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ELECTRICAL TACHOMETER FOR INTERNAL COMBUSTION ENGINES

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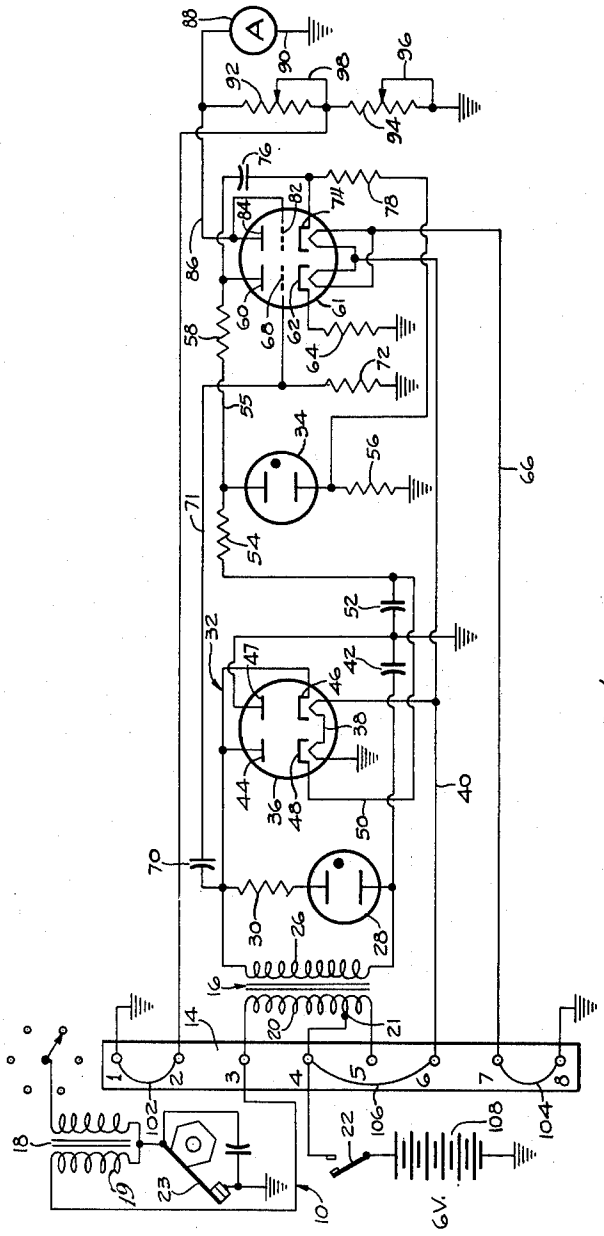


Fig. 1

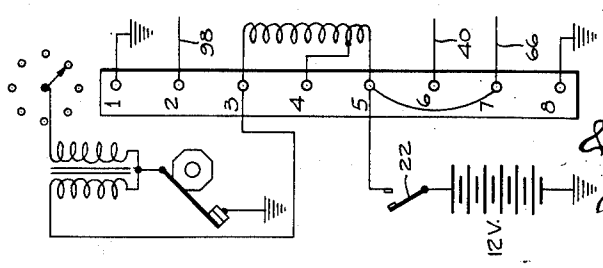


Fig. 2

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ELECTRICAL TACHOMETER FOR INTERNAL COMBUSTION ENGINES

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8 Claims. (Cl. 324—70)

The present invention relates to an improved electrical tachometer for internal combustion engines having electrical ignition systems.

One object of the invention is to provide as an accessory for an automotive vehicle, an internal combustion engine tachometer energized and controlled by the ignition system of the vehicle engine, and capable of accurately indicating the engine speed without calibration on the engine. A related object is to provide a tachometer of this character that will not interfere with the normal operation of the ignition system which serves as its power source and controlling agency.

Another object is to provide an electrical tachometer energized and controlled by the ignition system of an internal combustion engine and capable of giving accurate indications of engine speed which, for practical purposes, are unaffected by changes in the ambient temperature, by variations in the compression level, dwell time, primary battery voltage, or other factors which influence the operating characteristics of the ignition system.

Another object is to provide a tachometer of the above character, which will accurately indicate engine speeds ranging from speeds even below normal idling speed, to speeds above those reached by the highest speed engines.

