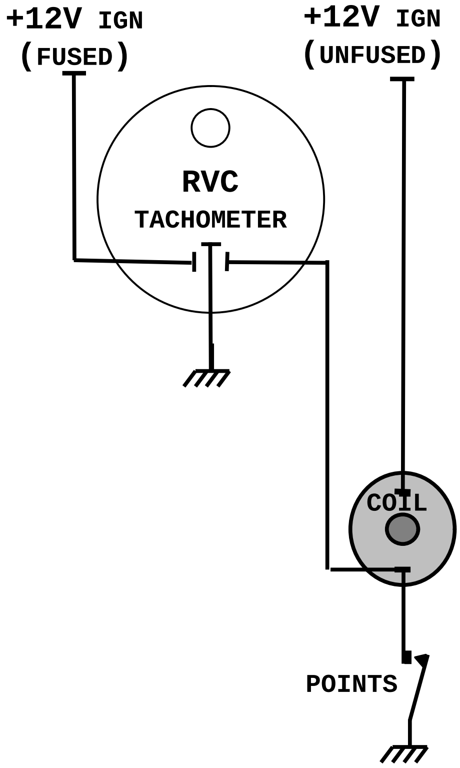



*FIGURE 7.1:* **RVC-STYLE WIRING:**

The trigger lead is connected to the distributor side of the ignition coil.

Tachometer supply is taken from an ignition-controlled source through a fuse.

**This wiring diagram assumes vehicle is negative earth. Swap supply and earth connections if vehicle is positive earth.**

Wiring this way should work with most ignition systems.

Accessory tachometer connections are shown here. OEM tachometers will have the negative supply connection to the case, usually a bullet type terminal for the pulse lead connection and a 1/4" blade terminal for the positive supply connection.

These tachometers may not work on "tachometer" outputs from electronic ignition systems.

For OEM tachometers fitted to vehicles with points-based, or Kettering, ignition systems the above wiring will work. Where a factory-installed electronic ignition system is fitted, there may be issues connecting the tachometer as shown above. (*Refer to Appendix F.7 "Connecting RVC tachometers to modified ignition systems".)*

The Smiths RVC OEM tachometer wiring will be similar to that for the accessory tachometer as shown in *fig. 7.1*. In the event that you are having tachometer issues after upgrading a car's ignition system, try to find someone who has done a similar upgrade and has solved the same issues. Vehicle specific forums on the internet are a great place to start.

Smiths, and other brands of tachometers that connect directly to the coil at the distributor side terminal will not work successfully from dedicated "TACH" output terminals on aftermarket ignition systems without internal modification. This is due to the fact that most tachometers of this type are designed to be triggered by a pulse of 200V or more and "TACH" outputs usually provide either 5V, 6V or 12V pulses. *(See also Appendix F.7.)*

# 8 FITTING A TACHOMETER TO THE CAR AND GETTING IT WORKING!

Any tachometer that relies on the case for one of its supply connections will be permanently damaged if connected to a vehicle with opposite polarity, as will any accessory tachometer if the power supply is connected the wrong way around. Note, if present, the polarity printed on the dial of the instrument and if it does not agree with what you have determined, then get it checked out. Note that most Gen-2 and all Gen-3 and Gen-4 OEM instruments will be negative earth as supplied to the vehicle manufacturer.

## 8.1 ALL SMITHS TACHOMETERS:

First step when fitting any tachometer is to check the polarity and voltage is correct for the target vehicle. If you had a working tachometer and it has stopped working, refer to section "*5.4. Troubleshooting - tachometer already fitted*" later in this document.

***Take time to make sure the polarity of the tachometer supply leads is correct. If you get this wrong, then internal tachometer components <u>will</u> be damaged.*** *(Refer to Appendix B if polarity of an OEM tachometer cannot be determined.)*

For accessory instruments, with no electrical connection between the internal electronics and the case, this simply means wiring the power supply terminals correctly and selecting the correct voltage.

**<u>Note:</u>** The presence of an alternator ***<u>does not</u>*** mean a vehicle is negative earth. Back in the day, BMC, and possibly other car manufacturers, equipped some of their positive earth vehicles (Notably Austin/Morris/MG…saloons) with alternators. Probably not many around now but you have been warned.

Once the polarity is known and is correct for the target vehicle, the power supply can be connected to the instrument.

## 8.2 TACHOMETER TROUBLESHOOTING NOTES:

If the tachometer is not working, recheck the voltage supply at the instrument paying particular attention to the earth connection. Use the spade connector on the case or, if not present, secure the connection under one of the tachometer mounting screws on the case using a proper terminal and a shakeproof washer, rather than just a loop of wire.

**Hint:** If the tachometer operates until you turn the lights on, then you have a dashboard earth problem.

### RVI type:

If the tachometer is an RVI type check the pulse leads are correctly connected in series with the coil and for Gen-1 tachometers that the iron core is properly fitted. The legs of the external iron core should sit inside those protruding from the case. Try swapping the pulse leads (again) to see if it works/improves. This should not be an issue if replacing an OEM unit with an equivalent good replacement unit but will be required if changing vehicle from positive- to negative-earth.

**<u>Note 1</u>**: If the pulse lead is connected on the supply side of the coil, then check for "extra" connections at the coil. There should be only one wire connected (plus possibly a suppression capacitor) to the coil supply terminal in an un-ballasted ignition system and two wires for a ballasted system. Either re-locate any extra connections or wire the tachometer pulse lead between the coil and distributor. (*Thanks to Brian Gough of Vancouver, Canada for raising this.*)

**<u>Note 2:</u>** The RVI tachometer is a very reliable instrument but it is also very fussy. If the current drawn by the coil is too high they can play up. Ignition coil currents in the range 3 to 4 Amps are what it's designed for. If a sports or high-performance ignition coil has been fitted the tachometer may not operate correctly or at all. If this is the case, temporarily replace the higher spec coil with a standard coil to determine whether this is the problem. There is not a lot you can do with a Gen-2 instrument in this situation but the Gen-1 instrument can often operate with a high-performance coil if the pulse lead assembly is modified so that the pulse lead passes through the plastic block without looping. (*See fig. 8.1 below*)

### RVC TYPE:

If you have replaced a Gen-2 RVI tachometer with an RVC type then check that the old tachometer pulse leads have been joined together. Failing to do this, or to run a new ignition supply wire to the coil, will leave the coil unpowered. In a car with a ballasted coil, there will be spark when cranking the engine but not otherwise!

For an RVC type meter make sure the pulse is taken from the **distributor** side of the ignition coil.

In the case of a Gen-4 RVC tachometer reading zero with the engine running, firmly tap the tachometer glass a couple of times to free a stuck meter. These instruments are prone to the needle sticking at zero. It may also free up itself at higher revs. *(For an explanation* why *Gen-4 tachometers can stick on zero, see article at http://www.team.net/TR8/tr8cca/wedgelab/other/tach/tach.htm.)*

Check the current drawn by the tachometer. There should be some but it will only be a few tens of milliamps. If no current can be measured, the instrument needs servicing or the external wiring is faulty. Check connections.

If you are handy with a multimeter and soldering iron, and have some basic knowledge of electronic circuits, then almost all the data you need to repair one of these instruments is available on the internet. Otherwise find someone with the necessary skills to check/repair it.

## 8.3 MODIFIED IGNITION SYSTEMS:

None of the Smiths tachometers described in this document are suitable for use in systems using multiple coils.

If a Transistor Assisted Ignition (TAI)/Transistor Assisted Contact (TAC) system is installed with an original specification coil then the RVI tachometer should continue to work.

An RVI tachometer may not work reliably in systems with high (>4 Amps) coil primary current, such as when a "Sport" coil is fitted. Gen-1 instruments can be modified, if necessary, by reducing the number of turns of the pulse lead in the pickup. Fig. 8.1 below shows this modification. [From "Smith Tachometer.pdf" which may be downloaded from the Pertronix website http://support.pertronix.com/kb/faq.php?id=34],

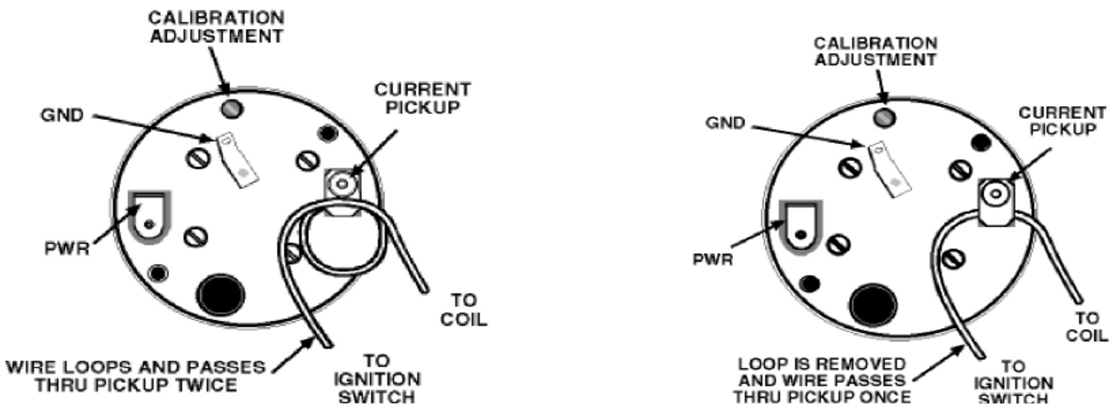



***Figure 8.1:*** Showing how to modify Gen-1 pulse loop for systems with higher coil currents.

Unmodified RVI tachometers will not work in Capacitor Discharge Ignition (CDI) systems and should be replaced by an RVC type. CDI ignition systems typically generate very short ignition pulses and run at several hundred volts, which exceeds the voltage rating of automotive electrical cable. Similar comments apply to RVC tachometer wiring and this would need to be considered for any CDI system without a dedicated tachometer output. Ignition pulses from CDIs are negative (or falling) voltage where the tachometer (this applies to many tachometer brands) requires a positive (or rising) pulse.

Further information may be available from the ignition system manufacturer so check their website.

For many cars supplied with RVI tachometers there may be an equivalent RVC version available from a later model vehicle. Gen-0 to Gen-3 instruments all used the same meter movement so swapping dials and pointers is possible with little trouble. Gen-4 tachometers use a different meter, different pointers and dial mounting hole spacing, so swapping out parts is not readily done. MG and Jaguar owners are well catered for here as tachometers of similar, or identical, appearance were used in later cars, so replacing an RVI instrument with an RVC type can be readily done.

## 8.4 TACHOMETER OUTPUT SIGNALS FROM ELECTRONIC IGNITION SYSTEMS:

***Refer also Appendix F.7*.**

Tachometer outputs from aftermarket ignition systems, those that are supplied with a dedicated tachometer output, output either a 0 – 5V or 0 – 12V pulse each time the system fires. A Smiths RVC tachometer will not operate on a 0-5V pulse nor will it operate reliably on a 0-12V pulse. For a 0-12V output, the tachometer is sensitive to duty cycle, which varies between manufacturers and models, and indicated rpm will drop to zero at some value – for most installations between 2000 and 3000 rpm until the motor slows below the drop out rpm.

When it comes to OEM electronic ignition systems, for early types at least, there seem to be no standards and a number of variants exist. These will need to be addressed on a case-by-case basis.

## 8.5 EXTERNAL TACHOMETER INTERFACE MODULES:

Interface modules are available that may allow RVI tachometers to work with modified ignition systems. Two examples may be found at:

http://www.technoversions.com/TachMatchHome.html (U.S.A)

and

https://www.spiyda.com/tachometer-electronics.html (U.K.)

I have not used either device and there may be others out there. The reader will have to judge for her/himself whether options such as these present a suitable solution.

