

Tachometers

TACHOMETERS

The tachometer consists of three units, the generator, the computer box and the indicators.

The total range indicator is operated by the voltage parameter of the generator, and covers the full speed range of the engine. The expanded scale instrument is acted upon by a frequency parameter fed to it through the computer box, and covers only an expanded or critical portion of the total speed range.

A conventional rectifier type, permanent magnet moving coil voltmeter forms the voltage sensitive indicator. The frequency sensitive indicator operates in conjunction with a specially developed electronic circuit designed to provide the required high accuracy.

As the output frequency of the generator is a direct function of the engine speed, the frequency ratio available for the indicator over the expanded or critical portion of the total engine speed is reduced as the speed range to be indicated is reduced. It is therefore necessary to increase the frequency ratio supplied to the indicator, and this is done in the following manner. The figures quoted are only by way of an example.

Assume the required range of the frequency sensitive indicator to be from 7,000 to 8,000 r.p.m. Then with a 24 pole generator running at half engine speed, the frequency range of the generator output will be 700-800 c.p.s. which is a ratio of 1: 1.14. This must be raised to at least 1: 2.5 to give a good circular scale instrument, and is accomplished as follows:

The generator output of 700 to 800 cycles is made to beat with the output of a 650 cycle tuning fork oscillator. This gives a beat frequency of 700 minus 650, to 800 minus 650 cycles, that is, 50 to 150 cycles. By this method, the ratio is increased to 1: 3. A high input filter is connected in the input to the modulator to eliminate all frequencies below 650 cycles, as, at generated frequencies of 500 to 600 cycles, beat frequencies of 150 to 50 cycles are produced, which, unless removed, would give false indications.

After passing through a low pass filter which takes out any unwanted higher frequencies, the beat frequency is amplified and applied to a transistor relay which transfers a condenser charge from a 28 volt d.c. supply to one coil of the expanded scale indicator. The time constant of the condenser is made of such a value that the condenser is fully charged and fully discharged at each cycle. Therefore, the average d.c. current flowing in the indicator coil is directly proportional to the frequency.

This is given by the equation:-

	I_{av}	=	CEn
	I_{av}	=	average d.c. current in amperes.
where	C	=	value of condenser in farads
	E	=	voltage of supply
	n	=	number of pulses per second

The other indicator coil is energised from the same 28 volt supply through a suitable series resistance. The current flowing in this coil is thus also proportional to E , and as the indicator is of the ratiometer type, the combined effect is that the indication is independent of E , and proportional only to Cn . Accuracy and stability depend upon C , which is a high stability, silvered mica condenser.

It should be noted that the equation for I_{av} contains no function of resistance; consequently the indication is independent of lead resistance over a wide range.

It may be necessary to reduce the engine to generator gear ratio from 2:1 to 4:1, so that a generator runs at 1/4 engine speed. This would reduce the generator frequency output by one half, and a way must be found to restore the frequency range to its original value.

This is done by using a frequency doubler after the input filter.

The frequency doubler takes the form of a full wave bridge rectifier which produces a d.c. output with a superimposed ripple of twice the input frequency. This ripple is used to modulate the fork frequency in the usual way.

When using this system, it becomes necessary to eliminate a second harmonic in the frequency doubler output which reacts with another second harmonic in the cathode of the modulator to produce a spurious output. To this end, a parallel tuned condenser/choke circuit is placed between the frequency doubler rectifiers and the cathode resistor of the modulator.

POWER SUPPLIES

- a) 115 volts, 400 c.p.s. 3 phase
Consumption 30VA at .9 power factor approximately with substantially balanced loading.
- b) 28 volts d.c. at 50mA approximately. This supply, including the wiring to the computer box, must be of low impedance, that is, not greater than 10 ohms. In order to eliminate possible pointer oscillation on the expanded scale indicator, the 28V d.c. supply must be reasonably free from ripple.

The above ratings apply to a two-engine equipment.

MODEL S 168 FORM 1—TACHOMETER GENERATOR

The Model S168 Form 1 generator is a single-phase 24 pole alternator type generator, having a permanent magnet rotor operating in conjunction with a wound stator structure in which the output voltage is generated.

The electrical terminations are brought out to a 2-pin glass-sealed plug which mates with two core leads having moulded sockets, listed in Section 18.

The steel shaft of the rotor is fitted with a 16 tooth male spline for attachment of the driving gear (Square shafts may be supplied if required)

The fixing dimensions conform to B.S.I. drawing No. 1677

Output of generator = 10 volts, 200 c.p.s. per 1000 r.p.m.

Wave form approximates to a sine wave.

Resistance of generator = 25 ohms approx.

Operating temperature = $-70^{\circ}\text{C} + 125^{\circ}\text{C}$

Temperature co-efficient approximates to 0.0001 volts per $^{\circ}\text{C}$ rise over operating range

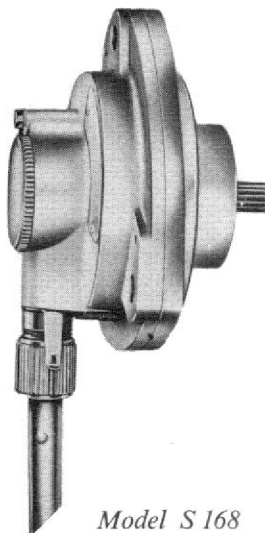
Minimum rotational speed of generator = 1000 r.p.m.