In conjunction with the preceding objects, a further object is to provide an electrical tachometer which can be readily adapted through simple wiring connections to give accurate indications of the speed of engines having different numbers of cylinders and equipped with ignition systems of different primary voltages, no calibration of the tachometer on the engine being required.

An additional object is to provide an electrical tachometer of the above character which is inherently suited to be quickly installed and readily serviced in an automotive vehicle.

Other objects will become apparent from the following description of the embodiment of the invention illustrated in the drawing, in which:

Figure 1 is a schematic wiring diagram of a preferred form of the invention, illustrating terminal panel interconnections with a six volt ignition system for a six cylinder engine; and

Fig. 2 is a fragmentary diagram showing the terminal panel connections for a twelve volt ignition system for an eight cylinder engine.

The tachometer illustrated is grounded and interconnected with a typical ignition system **10** for an internal combustion engine (not shown) through a series of terminals located on a panel **14** and numbered from **1** to **8**. Energization and control of the tachometer from the ignition system without interfering with the normal operation of the latter is effected by a voltage step-up transformer **16** which maintains an effective isolation of the tachometer from the ignition system. Designed to be connected in series with the primary winding of the engine ignition transformer **18**, the primary transformer coil **20** has a very low impedance.

Opposite ends of the primary coil **20** are connected to terminals **3** and **5**. An intermediate tap **21** on the coil is connected to the terminal **4**. When the tachometer is used with six volt ignition systems, for example, the terminal **4** (as shown in Fig. 1), is connected to the ignition switch **22** and the terminal **3** is connected to the primary winding **19** of the ignition transformer **18**. Thus, in this instance the interrupted current flowing through the ignition primary **19**, as controlled by the circuit breaker **23**, passes through only that portion of the tachometer primary **20** interconnected between terminals **3** and **4**. As shown in Fig. 2, the connections for a twelve volt ignition system are the same except that the ignition switch **22** is connected to the terminal **5** instead of terminal **4**, thus placing all the tachometer primary coil **20** in series with the ignition primary **19**. By thus changing the effective turns ratio of the transformer **16**, compensation is made for the difference in the primary current flow in twelve volt and six volt ignition systems. The transformer **16** is designed and the tap **21** so located as to effect a voltage step-up of the order of 50 to 1 for twelve-volt operation and 66 to 1 for six-volt operation.

The output voltage of the transformer secondary coil **26** of the tachometer is limited by a gaseous discharge element or glow lamp such as a neon tube **28** connected across the outlet terminals of the coil in series with a resistor **30** having a resistance of about 22 kilohms.

Thus limited, the voltage output of the transformer **16** is rectified by a voltage doubling rectifier circuit means **32**, which supplies a unidirectional voltage that is controlled by a second gaseous discharge element or neon tube **34**. The rectifier circuit means comprises a full wave voltage doubler rectifier tube (6AL5) **36** having heaters **38** connected between ground and a conductor **40** which leads to the terminal **6**. The manner of energizing tube heating terminals on the panel **14** will be described later. One terminal of the transformer secondary **26** is grounded through a filtering capacitor **42** which may have a capacity of 8 microfarads. The other terminal of the secondary **26** is connected to the anode **44** and the cathode **46** of the respective sections of the twin diode rectifier **36**. The other anode **47** of the tube is grounded, while the other cathode **48** is connected to a conductor **50**.

The rectified voltage on conductor **50** is filtered by a grounded capacitor **52** of 30 microfarads capacity and by a series resistor **54** connected between conductors **50** and **55** and having a resistance of the order of 47 kilohms. Thus filtered, the voltage of the pulses is limited to a substantially constant amplitude by the previously mentioned voltage regulator **34** connected between the conductor **55** and a grounded resistor **56** having a resistance of about 1200 ohms.

The controlled voltage thus derived from the ignition system is used to supply the plate voltage to the frequency meter section of the tachometer. As shown, the voltage in the conductor **55** is applied through a resistor **58** of about 47 kilohms to the anode **60** of the first half of a dual triode (12AT7) **61**. The anode **60** thus forms an input terminal of the frequency meter. The cathode **62** opposing the anode **60** is grounded through a resistor **64** of about 680 ohms. The heaters of the dual triode **61** are connected in parallel between conductors **40** and **66** leading to the terminals **6** and **7**, respectively.