## 8.6 INTERFACING RVC TACHOMETERS WHEN REPLACING OPUS IGNITION SYSTEM:

If you have upgraded from an Opus ignition system then put a series resistor in the pulse lead to the coil. A 47k Ohm resistor should be sufficient though you may need to experiment starting with this value and reducing it if required. The issue is that the pulse input circuitry of tachometers in some Opus systems has a very low resistance and components can be damaged if a series resistor is not fitted. This has been noted when fitting a Lumenition ignition system but will likely apply for other Brands of electronic ignition systems. (*See also Appendix F.7, "Connecting RVC tachometers to modified ignition systems"*)

*Thanks to Martyn Smith of the United Kingdom for bringing this up.*

## 8.7 TROUBLESHOOTING - TACHOMETER ALREADY FITTED:

This section assumes that a tachometer is already fitted to a vehicle, possibly as original equipment, and has now begun operating erratically or is determined to be out of calibration. It is further assumed that the first step already taken has been to check the ignition system and adjust or repair as necessary.

Ensure that all connections to the tachometer are secure. For Gen-1 instruments ensure the nut securing the input lead assembly is tight. Pay particular attention to earth connections behind the dash, both at instruments themselves and the connection to the body of the car.

RVI instruments may no longer work if a bit of "extra" current has been added to the pulse lead, such as using the 12V coil supply terminal to power some other device. This does not apply to tachometers wired in the accessory tachometer style but only an "OEM" style connected instrument.

If the chassis polarity has been changed, both the power supply **and** pulse lead connections to RVI tachometers will also need to be changed!

Beyond carrying out the steps set out above there is really nothing that can be done without removing the tachometer and opening up the case. Another tachometer could be obtained and fitted but unless its maintenance history is known you may be no better off.

These instruments are decades old and have possibly had no maintenance nor been otherwise serviced for a considerable period, if at all. The internal electronic components inside are affected by age. Lubricants can thicken or dry out over time to the point that they behave more like glue and the needle exhibits slow or jerky movement.

End float on the meter spindles of these instruments should be 0.002 to 0.004 inches. If this reduces for any reason then meter (pointer) movement will be sluggish/erratic/cease and will be worse at low temperatures. If the end float is too great then the pointer will waver excessively.

Balance of the meter and pointer is achieved by adjusting weights on the meter assembly itself. For the Gen-0 to Gen-3 instruments, these are held in place by friction. If a tachometer has been dropped then one or more of these "balance weights" may have moved which will affect the linearity of the instrument. It may read low over the first half of the range and high over the upper half of its range or vice-versa. This will require that the meter is balanced ("poised" is the term used in Smiths literature) which is a fiddly job at the best of times and also requires that the instrument is removed from, and can be operated outside of, its case.

Gen-1 to Gen-3 tachometers have a calibration potentiometer that may be tweaked to improve calibration but it will not correct linearity errors. Not all tachometer cases have an access hole for the calibration potentiometer but if no hole is present access may be provided as shown in *Appendix E*. If drilling a calibration access hole, remove the tachometer works from the case and when done, place a piece of adhesive tape over, or insert a rubber plug into, the access hole to reduce dust ingress.

## 8.8 COMMON FAULTS WITH ELECTRONIC TACHOMETERS:

The following table sets out some faults found with these tachometers, common causes and their remedies. Items marked with an asterisk require tachometer to be removed from case.

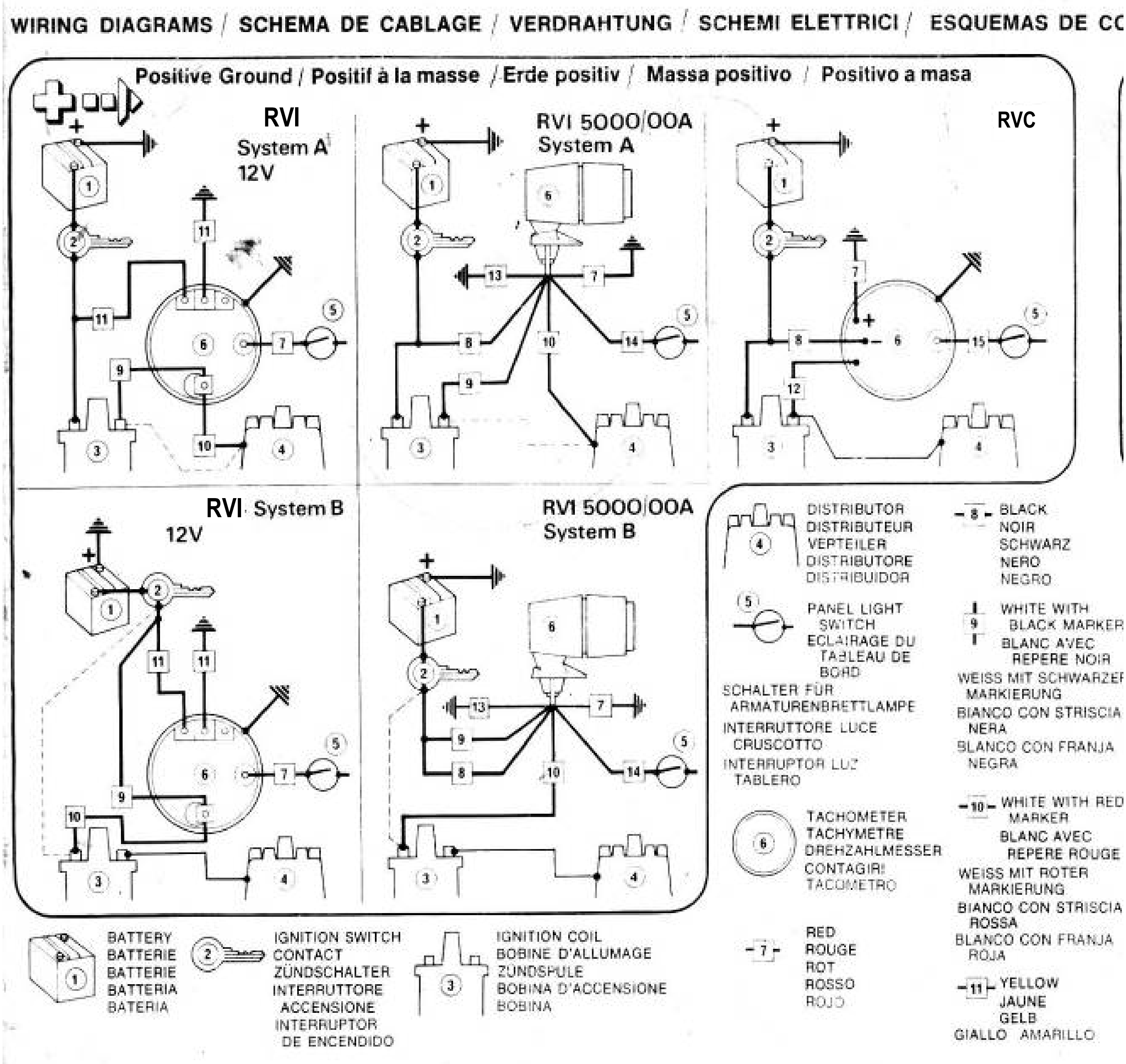
If the fault only shows either when cold or after the tachometer has been operating for a while then ensure checks are carried out under those conditions.

| SYMPTOM | POSSIBLE CAUSE | REMEDY |
|---|---|---|
| Pointer wavers excessively after change in rpm | Excessive end float in meter armature.<br>Binding meter armature bearings<br>**Gen-1 only**; poor coupling between iron core pieces | * Reduce armature end float **Note 1**<br>*Clean and lubricate meter<br>Check iron cores are in close contact and retaining nut is tight. |
| Pointer swings over a significant part of the dial for steady rpm | Points need adjusting.<br>Faulty points capacitor<br>Fault in tachometer wiring<br>**Gen-1 only**; poor coupling between iron core pieces | Check points<br>Replace capacitor<br>Check for loose connections and terminals in ignition system and tachometer wiring |
| Pointer sticks or moves jerkily | Insufficient end float in meter armature<br>Meter armature bearings binding<br>Meter hairsprings distorted<br><br>Pointer fouling on dial | * Increase meter armature end float<br>* Clean and lubricate bearings<br>* Re-align hairsprings (**Note 2)**<br><br>Carefully bend pointer away from dial just enough to avoid fouling |
| Pointer moves to full scale when powered up | Fault in tachometer electronics | * Have tachometer serviced |
| Tachometer is inaccurate | Meter/pointer out of balance<br><br>Fault in tachometer electronics<br><br>Loss of magnetism in meter field magnet | * Re-balance meter as required (**Note 3**)<br>* Have tachometer repaired (**Note 4**)<br>* Replace field magnet |
| | **Notes:** | |
| **Note 1** | Some overshoot/slight waver on rapid change in rpm is normal for these instruments but should not be noticeable under normal motoring. Later Gen-4 tachometers are quite heavily damped with damping fluid and waver should not be seen. | |
| **Note 2** | This is only possible when hairsprings have been moved out of position during a service and should never be observed in the car. If the distortion has been caused by overheating due to excessive current, re-alignment will not be possible and replacing hairsprings or the complete meter assembly is the only solution. | |
| **Note 3** | There are only three scenarios under which this may occur.<br>The pointer has been changed<br>The tachometer has been dropped on the side of its case<br>The meter has been subject to excessive current causing distortion of the coil in which case the meter is unserviceable. | |
| **Note 4** | This could be caused by older electronic components changing their value with time. In this case, the calibration adjustment may correct this fault in the short term, though ideally out of spec components should be replaced with modern equivalents. Gen-4 instruments have no calibration adjustment provided. | |

## *APPENDIX A: SMITHS ACCESSORY TACHOMETER WIRING:*

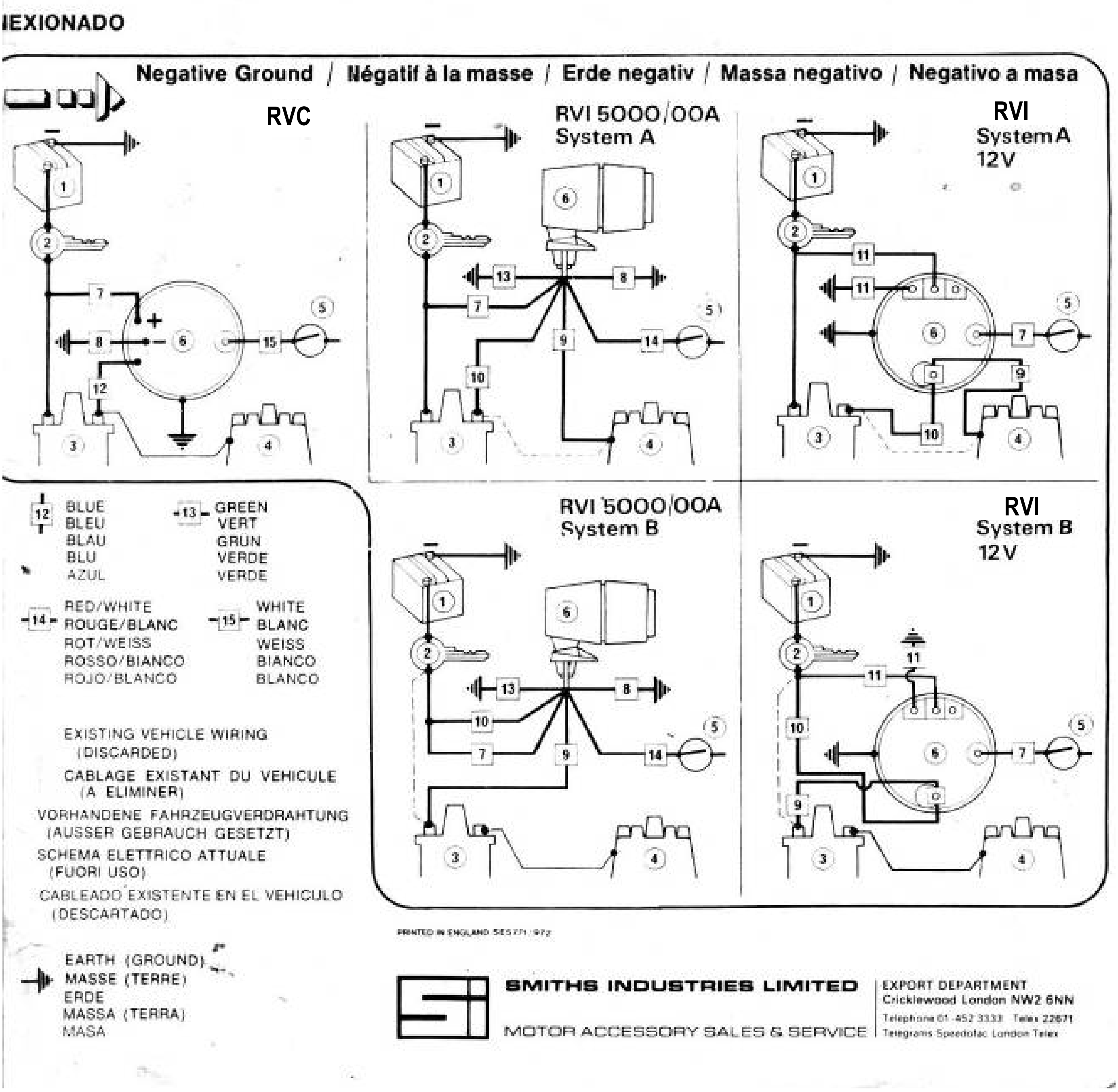
In the following wiring diagrams, for RVI tachometers, "System A" corresponds to "Accessory style" wiring method and "System B" the "OEM style" in the section "Smiths RVI tachometer wiring" earlier in this document.