For speeds above 6000 r.p.m. reduction gears should be fitted between drive shaft and generator.

Initial adjustment of output voltage = $\pm 1\%$ at 20°C

Weight = 19 oz (539 g)

Fixing Diagram = FD.881



Model S 168

MODEL S 169 FORM I—COMPUTOR BOX

This is of splashproof metal construction, and all connections are made via Plessey Mark IV 6-pin plugs. There are three sub-chassis, of which one is a combined power supply and tuning fork oscillator, the remaining two being identical tachometer channels.

These separate sub-chassis have been designed for easy removal, the only connections between them consisting of six soldered "bus-bar" type leads.

All components are fully tropicalised, and the complete unit is satisfactory for use over the range -40°C to $+55^{\circ}\text{C}$, the upper limit of which is determined by the metal rectifiers used on the power supply chassis.

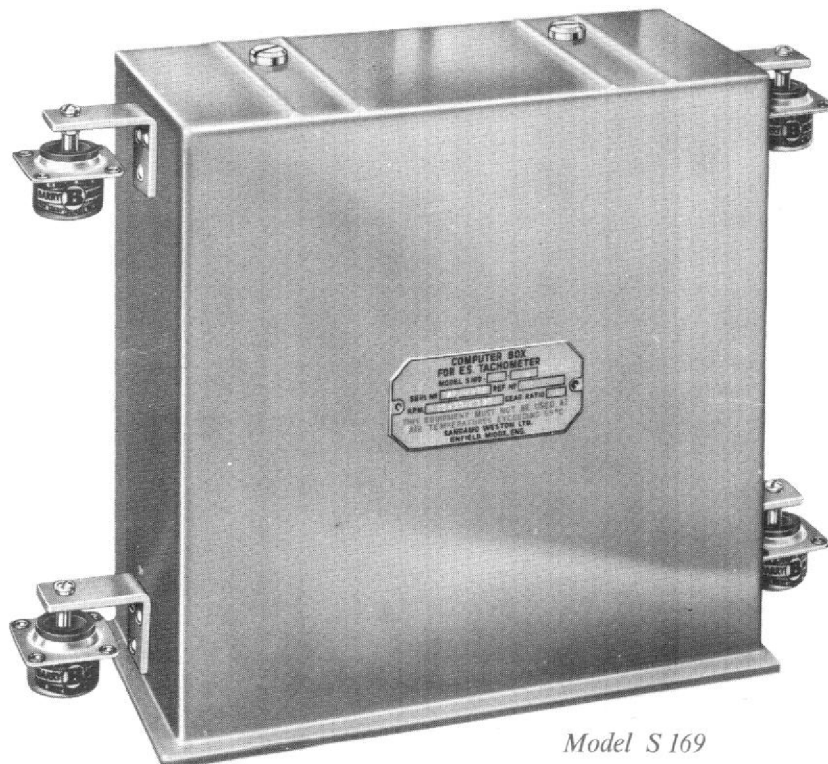
The valves used are type 13D2 (Brimar Trustworthy Range). These are double triodes and may in extreme circumstances be replaced by type 6SN7.

The computor box is not affected by changes in pressure, the error introduced by a change of altitude of 40,000 ft. being less than 0.02%.

For the protection of the valves and relays the unit should always be anti-vibration mounted.

The connection to the tachometer channels is arranged so that generators and indicators cannot be cross connected.

Weight = 10 lb 8 oz (4.763 kg) Fixing Diagram = FD.883



Model S 169

TOTAL RANGE R.P.M. INDICATORS

A.C. Voltmeters listed in Section 2 may be supplied as total range r.p.m. indicators and are suitable for direct use with Model S168 generators.

This type of indicator is basically an a.c. voltmeter scaled in r.p.m. and indication is proportional to the voltage output of the generator. 10V per 1000 r.p.m.

For ranges over 6000 r.p.m. reduction gearing is used to keep the generator speed within its maximum rating. The gear ratio must be specified when ordering indicators.

MODEL S 175 DUAL INDICATOR

When used as a tachometer indicator, the instrument consists of two movements, one of which is an S63 ratiometer used as a frequency sensitive indicator, and another which is an S78 movement used as a voltage sensitive indicator.



Model S 175

The voltage sensitive indicator is an a.c. rectifier type voltmeter with a sensitivity of 1000 ohms/volt, and a scale length of 260 degrees. The frequency sensitive indicator is a circular scale ratiometer with a scale length of 245 degrees. This reduction of scale length is necessary to accommodate a pointer shield at its lower end. When the r.p.m. is below the minimum value shown on this scale, the pointer disappears behind the shield, thus obviating ambiguity. Any failure in the 28 volt d.c. supply will cause the expanded pointer to be swept off behind its shield due to the operation of the pointer return unit.



Accuracy:

Voltage indicator (Total range) = $\pm 2\%$ of full scale

Frequency indicator (Expanded scale -
range intercept of 1000 r.p.m.),

0°C to 40°C = ± 20 r.p.m.

-10°C to 0°C and +40°C to +50°C = ± 30 r.p.m.

-20°C to -10°C and +50°C to +60°C = ± 40 r.p.m.

Size = Large S.A.E. case

Weight = 19 oz (539 g)

Fixing Diagram = FD. 895

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