The amplifier formed by the first half of the tube **61** is controlled by voltage pulses having a frequency determined by the intermittent energization of the engine ignition system **10**. A highly satisfactory source of such impulses is formed by the transformer secondary **26**. Due to the very low impedance of the transformer primary coil **20**, the breakdown voltages induced in the secondary coil are substantially unaffected by changes

in the ignition system primary voltage, compression level, dwell time, and other factors which normally vary the operating characteristics of the ignition system itself.

The uniform breakdown voltages in the secondary coil **26**, which for practical purposes are sensitive only to the make and break of the ignition system, are impressed upon a grid **68** of the first triode of tube **61** through a conductor **71** and a blocking capacitor **70** which allows only the oscillatory components of the pulses to be impressed on the grid. The amplitude of the pulses applied to the grid **68** is sufficiently great to drive the amplifier alternately to saturation and to tube cut-off to produce output pulses of uniform amplitude. The grid **68** is grounded through a resistor **72** of approximately 470 kilohms.

The output pulses of the amplifying section of the tube **61** are rectified in the second half of the tube. As shown, the anode **60** of the amplifier section is connected to the cathode **74** of the rectifying section of the tube through a capacitor **76** having a value of 0.012 to 0.015 microfarads. This capacitor has a positive temperature coefficient which balances the negative temperature coefficient of the coacting resistors, thus maintaining the overall accuracy of the tachometer substantially immune from changes in the ambient temperature.

A bucking voltage for the contact potential across the rectifier portion of the tube **61** is applied to the cathode **74** through a resistor **78** of about 22 kilohms connected between the grounded resistor **56** and the voltage regulating tube **34**.

The grid **82** of the rectifier portion of the tube **61** is connected to the adjacent anode **84**. A conductor **86** connects the anode **84** to one terminal of a microammeter **88**. The other ammeter terminal is grounded through a second lead line **90**. The microammeter dial is suitably graduated to indicate engine speed. A standard 0–100 microampere D'Arsonval movement meter can be used for this purpose.

Precalibration of the tachometer for use on engines having different numbers of cylinders—for example, 6 or 8 cylinder engines—is provided for by two variable resistors **92** and **94** connected in series between the conductor **86** and the ground to shunt the ammeter **88**. A shiftable grounding contact **96** on the resistor **94** is so adjusted that the total effective resistance of the two resistors **92** and **94** properly calibrates the meter to give accurate speed indications when the tachometer is used on 6-cylinder engines. A second contact, connected by conductor **98** to the terminal **2**, is preadjusted in relation to the resistor **92** so that upon connection of terminal **2** to grounded terminal **1** by a jumper **102** the tachometer is properly calibrated for use on 8-cylinder engines.

The ammeter pointer of the tachometer will give steady indications of even very low engine speeds. Pointer movement toward zero is dynamically braked by short circuiting of the ammeter coil through the rectifier portion of the tube **61**.

The tachometer is well suited for use as an accessory for an automotive vehicle. Energized through the two conductors **86** and **90**, the ammeter **88** can be easily adapted for mounting on the dash, steering column, or other suitable location on the vehicle. The remaining elements of the tachometer are preferably mounted as an assembly housed in a casing adapted for attachment to the fire wall.

Interconnection of this assembly with the vehicle requires only three conductors, one being a suitable grounding strap. A conductor from the terminal **4** or **5** is connected to the vehicle ignition switch **22**, and another conductor connects the terminal **3** to the ignition transformer **18** as previously described. It will be understood that the connections from the terminals **3** and **4** or **5** to the switch and to the ignition transformer may be reversed to provide proper polarization of the transformer **16**, depending upon which terminal of the battery is grounded.

For installation convenience, the tachometer can be supplied from the factory ready for use on 8-cylinder engines equipped with six-volt ignition systems. In this instance, the terminal **2** will be connected by the jumper **102** to the grounded terminal **1**, thus making use of the precalibration for eight-cylinder operation (Fig. 1). Upon removal of the jumper **102**, the tachometer is ready for use on a six-cylinder engine (Fig. 2).