### POSITIVE EARTH VEHICLE



## *Appendix A: - Smiths accessory tachometer wiring continued*

**NEGATIVE EARTH VEHICLE:**



## APPENDIX B: CHECKING AN ELECTRONIC TACHOMETER:

The following tables set out a few quick checks that can be made, prior to connecting, to determine if an OEM tachometer has a chance of working. Connections will differ on Accessory type tachometers but values should be similar. These are listed below for each type I have available to test.

The only tool required is a multimeter that can measure both resistance (Ohms) and current draw in milliamps. Generally a digital meter has the red lead positive on resistance ranges, but it is negative on an analogue multimeter. To make life easier, tests have been carried out using each type of meter and the results set out in separate tables for each multimeter type. Where resistance values are given, these can help determine the polarity of the tachometer.

The "supply" terminal is the one that connects to the car's ignition controlled supply, the other lead to case earth. For accessory-type tachometers, which have isolated terminals for positive and negative, the "supply" terminal for these measurements is the positive terminal of the tachometer.

**THE RESISTANCE READINGS ASSUME A NEGATIVE EARTH TACHOMETER BUT IF THE READINGS ARE "BACK-TO-FRONT" THEN, EITHER THE POLARITY OF THE MULTIMETER LEADS IS NOT WHAT YOU THOUGHT OR THE TACHOMETER IS POSITIVE EARTH. CHECK POLARITY OF METER LEADS FIRST.**

Perform the resistance check first, using the nearest range on your meter to that given in the table. Avoid using the higher resistance ranges on multimeters.

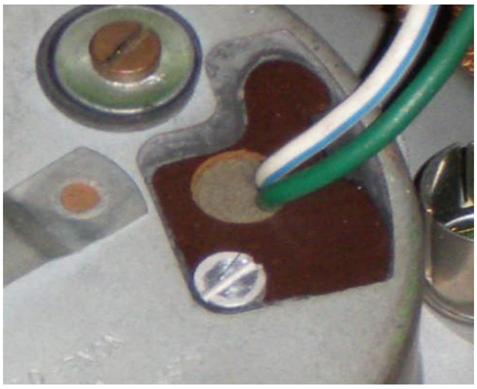
***Notes:***

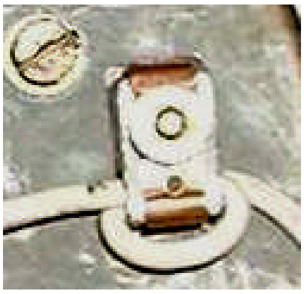
> *Values in the tables below apply only to instruments fitted with their original Smiths circuit boards. If the internals have been altered or replaced quite different readings may be observed.*
>
> *The measured resistance may "wander" when the meter leads are first connected to the instrument. Allow reading to settle down to a steady value before checking against values provided.*

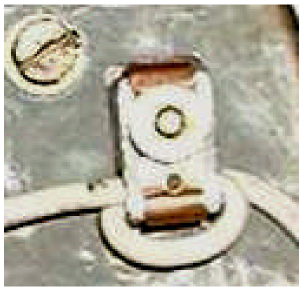
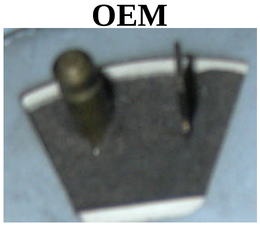
If resistance checks are satisfactory proceed to connect and check the current drawn by the tachometer.

In any event a substantially different resistance or current reading, lower or higher, than the range provided in the table implies a fault in the tachometer.

If testing Jaguar tachometers, make sure you identify the correct type, which is printed on the dial but may not be legible. The left-hand tachometer in the picture above is a Jaguar Gen-2 RVI tachometer (two white leads from inside case), the one on the right a Gen-3 RVC (single white/blue lead from inside case). Use tests below appropriate for type.

| **TEST METHODS – DIGITAL MULTIMETER**<br>(Red lead positive) | **TACHOMETER IDENTIFICATION** |
|---|---|
| RVI Gen-1 monostable type with external pulse coupling.<br>Positive and negative earth OEM versions available.<br>Seven instruments tested using meter's **0-2000Ω** range.<br>Measured resistance should be in the range 600Ω to 900Ω with the red meter lead to (12V) supply terminal.<br>Measured resistance should be in the range 300Ω to 600Ω with the black meter lead to supply terminal.<br>Tachometer draws about 40mA to 80mA from a 12V power supply with no input pulse. (Refer Appendix F.4.)<br>No current indicates an open circuit inside the tachometer. A lower or higher current than the above indicates the tachometer needs service. |  |
| RVI Gen-2 blocking oscillator type with internal coupling.<br>Two instruments tested using meter's **0-2000Ω** range<br>Measured resistance should be infinite (no reading) with the red meter lead to supply terminal.<br>Measured resistance should be in the range 150Ω to 300Ω with the black meter lead to supply terminal.<br>If no resistance can be measured, the transistor, resistor or pulse transformer winding is open-circuit.<br>This tachometer draws no current from the power supply with no input<br>If a current is measured with no pulse input, transistor is leaky or shorted. |  |
| RVC Gen-3 early type with rectangular pattern mounting screws.<br>One instrument tested. Read about 6500Ω irrespective of the polarity of the leads.<br>Current draw with no pulse lead connected is about 30mA. |  |
| RVC Gen-4 later type with "Y" pattern mounting screws.<br>Negative earth OEM instrument only.<br>Five instruments tested using meter's **0-20kΩ** range<br>Measured resistance should be in the range 6000Ω to 7000Ω with the red meter lead to the positive supply terminal.<br>Measured resistance should be in the range 4500Ω to 5000Ω with the black meter lead to the supply terminal.<br>Current draw with no pulse lead connected is 30mA to 50mA. | **OEM**<br><br>**Accessory**<br> |

| **TEST METHODS – MOVING COIL MULTIMETER**<br>(Red lead negative) | **TACHOMETER IDENTIFICATION** |
|---|---|
| RVI Gen-1 monostable type with external pulse coupling.<br>Positive and negative earth OEM versions available.<br>Seven instruments tested using meter's **Rx100Ω** range.<br>Measured resistance should be in the range 600Ω to 700Ω with the red meter lead to supply terminal.<br>Measured resistance should be in the range 900Ω to 1200Ω with the black meter lead to supply terminal.<br>Tachometer draws about 40mA to 80mA from a 12 Volt power supply with no input pulse. (Refer Appendix F.4.)<br>No current indicates an open circuit inside the tachometer. A lower or higher current than the above indicates the tachometer needs service. |  |
| RVI Gen-2 blocking oscillator type with internal coupling.<br>Two instruments tested using meter's **Rx100Ω** range<br>Measured resistance should be in the range 150Ω to 300Ω with the red meter lead to supply terminal.<br>Measured resistance with the black meter lead to supply terminal should be infinite (no reading).<br>If no resistance can be measured, the transistor, resistor or pulse transformer winding is open-circuit.<br>This tachometer draws no current from the power supply with no input<br>If a current is measured, with no pulse input, transistor is leaky or shorted |  |
| RVC Gen-3 early type with rectangular pattern mounting screws.<br>One instrument tested using meter's **Rx100Ω** range<br>Measured resistance 1200Ω with the red meter lead to supply terminal.<br>Measured resistance should be in the range 4500Ω with the black meter lead to supply terminal.<br>Current draw with no pulse lead connected is about 30mA. |  |
| RVC Gen-4 later type with "Y" pattern mounting screws.<br>Negative earth OEM instrument only.<br>Five instruments tested using meter's **Rx100Ω** range<br>Measured resistance should be in the range 3000Ω to 5500Ω with the black meter lead to the positive supply terminal.<br>Measured resistance should be in the range 4500Ω to 5500Ω with the red meter lead to the positive supply terminal.<br>Current draw with no pulse lead connected is 30mA to 50mA. | **OEM**<br><br>**Accessory**<br> |

# *Appendix C: Possibly useful information ?*

## Mechanical tachometer troubleshooting:

Mechanical tachometers are fairly reliable but will lose accuracy over time and will need re-calibrating. Internal wear can also cause them to lose accuracy and read erratically. Specialised equipment is required to recalibrate these.

Some faults with these tachometers are external to the instrument. The following table provides some troubleshooting tips for these tachometers.

Note that these "faults" also apply to any cable-driven instrument such as a speedometer.

| Symptom | Probable cause | Troubleshooting/Solution |
|---|---|---|
| Instrument doesn't read | Drive/drive cable faulty. | Disconnect drive cable from instrument and remove inner drive cable. Check that ends of cable are square. If broken or worn then replace. Re-connect drive cable and check the inner cable turns when engine cranked/run. If cable/drive serviceable, refer to "Needle doesn't move…" below. |
| Needle doesn't move or pointer moves erratically | Internal wear and instrument needs repair. | Wear in the instrument. Speedcup (aka "drag-cup") is pinched between thrust plate in rotor and top bearing in older instruments. This could be due to a too long inner drive cable. Instrument will require a new thrust bearing plate. |
| | Inner drive cable may be too long. | There must be no end thrust applied to the instrument head by the drive cable. Check the length of the inner drive cable by undoing the cable nut at the rear of the instrument and check that the ferrule on the end of the outer cable butts up to the instrument body readily without applying any force to the instrument. |
| Needle wavers at low revs | Drive cable | The drive cable needs replacing. Also check tachometer shaft is not binding or hard to turn else a new cable will only be a very temporary fix. |
| Needle flicks to full scale or beyond | Severe internal wear or oil in instrument. | Replace or repair instrument. Replace oil seal on driving gear. |

Instrument drive cables comprise an inner wire core with closely wound layers of thin wire wound over this core. Each layer is wound in the opposite direction to the previous one. The end result is a cable with very little torsional movement (twist) when new. These deteriorate over time and allow the cable to "wind-up" in use. This leads to erratic operation and is the most common cause of "waver" in the needle at low-scale readings.

## Bezel refurbishing:

**A word of explanation:** *Throughout this part of this document I use the word "meths" to refer to methylated spirits which in other parts of the world is called "denatured alcohol".*

Most, if not all, of this section applies to any Smiths gauge such as Speedometers, tachometers, gauge clusters and any individual gauge fitted with a tabbed bezel.

Smiths bezels incorporated a resilient material to retain the instrument glass and seal the "front" end of the instrument. Over time, this loses its resilience and may break down and "bleed" onto the glass. Remove the bezel and replace the resilient seal material with 4mm diameter sponge rubber cord for 4 or 5 inch diameter instruments. For 2" instruments, 3mm sponge cord works well.

In New Zealand Rubbermark stock 3mm and 4mm sponge cord. Rubbermark's stock codes are:

73.16030N SPONGE CORD 3MM DIA (Neoprene)

73.16040E SPONGE CORD 4MM DIA (EPDM)

To remove the old (formerly) resilient material from chrome bezels:

1. Scrape out with a piece of wood (toothpick e.g.) or plastic. If it's so hard a toothpick won't touch it then go to 2.
2. Soak the bezel in meths overnight and remove the resulting gunge with a toothpick or stiff brush (an old toothbrush works just fine).
3. Repeat step 2 until clean.

Give a chrome bezel a touch up with metal polish once cleaned.

Do not soak (black) painted bezels or the paint finish will be damaged.

Note that chrome-finish bezels are made from brass and painted bezels are steel. (It may be that older bezels are brass, newer are steel.)

Join rubber foam cord with contact adhesive using a butt joint. If using cyano-acrylate (Super-glue) or similar rigid adhesive, use a lap joint.

Make sure all the rust and old rubber has been cleaned from the outer rim of the instrument case before refitting the bezel. A light smear of K-Y jelly (the best rubber lubricant known to man!) on the sponge cord prior to assembly helps too.

If you want to replace a bezel that is in poor condition, then those from a Smiths speedometer or instrument cluster of the same physical size work as they are the same part. Note there are three styles of bezel profiles; round, vee and half-vee.

## Tabbed bezel removal:

***The following information applies to all instruments fitted with round tabbed bezels.***

For most OEM instruments the bezel is retained against the rim of the case by tabs. To remove a bezel, rotate the bezel relative to the case until the tabs align with the slots in the case's rim and pull off. Often this can be hard to do. Various methods can be employed to remove "difficult" bezels and some are listed below.

Note that bending the tabs up will permanently distort, and possibly crack, the bezel adjacent to the tabs. Don't do it if it can be avoided.

If the instrument's glass is broken, carefully remove as much as possible which will release pressure from the joint.

If it is not possible to turn the bezel by hand, the following tips may help:

With a small screwdriver, or similar tool, placed between a bezel tab and the case, carefully lever the tab away from the case just enough to cause the tab to move. Repeat for each of the six tabs. This will break any bond that may have formed between the bezel tabs and the case rim. In some cases this may be all that is required to free the bezel sufficiently for it to be removed.

Mark Olson advises that a pair of strap wrenches can be used to remove a bezel. Strap wrenches will give you better grip on the components.

Don't get too carried away with this method as cases are made from thin steel and too much pressure could distort or dent these.

Tom Hayden, from Ohio, advises that he has used a shallow pan of hot water to free stuck bezels. Water temperature should be between 50°C and 60 °C or the temperature from a tempered hot water system tap (nominally 55°C). Depth of water needs to be just sufficient to cover the bezel and case rim when the instrument is placed in the water face-down. 3/8 inch or 9mm is plenty for a flat-bottomed pan. Allow to soak for a few minutes then remove the bezel.

If necessary soaking in hot water can be repeated. Tom also notes that hot water is good for removing hardened seal material from the bezel itself in a similar manner to that set out for meths in "Bezel refurbishing" above.

**Note:** Do not use boiling water if using this "hot water" method! There is a risk that very hot water contacting a cold glass could cause the glass to crack. In order to reduce the risk, ensure that the instrument (glass) itself is as warm as possible which will be achieved if the instrument has been sitting in a reasonably warm room for a while.

As a method of last resort, the above method in "Bezel refurbishing" for removing old sponge seals from the bezel dissolves the adhesive that holds the sponge seal in place but can also dissolve the material itself. However, meths can also assist with separating a stubborn lugged bezel from the instrument case.

Place the instrument face down on a flat surface. Sheet plastic with cloth on top serves well to protect the bench top from any damage meths may cause.

Using an eye-dropper, brush or other means, apply, around the full circumference of the bezel, enough meths to wet the rim of the bezel where it meets the case flange.

Allow to soak for several minutes then try rotating the bezel keeping the tachometer face-down to ***prevent meths contacting the trim ring or dial***. The bezel should now turn reasonably easily and can be removed.

Separate glass, trim ring and bezel and allow to air dry to avoid damage to the sponge seal.

Note that this may separate the sponge material from the bezel. Replace when dry.

The reason this works appears to be that the meths penetrates and lubricates the joint between the bezel seal and case. This method has been successfully used with bezels fitted both with original sponge material and where this sponge has been replaced with alternative material as described in "Bezel refurbishing" section above.

Both the meths and hot water methods can be used if the glass is cracked and meths may be the better option in this case.

### **Spun-on bezel removal:**

Spun-on bezels, as used on 3” instruments, are not intended to be re-used. The official Smiths method of removal is to cut the bezel around and replace with a new one. Bezels can be reused once if care is taken. Some means of supporting the rim of the bezel is required for recovery to be successful. One such tool is shown in *fig. C.1* below.

***Figure C.1***: Tool for removing spun-on bezel. A strip of adhesive backed foam rubber is stuck to a worm-drive hose clamp which is clamped around the rim of the bezel. The rubber is to protect the finish on the bezel itself. A blade screwdriver or similar is used to lift the spun over metal to remove the bezel. Right hand photograph shows tool fitted to a Volvo RVI 3410/00 tachometer.

Roll the edge back over the rim of the case when done.

*Photographs and method from a document supplied by Mark Olson (Accutach)*.

*Replacement bezels for most Smiths instruments are still advertised for sale on several internet websites.*

## *APPENDIX D: GEN-1 TACHOMETER IRON CORE AND PLASTIC FORMER:*

Fig. D1 below shows the iron core of the Gen-1 tachometer. One can readily be made if required. Dimensions have been obtained from a Smiths item in good condition.

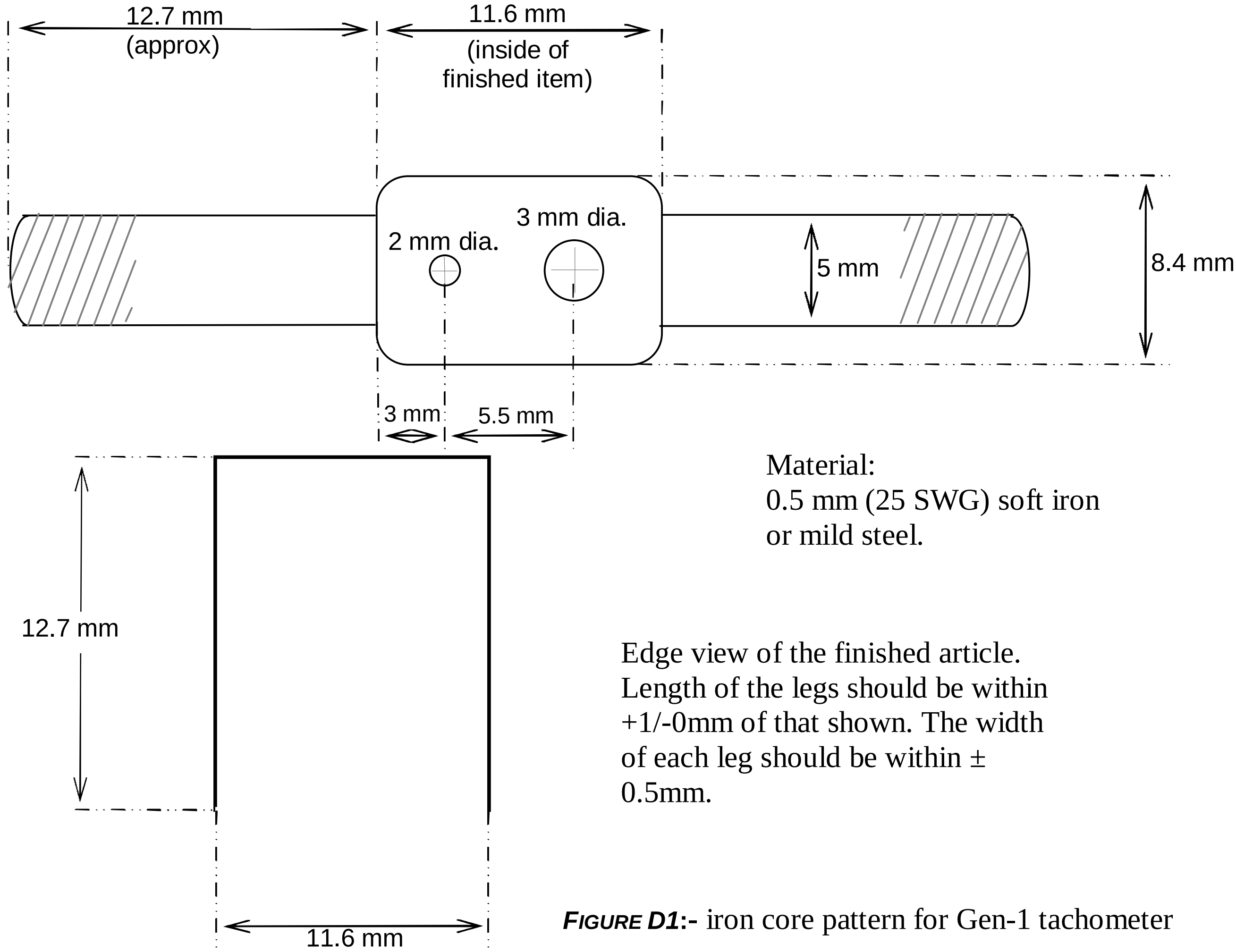



***FIGURE D1*:-** iron core pattern for Gen-1 tachometer

The material used must be soft iron or mild steel. If you can find a dead oil-filled ignition coil, the laminations that form the core of these are an ideal material for these clips. The thickness is not absolutely critical. 24 to 28 s.w.g /23 to 27 a.w.g/0.4 to 0.6mm is the ideal range. Thinner material may be too flimsy and thicker material will not fit.

***The legs of this core must be flat and a close sliding fit inside the legs of the internal core (protruding from the tachometer-see figure D2 below). To provide the necessary magnetic coupling between the internal and external cores, the legs must be in close contact over the entire available area and with no air gap. For this reason, the use of a nibbler, in lieu of tinsnips, is recommended for shaping cores.***

When bending the legs of the core, ensure that they are parallel. The upper part of each leg may be twisted with a pair of long-nosed pliers to account for very small alignment errors here. It is important that the hatched area in the above drawing is free of paint, including varnish, and burrs. Ensure that any ragged edges and burrs on the completed core have been removed.

The 2mm diameter hole shown accepts the nub formed on the top of the original plastic former. The mounting bolt passes through the 3mm diameter hole.

The extra width of the centre part is primarily to provide support around the mounting bolt hole. A strip of metal 5mm wide could be used and a brass washer placed beneath the securing nut as drawn in *fig D.2* below.

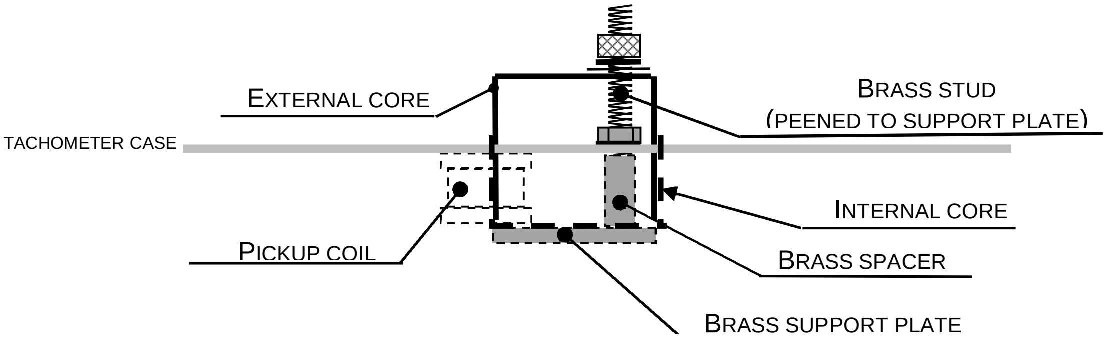



***FIGURE D.2:--*** **CROSS-SECTION OF IMPULSE TRANSFORMER**. The heavy broken line is the internal iron core piece. (Wires and plastic former not shown, )

The plastic former (*fig. D.3* below) is not critical in most dimensions and can be made from any insulating material, such as polyethylene from an old kitchen cutting board.
The purpose of this block is to prevent chafing, and eventual shorting, of the pulse lead wire against any metal components and to provide support for the retaining nut and washers. The original part has raised guides to locate the iron core. These have not been shown here. If it was desired to more accurately mimic the original part then increase the width of the plastic former by 1 mm and cut a 5 mm wide chase, 0.5 mm deep, on each side of the block. If no chase is provided for the clip legs, a small dab of silicone sealant between the plastic former and the iron core would prevent movement.

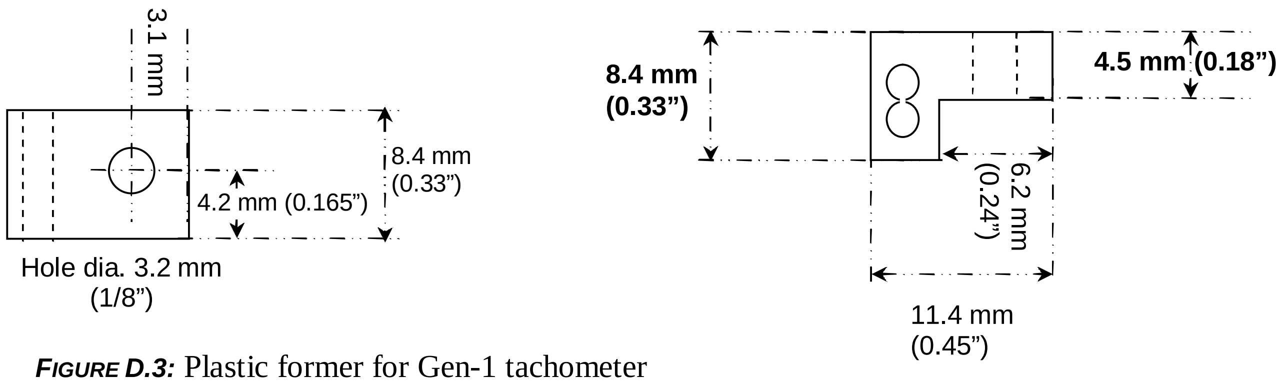



***FIGURE D.3:*** Plastic former for Gen-1 tachometer

The most critical dimension is the overall height which must be close to ensure the iron cores align and that overlap between the cores is sufficient to provide good magnetic coupling. The chase cut to clear the nut supporting the internal core/coil assembly must be sufficient to just clear the nut (approx 4 mm).

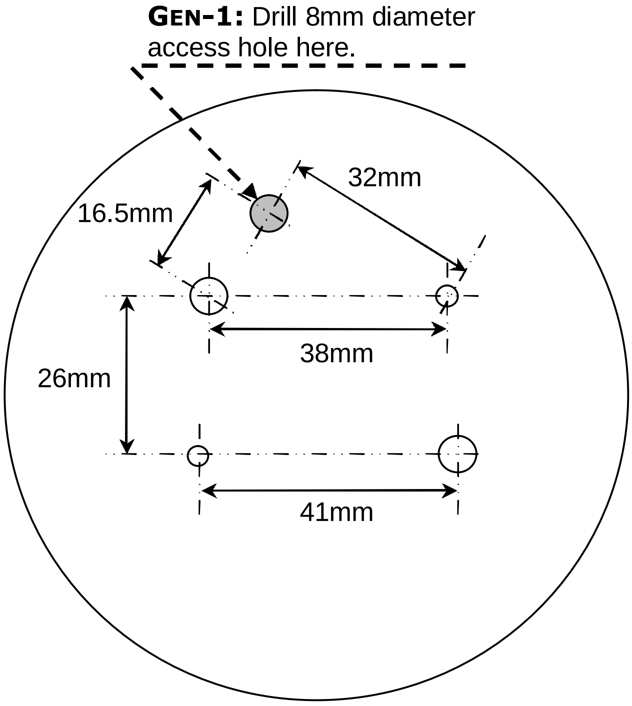
Holes for the pulse lead wire are shown as for the original pattern and are 3.2 mm (1/8") diameter. The holes can be separated slightly if needed and the pulse lead wire should be a firm fit through them. Some modern automotive electrical wires have thinner insulation and such wires will be loose within the plastic former. Drill these holes to suit the wire you are using or apply a dab of silicone adhesive/sealant to secure wire if required.

## *APPENDIX E: GEN1 TO GEN-3 CALIBRATION ACCESS HOLE LOCATION:*

The templates presented in this section show the location of the calibration access hole for Gen-1 to Gen-3 tachometers. As a general rule, the access hole was provided for all Gen-3 but not for many OEM Gen-1 and Gen-2 tachometers.

Measurements provided were taken from tachometer cases to hand. ***Do not try drilling these holes without removing the tachometer works from the case!*** Note that two different circuit boards were used in Gen-1 tachometers so verify dimensions against those of the circuit board before drilling the hole.

### DRAWINGS AS VIEWED FROM REAR OF CASE.



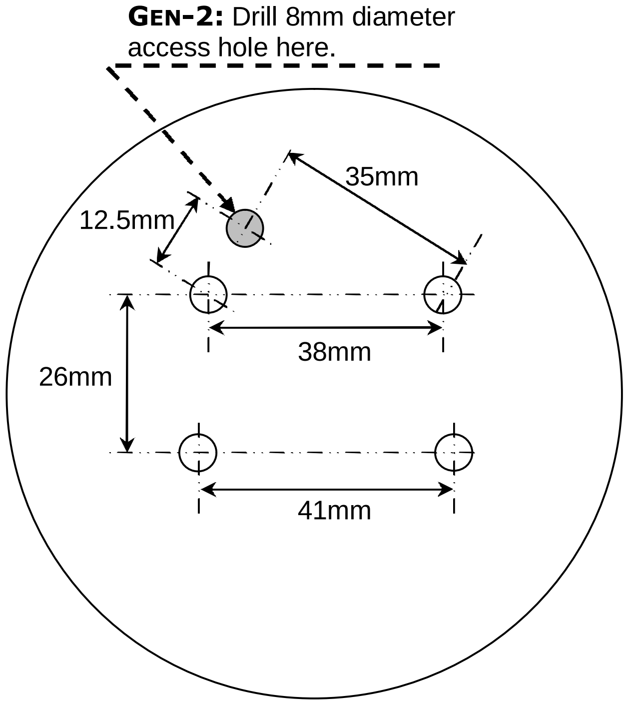




***FIGURE E.1:*** Location of calibration access hole in RVI tachometers. (rear view, not to scale)

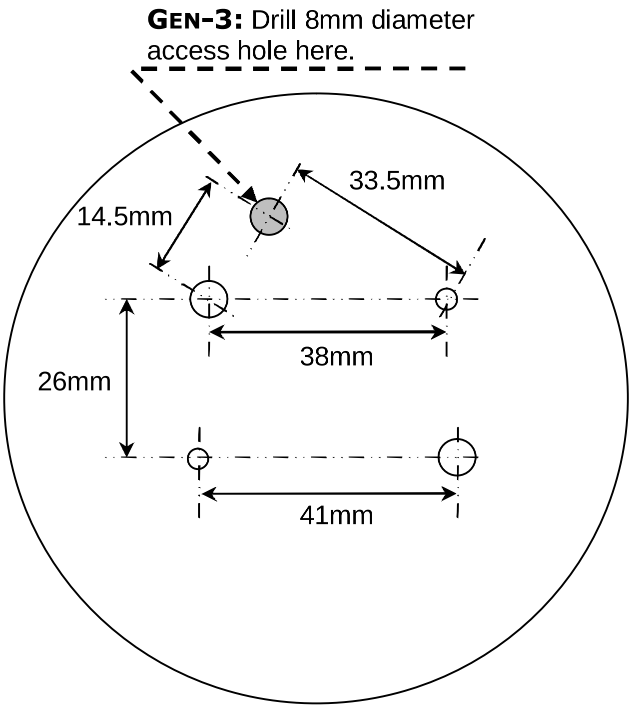



***FIGURE E.2:*** Location of calibration access hole in Gen-3 RVC tachometers. (rear view, not to scale)

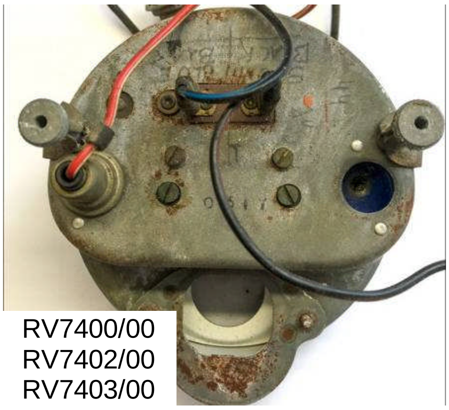
# APPENDIX F: MISCELLANEOUS TECHNICAL INFORMATION:

## F.1 EARLY PATTERN METERS:

The original Smiths tachometer meter was produced from 1959 to c1961. These meters have a different frame casting, with a different mounting hole spacing. These were only used in RV tachometers. A Smiths tachometer circuit board cannot be fitted to these, though a custom electronics circuit board can be.

**RV 74nn/nn – Daimler/Jaguar 5" diameter**

1959 - 1961




1961 – 1968

**RV 1310/00 and RV 1310/02 - Jensen-Volvo – 4" diameter**

To November 1961

December 1961 – November 1963

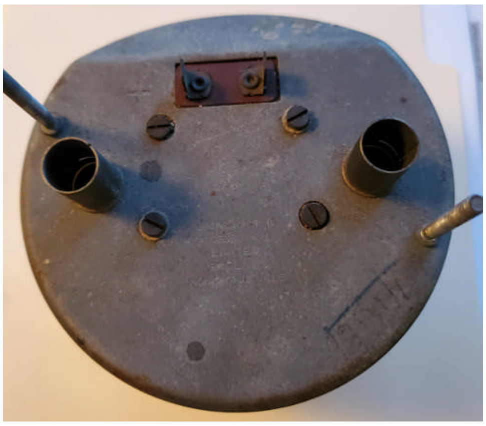
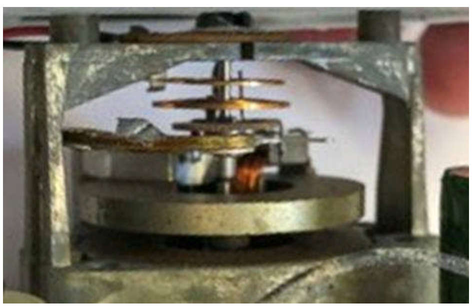


***FIGURE F.1:*** Early pattern meter mountings vs later pattern. Note that dates provided with the above photos are best estimates and should be reasonably close, determined from vehicle production dates.

Pictures in *fig F.1* show the difference in the mounting hole patterns between the two meter styles – closer vertically spaced holes on the cases on the left with the wider spacing of the later meter shown to the right. The upper two photos were supplied by Phil Turnbull and show Jaguar tachometers. See his website **†,** which shows one of these tachometers along with a photograph of a custom electronic circuit board fitted.

*Fig. F.2* shows the meter used in the earlier instruments. This is quite different to the later meter.

Since these earlier style instruments were never fitted with internal electronic circuitry within the dash-mounted casing, they will not be addressed further here.



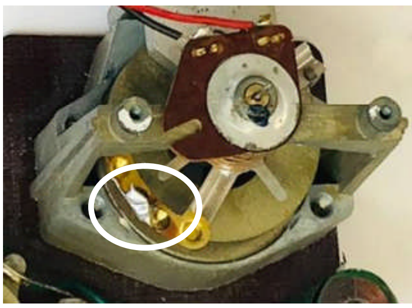


***FIGURE F.2:*** Early meter assembly showing the die cast bridge that is part of the meter body casting. Circled area in right-hand picture shows solder added to the meter armature counterweight to balance the assembly.

**† *Smiths RV tachometer — Electronic upgrade:-***
https://landieman.com/2020/10/23/smiths-tachometer-tach-rev-counter-electronic-upgrade/

## *F.2* RV (Gen-0 and Gen-0.5) Tachometers:

### F.2.1 RV 7000 series (Gen-0) instruments:

These tachometers, fitted mainly to Daimler/Jaguar cars, are five inch diameter instruments and frequently have an inset time clock fitted at the bottom of the dial, as in *fig. F.3* at right.


***Figure F.3:*** Typical Smiths RV 7000 series tachometer. This one a RV 7403/00 from a 1962 Mk. II Jaguar.
*Photograph by Phil Turnbull, NZ*

They are simply an a.c. voltmeter as shown in the circuit diagram below and required a generator to be fitted to the engine. Output of this generator was nominally 1 Volt per 100 rpm of the generator (camshaft). Hence the 2-1 ratio marked on the dial (30V = 6000 rpm).

The circuit is straightforward. A full-wave selenium rectifier assembly rectifies the input a.c. waveform and the rectified output drives the meter.

Calibration is achieved by selecting a resistance coil of different values. Values from 800 to 1250 Ohms, in 50 Ohm steps, were provided as service items by Smiths. Resistances of 900 to 1050 Ohms are the normal values range according to Smiths data.

The full-scale meter current is c30mA.

The rectifier can be replaced with a modern silicon full-wave bridge rectifier or use four discrete diodes. The resistance should be replaced by a fixed and variable resistor combination. A filter made from a small ferrite toroid with 5 to 10 turns of wire should be added in series with the input to filter out any induced voltage spikes.

(***Note that the tachometer will need to be recalibrated if this change has been made.)***

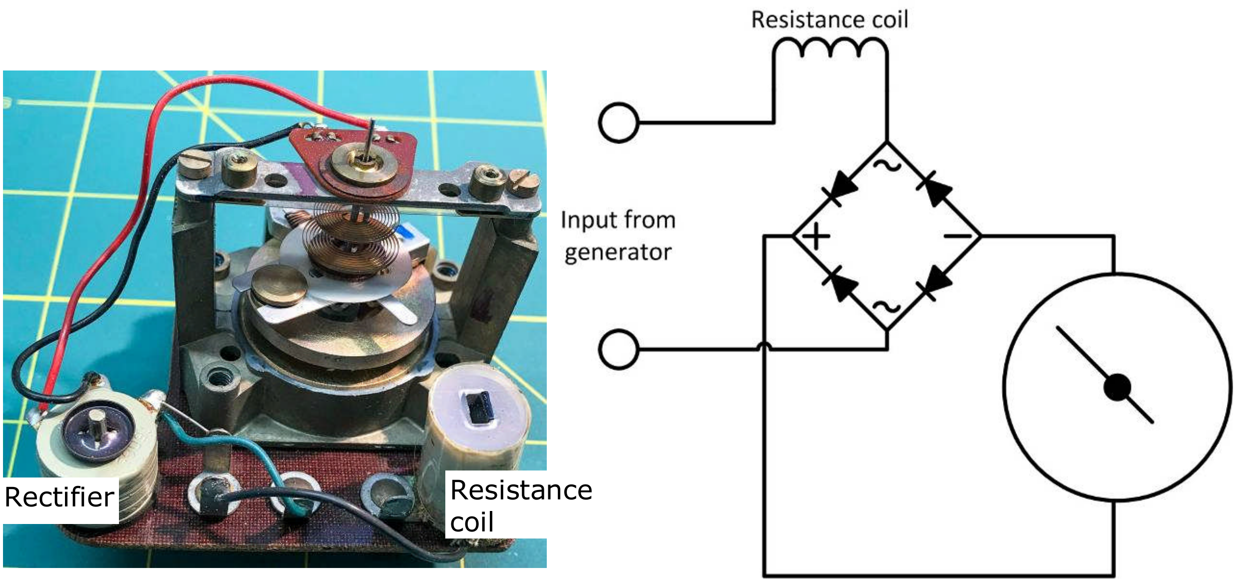



***Figure F.4***: Smiths RV (Gen-0) tachometer. This tachometer has the later style meter as shown at left and the electrical circuit diagram on the right.
*Photograph supplied by Phil Turnbull, NZ*.

### F.2.2 RV 1310/00, RV 1310/01‡, RV 1310/02, RV 1310/03‡ (Gen-0.5) fitted to early sixties Volvo P1800s:

These **negative earth** tachometers were fitted to the 1961 – 1963 P1800 Volvo, aka "Jensen-Volvo" cars. Internally, the tachometer head contained only the meter and a c300 Ohm resistance connected in parallel as shown in *fig. F.6* below

This instrument is driven by a remote electronics module (Volvo Part No. 665258 – No Smiths Part No. for this) that was mounted near the front of the car, and which is connected to the ignition system by a single wire from the distributor points. From the mid 1960s, Volvo recommended replacement of these earlier instruments with the later Gen-1 type (RVI 3410/00).

Information on the Smiths tachometers fitted to 1960s era Volvo cars can be found at:
<http://sw-em.com/Smith%27s%20Tachometer.htm#Smiths_Tachometers_Gen1_vs_Gen2_vs_Gen3>

Regarding the sw-em site, three generations of tachometer are defined which are not the same as the generations defined here.

| sw-em website generation | Gentleman's Guide generation |
|---|---|
| Gen 1 | Gen-0.5 |
| Gen 2 | Gen-1 |
| Gen 3 | Gen-2 |

An excellent reference for Volvo tachometers from 1961 to 1973, compiled by Warren Townsend, can be downloaded from:
https://www.v1800.org/index.php/en/workshop-en/3-electrical-system-en/38-instruments-en/rev-counter-warren-en.html .
At the time of writing, this site also provided a link to a source of replacement remote modules (senders) for these tachometers:
https://www.v1800.org/index.php/en/workshop-en/3-electrical-system-en/38-instruments-en/transmitter-for-tachometer-en.html

**"GEN-0.5" TACHOMETER WIRING AS PROVIDED IN VOLVO SERVICE MANUAL.**
***THIS WIRING DIAGRAM APPLIES ONLY TO RV 1310/nn TACHOMETERS!***

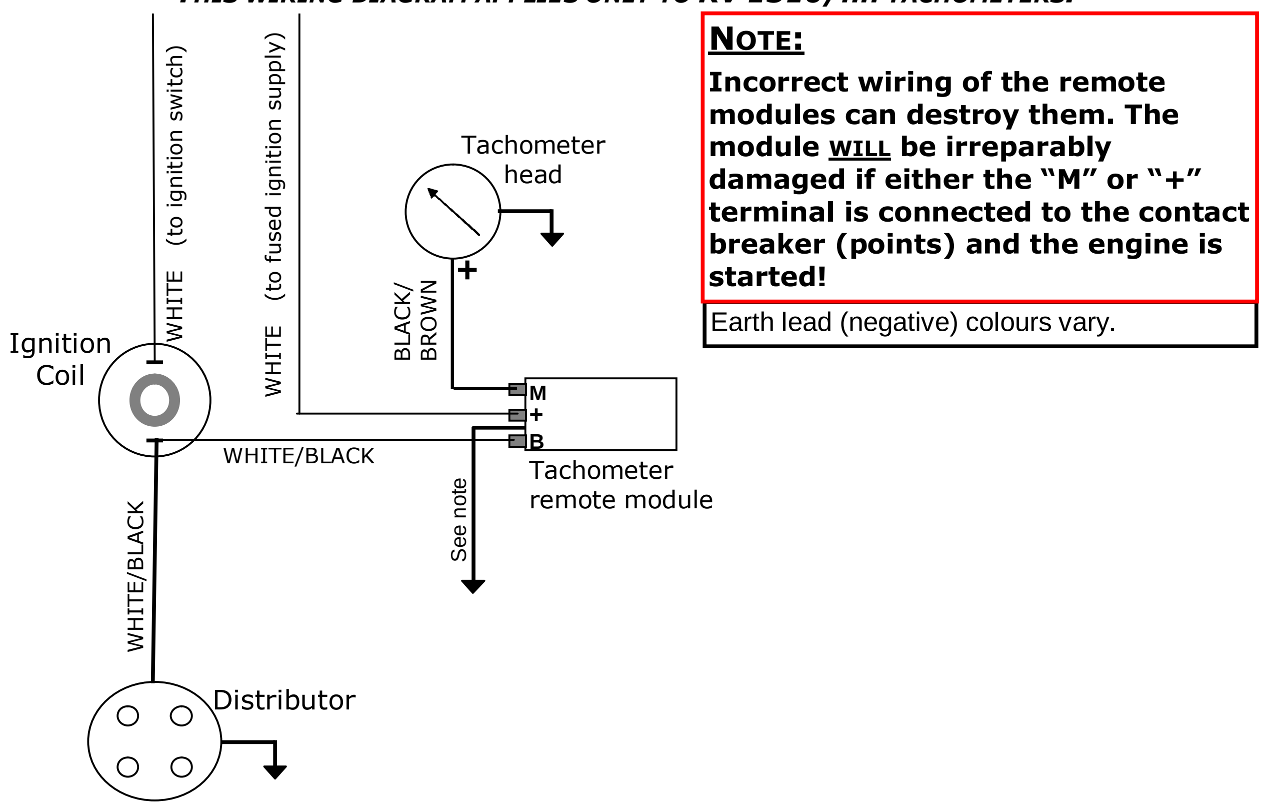



***FIGURE F.5:*** Gen 0.5 tachometer wiring. As fitted to early 1960s Jensen-Volvo P1800 cars.

‡ These instruments have "Swedish wording" on their dials, presumably "V/min" instead of "RPM" though I have not yet seen one. Source: Smiths equipment schedules.

Figure F.7 below shows the internal circuit and construction of the RV 1310/00 style tachometer head.

I have assumed here that factory calibration of the tachometer head, 25mA full scale reading, is performed by changing the ballast resistor value (c300 Ohm in *fig. F.6*). There is no means of calibrating otherwise. The use of a copper coil for calibration, rather than some other form of resistance ensures the meter resistance to ballast resistance ratio remains constant with changing temperature.

The tachometer head itself can be readily checked using the values below and a suitable current source.

| R.P.M. | TEST CURRENT |
|---|---|
| 1000 | 3.6 |
| 2000 | 7.1 |
| 3000 | 10.7 |
| 4000 | 14.3 |
| 5000 | 17.9 |
| 6000 | 21.4 |
| 7000 | 25.0 |

Values at left have been calculated and a good tachometer should show, within a pointer's width, these values. Loss of magnetism in the meter magnet (and ageing of components in the sender) will reduce the reading of the tachometer and there is no provision for user calibration.

*(I would like to thank Benjamin Büttner, of Hamburg, Germany, for his assistance in verifying these figures.)*

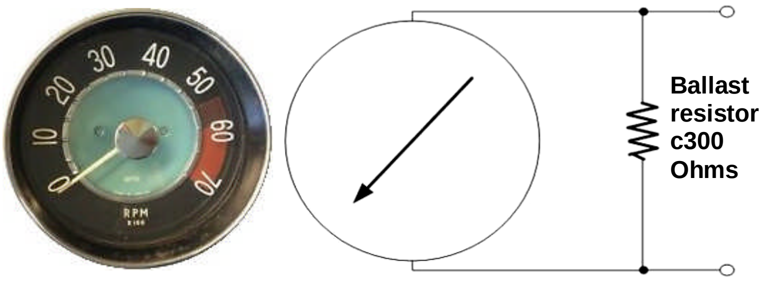



***FIGURE F.6:*** Gen 0.5 tachometer head and internal circuit diagram, as fitted to early 1960s Jensen-Volvo P1800 cars.

Tachometer calibration may be altered by changing the value of the 300 Ohm ballast resistor but the tachometer works need to be removed from the case to do this – not an easy task!

***THE CIRCUIT DIAGRAM OF THE REMOTE SENDER MAY BE FOUND AT WWW.ACCUTACH.COM.***

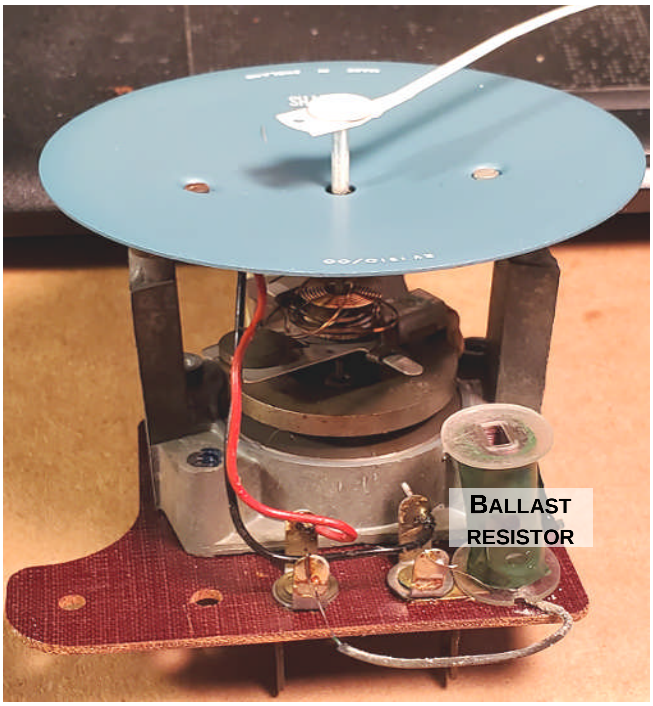



***FIGURE F.7:*** Internal view of Gen 0.5 tachometer head.(*Photograph of tachometer courtesy of Mark Olson, Accutach.)*

Failure of the ballast resistor may be a common form of failure in these tachometers (very high or full-scale reading). Resistance of an electrically sound unit, measured at the rear terminals with connecting wires removed, should be between 55 and 65 Ohms.

If resistance measured across the terminals on the rear of the tachometer case is between 70 and 80 Ohms then an open-circuit ballast resistor is the problem. A measured resistance of c300 Ohms indicates an open-circuit meter or broken wire.

Repair an open-circuit internal resistor fault by fitting an external c300 Ohm resistor to the tachometer external terminals, A fixed resistor/variable resistor combination, will allow (limited) future adjustment should it be required.

Note that the meter shown here has a distorted lower hairspring, possibly caused by connecting a 12V supply directly to the rear terminals.

## *F.3* SMITHS RVI TACHOMETER TRIGGERING:

The following is Smiths description of operation for the Gen-1 instrument. The Gen-2 instrument operates similarly.

> "The primary of the triggering transformer (pulse lead) 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 "short duration voltage pulse", in Smiths description of operation above, must be of the correct polarity to turn a transistor on. The polarity of this pulse is determined by the direction of the magnetic field generated by the coil current flowing in the pulse lead, which is determined by the direction of the current.

So if the current flowing in the pulse lead is flowing in the wrong direction, the generated pulse will try to turn off an already turned off transistor. So nothing happens! (*Thanks to Colin Shaw for raising this.*)

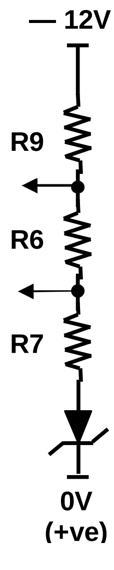
The voltage generated by the triggering transformer is a function of the rate of change of the magnetic field and this is very fast when the points open. It is much slower when the points close, due to the characteristics of the ignition (or any) coil.

**The purpose of the iron core (aka "clip", "Pole piece" "horseshoe"...) is to couple the magnetic field generated by the pulse lead to a similar core in the internal triggering winding. *The tachometer cannot work if this is missing*.** (*At the time of writing, Accutach are able to supply new iron cores for these tachs. Others also list from time to time.*)

The triggering transformer in the Gen-2 tachometer is housed within the tachometer case and only the pulse leads are externally accessible, at the connectors on the rear of the tachometer.

## *F.4* GEN-1 TACHOMETER QUIESCENT CURRENT DRAW:

Current draw, calculated from nominal resistor and Zener diode voltages, ranges from 40 to 80mA. Resistor values and Zener voltages varied between the tachometer types (Accessory, OEM & Diesel) and production date. Current draw greater than 90 or less than 40mA is indicative of an internal fault.




Circuit diagram at right shows the internal power supply circuit, for all except some early OEM tachometers which have a single 150 Ohm resistor.

Arrows show other connections within the circuit which adds about another 15mA to that drawn by the Zener regulator circuit.

R9 can be 82, 100 or 120 Ohms
R6 can be 0 or 27 Ohms
R7 can be 2.2, 3.3 or 5.6 Ohms.

The Zener diode can be 4.7, 5.1, 5.6, 6.2 or even 6.8 Volts.

Current draw was calculated for 12 Volts. Values at higher supply voltages will be slightly higher.

A low quiescent current, between 20 and 40mA, almost certainly indicates an open-circuit Zener diode though this could also indicate an open circuit R6 or R7, in the diagram at right. If no current draw can be measured, either an open-circuit R9 resistor or an internal broken wire are the most probable causes. In any event, the tachometer works will need to be removed from the case to confirm and repair the fault.

## F.5 EARLY GEN-1 OEM TACHOMETER CIRCUIT:

The Gen-1 OEM tachometer was produced in two forms. The earlier form had a limited calibration range. The circuit is shown in *fig. F.8a*. (Note that the presence of the calibrated cylinder number on the dial does not necessarily indicate the earlier OEM circuit.) *Fig. F.8b* is the later rationalised circuit, used for both OEM and accessory instruments – RVI nnnn/nn**A**.

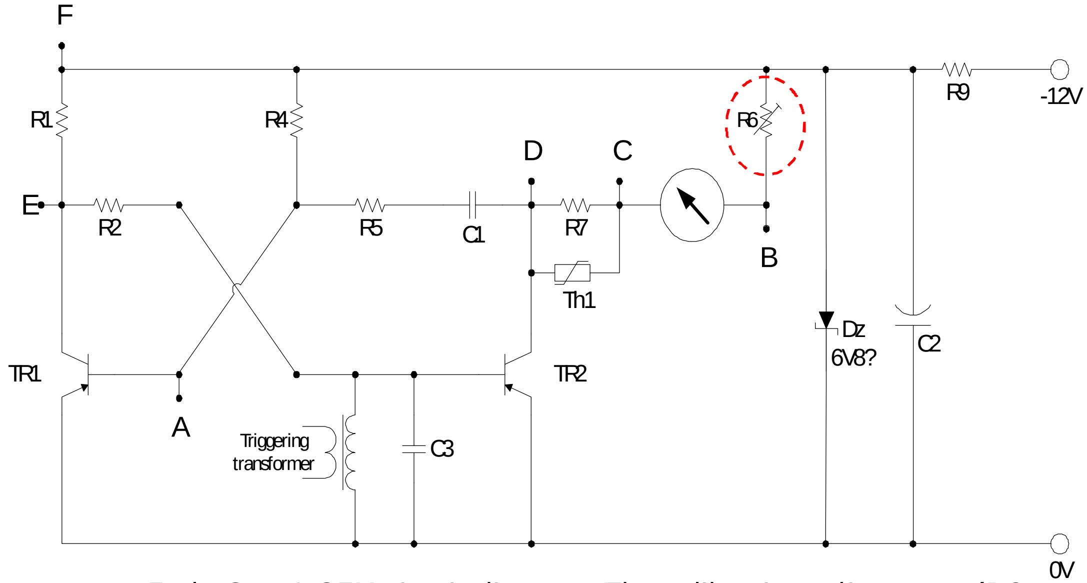



***FIGURE F8a:*** Early Gen-1 OEM circuit diagram. The calibration adjustment (R6, dashed circle) is in series with the meter and will have a value of 50 Ohms. Re-calibration for a different number of cylinders may require changing the timing capacitor C1. and resistor R4 (Part numbers of "C1", "C4" or "C5" for capacitor C1 and "R3", "R4", "R8" and "R10" for resistor R4 are shown in Smiths literature but no specific values provided.)
*Letters on diagrams refer to test points in Smiths literature.*

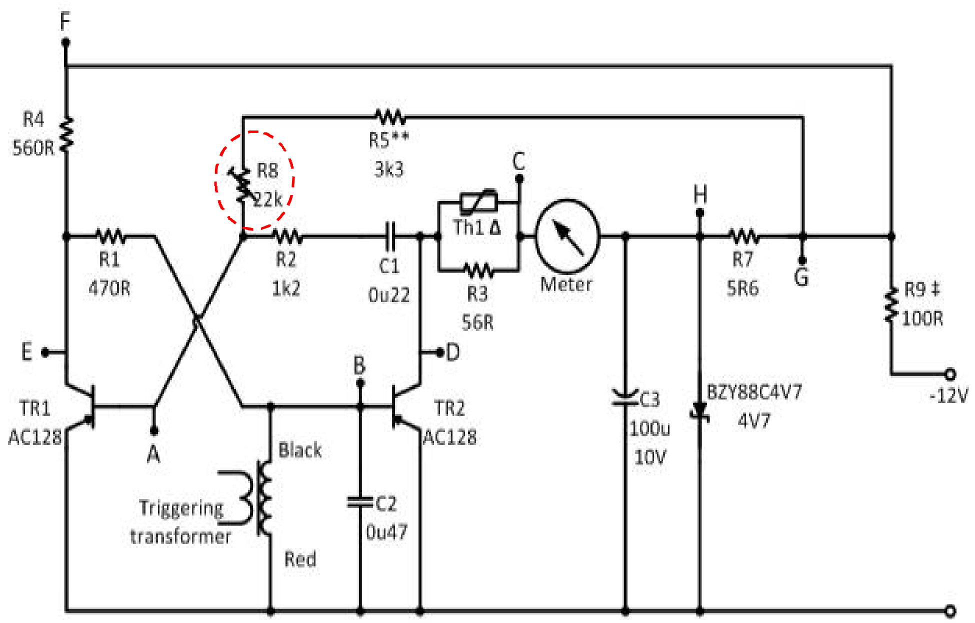



***FIGURE F8B***:Gen-1 rationalised circuit diagram. The calibration adjustment (R8 dashed circle) will have a value of 15k to 22k Ohms and forms part of the pulse-width control circuitry. Re-calibration for a different number of cylinders is simply done by adjusting R8.

## *F.6* GEN-2 CIRCUIT BOARD TYPES:

Two different circuit boards are used in this model tachometer. Later production circuit boards could only ever be used on negative earth vehicles. Early production boards could be fitted to cars of either polarity. Should you have removed a Gen-2 movement from its case, *figs F.9 and F.10* show the difference between the two circuit boards used in these instruments.

The late production Gen-2 circuit board is shown in *fig F.9* and is the more common circuit board found in these instruments. The negative supply circuit board tracks around the mounting screw holes make electrical contact with the body of the meter and hence the chassis of the vehicle.
The upper left hand track is not generally connected but provides a negative supply connection point for a caseless instrument. Hence these instruments are always negative earth as isolation cannot be readily or reliably achieved due to the copper tracks extending to the edge of the mounting screw holes.

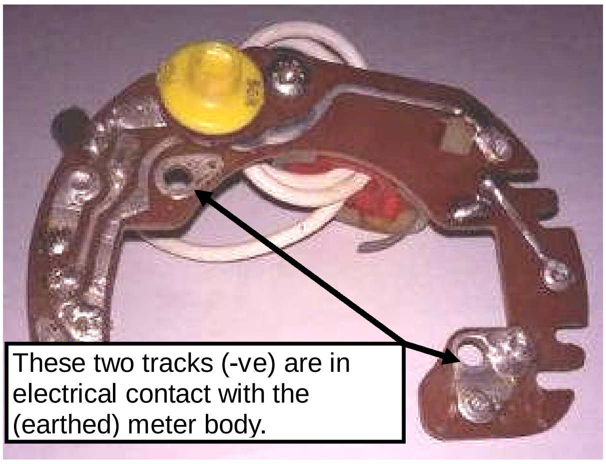



***FIGURE F.9:*** Later production Gen-2 tachometer circuit board for negative earth vehicles.

*Fig. F.10* shows a circuit board from an earlier Gen-2 instrument with a quite different track layout. It will be noted that the circuit board tracks, for both positive and negative, are located at the mounting screw points and that the copper track is set back from the mounting holes to prevent connection with the mounting screws. One supply track must be insulated from the meter frame by way of an insulating washer fitted between the circuit board and the meter frame. If this board is mounted without an insulating spacer then a dead short exists between the power supply terminal and the earth.
This particular board can thus be configured for positive or negative earth vehicles though this would have been a factory, rather than a user, option.

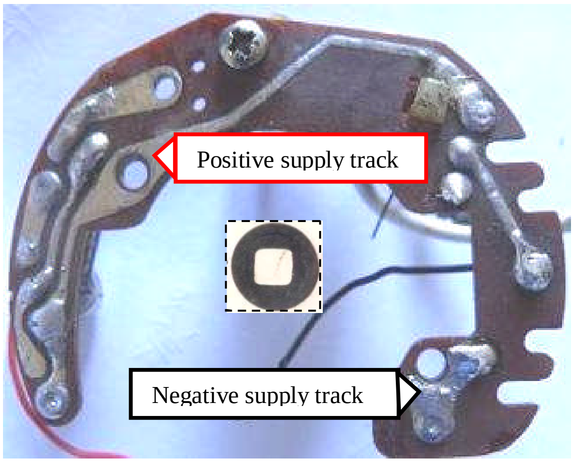
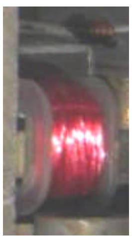



***FIGURE F10:*** Early production Gen-2 tachometer circuit board suitable for positive or negative earth vehicles.
(Note: Calibration potentiometer removed from board.)
Inset picture shows the factory supplied insulator used with this board. The centre hole is sized so that the washer is held in place on the thread of the screw.

As noted earlier, the Gen-2 meter coil differed from others of this style. *Fig F.11* below shows the visible difference. The Gen-2 meter can not be replaced by the others of this style nor vice versa.

***FIGURE F.11:-*** Smiths tachometer meter coil identification. Gen 0, 1, & 3 coil, c75 Ohms, at left. Gen-2 coil, c10.5 Ohms, at right. The red enamel is only used, in the Gen-2 meter.



## F.7 CONNECTING RVC TACHOMETERS TO MODIFIED IGNITION SYSTEMS:

### CASE 1: TACHOMETER TRIGGER ORIGINALLY CONNECTED DIRECTLY TO COIL.

RVC tachometers, OEM or accessory, originally triggered by a connection directly to the distributor side of the coil will almost certainly **not work** when connected to a dedicated tachometer output on an upgraded ignition system.

A diode or resistor (shown dashed/greyed) in *fig F.12* may need to be added to the trigger pulse lead when fitting aftermarket electronic ignition systems. If the tachometer reading is inaccurate, then add a 10k, 1 Watt resistor here. If the tachometer triggering is erratic, add a 1N4007, or similar, diode. Note that the diode is a polarised device so fit with the band marked on the case toward the tachometer. Both these items are readily available from electronic parts suppliers. The diode must have a reverse voltage rating of >400V and a maximum current rating of at least 1 Amp.

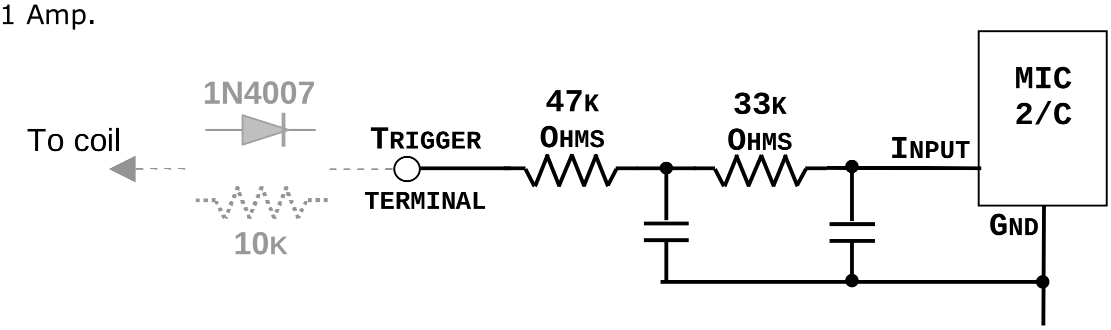



***FIGURE F.12:*** Input circuit diagram for Gen-3 and Gen-4 accessory tachometers.

### CASE 2: TACHOMETER TRIGGER ORIGINALLY CONNECTED TO DEDICATED TERMINAL.

(Found on some Lucas OPUS ignition systems and possibly others also.)

A tachometer of this type should work when connected to a "Tachometer" output terminal when provided on modified systems.

F*ig F.13* shows how to connect the Gen-3 tachometer used in Jaguar V12 powered vehicles (using the Lucas "OPUS" ignition system) directly to a coil. A resistor (shown dashed/greyed) must be added. The input circuit of this tachometer may be damaged if the resistor is not provided.

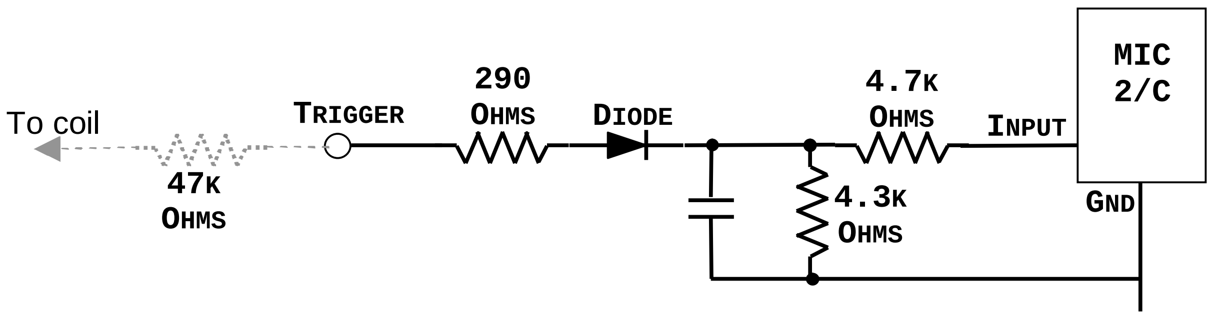



***FIGURE F.13:*** Input circuit diagram for Mk III Jaguar E-Type Gen-3 tachometer for use with Lucas OPUS ignition system. (*Circuit courtesy of Mark Olson*)

### TACHOMETER OUTPUT FROM BOSCH CDI BOXES:

Bosch "6-pin" CDI boxes have a 6V tachometer output signal.

Some Bosch "8-pin" CDI systems have a tachometer output connected internally via a resistor to the coil output terminal. The output is a pulse of amplitude c-450V.

Other units, from published circuit diagrams, have the tachometer output connected via a resistor to the "hot" end of a capacitor at c+450V.

Most tachometers, Smiths RVC included, require a rising pulse to trigger. 5 and 6V signals will be too small to trigger a Smiths tachometer.

## *F.8* MISCELLANEOUS INFORMATION:

### RVI & RVC TACHOMETER PART NUMBERS NOTES – (speculative):

It seems that the first 4 digits after the gauge type describe the size and appearance of the gauge. The next 2 digits signify minor differences such as full scale value.

Trailing letters indicate a hardware change not visible to the end user. A trailing "F" in the part number indicates a Gen-4 instrument with a thick film board. Gen-3 instruments with a copper laminate circuit board do not have the "F" appended. e.g. RVC 6419/00 is a Gen-3 instrument and RVC6419/00F is Gen-4 – both fitted in Triumph TR7 cars. Similar pairings are found for, particularly, MG tachometers.

Gen-4 early meter coil has a resistance of c155 Ohms, the later coil is c205 Ohms..
It appears that the early tachometers are marked "RVC nnnn/nn**F**", later tachometers, "RVC nnnn/nn**AF**".

The first digit appears to specify case size/type: 1 = 3" (80mm), 2 = 4" (100mm), 3 = 4 ¾" (120mm), 4 = 5" (125mm), 5 = pod and 6 = caseless.

## SMITHS AUTOMOTIVE TACHOMETER-RELATED TYPE-CODES

The table below lists Smiths part codes for the various technologies used which formed the first part of the part number. (Replace the "R" with "S" and you have the codes for the speedometer where relevant.)

Generally interpretation was straightforward: "RN" = **R**evolution counter, **N**emag. "Nemag" was Smiths name for the more common magnetic instrument.

"RVI" is unclear though. "RV" = **R**evolution counter, **V**oltmeter but does the "I" denote **I**nternal electronics, **I**nductive pickup or **I**mpulse? Take your pick.

Generators are **T**ransmitter **V**oltage – TV used with RV7000 series tachometers (Daimler/Jaguar) and Diesel tachometers, **P**ick **U**p **R**evolution counter – used with the diesel tachometers, and **S**peedometer **T**ransmitter. **E**lectronic **M**ulti-**P**urpose (?). Some (all?) "EMP" senders are 3-wire devices (Hall-effect?). Other codes may exist.

| PRODUCT | TYPE | PREFIX CODES |
|---|---|---|
| TACHOMETER (mechanical) | Nemag | RN |
| | Shallow Mag | RSM |
| TACHOMETER (hybrid electric/mechanical) | Electromag | RE |
| TACHOMETER (electric) | Moving Coil | RV |
| TACHOMETER (electronic) | current sensing | RVI |
| | voltage sensing | RVC |
| | Generator | RVP,RGP |
| GENERATOR/PICK-UP | Diesel tachometer | PUR |
| | Speedometer | ST |
| | RV7000 series tachometer | TV |
| | Later electronic tachometer/speedometer | EMP |

## *Change log:*

| Date | Version | Change list |
|---|---|---|
| Dec 2019 | 2 | Re-order document. contents<br>Add section for Gen 0.5 instrument<br>Change (widen) acceptable resistance values for Gen-1 testing to account for variations between accessory and OEM types.<br>Section on replacing mechanical tachometer with electronic removed..<br>Added comments re other types of tachometer (ATRC etc.)<br>Gen-1 pickup clip details added |
| Dec 2019 | 2.1 | Minor cosmetic changes. Some minor changes to wording (grammar/typography). |
| April 2020 | 2.1 | Add tips for removing bezel. Rename “Miscellaneous” to “Bezel refurbishing”. |
| June 2020 | 2.1 | Additional warning text added to “Tabbed Bezel Removal” section. Section re-ordered. |
| July 2020 | 2.1 | Minor enhancements to text/illustrations |
| November 2020 | 2.2 | Added information on the “Gen-0.5” tachometer. |
| March 2021 | 2.3 | Added section describing the differences in Gen-2 circuit boards. Added further information on the Gen-0.5 instrument. Also insulating block dimensions for Gen-1 tachometer. |
| July 2021 | 2.4 | Added section on mod to RVC wiring when replacing Opus ignition. |
| December 2021 | 3.0 | Rewrite of RVI sections and addition of wiring diagrams and tachometer triggering sections. |
| July 2022 | 3.1 | Re-write of Appendix D (iron core). Re-arrangement of some sections. Addition of information on early-pattern meters and Marine tachometer. |
| December 2022 | 4.0 | Complete re-hash of document. Sections re-ordered, data moved between sections and some additional information added. “Classic” added to title page. Factual errors corrected. |
| May 2023 | 4.0 | Final edits. Some additional information added. |
| May 2024 | 4.00 | Final final edits. Rewrite of Appendix F section F2.2.<br>Extensive updating of early 1960s Volvo P1800 tachometer sections. |
| July 2024 | | Final final final edits. Section on screw threads added. Some additional information in body of text. |
| | | |
| | | |
| | | |