For six volt operation the heater terminal **7** is connected to the grounded terminal **8** by a jumper **104**, as shown. The other tube heater terminal **6** is connected by a jumper **106** to the terminal **4**, which ordinarily will be connected to the vehicle battery **108** through the ignition switch **22**. Thus, the heaters of both tubes **36** and **61** are connected in parallel between the six volt battery and ground. In the event the terminal **3** is connected to the ignition switch to provide proper polarization of the tachometer, as previously discussed, the jumper **106** should be switched from the terminal **4** to the terminal **3** to receive power directly from the battery.

For use with engines having 12-volt ignition systems, the jumper **104** grounding terminal **7** to terminal **8** is removed and the jumper **106** is shifted from the terminal **6** to terminal **7** (see Fig. 2), thereby placing the heating elements of the two tubes **36** and **61** in series with each other between the twelve volt battery and ground.

The tachometer thus formed is well suited for use on any one of a very large percentage of the automotive vehicles produced, adaptation of the instrument for interconnection with engines having different numbers of cylinders and equipped with ignition systems of different voltages requiring merely a few changes in simple wiring connections on a terminal panel or strip. This not only facilitates installation of the tachometer but it eliminates any need for manufacturing and stocking a large number of different models or adapter units to equip the major portion of the automotive vehicles currently in use.

It will be appreciated further that the procedure for installing the tachometer on engines having standard ignition systems is highly simplified by the capability of the device accurately to indicate engine speeds without calibration on the engine. Calibration on the engine is ordinarily required only on engines having non-standard ignition coils. Unless the tachometer is calibrated for use with heavy duty ignition coils, its speed indications will be slightly high even though the linearity of the readings is not affected.

The capability of the tachometer to function accurately without calibration on the engine with which it is used is realized in part at least from the electrical isolation of the tachometer from the ignition system which serves as its signal and plate voltage source. Moreover, the voltage pulses produced by the transformer which achieves this isolation are, for practical purposes, unaffected by the varying operational characteristics of the ignition system itself. These pulses, as further refined in the tachometer, serve to produce the desired accuracy in the speed indications.

Energized from the pulsating current in the ignition system, the tachometer operates independently of an auxiliary power source, thus avoiding the inaccuracies which might otherwise arise due to plate voltage variations.

The capability of the tachometer to produce accurate speed indications throughout all operating conditions of the engine with which it is used is further assured by the ability of capacitors in the system to compensate for variations in the values of other electrical components of the assembly due to changes in the ambient temperature.

Having no mechanically moving parts except for those in the standard ammeter used, the tachometer is capable

of accurately indicating engine speeds attained by the fastest engines.

Manufacturing and servicing of the tachometer are simplified by the use of standard electronic components in its construction. Replacement parts can be obtained from radio repair shops. It will be understood that the ratings of the electrical components mentioned herein are illustrative only and do not limit the scope of the invention.

While I have shown and described a preferred embodiment of my invention, it will be apparent that numerous variations and modifications thereof may be made without departing from the underlying principles and scope of the invention. I therefore desire, by the following claims, to include all such variations and modifications by which substantially the results of my invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. An electrical tachometer adapted to be interconnected with the ignition system of an internal combustion engine and comprising, in combination, a power supply and electrical isolation transformer having a low impedance primary winding adapted to be connected in series with the ignition system, rectifier and filtering circuit means connected to receive the output voltage of the transformer secondary, voltage limiting means connected to limit the output voltage of the rectifier and filtering circuit means to a uniform value, frequency meter means including a vacuum tube amplifier having a control grid therein, means connected to apply the output voltage from said rectifier and filtering circuit means as a plate potential on the amplifier, means connected to apply voltage pulses from said transformer secondary to the amplifier control grid, rectifier tube means connected to rectify the output of said amplifier tube means, means interconnected with the output of said rectifier and filtering circuit means and said rectifier tube means to apply a reduced bucking voltage against the voltage supplied from said amplifier to said rectifier tube means, and a graduated ammeter connected to the output of said rectifier tube means.

2. An electrical tachometer adapted to be interconnected with the ignition system of an internal combustion engine and comprising, in combination, an electronic frequecy meter including a vacuum tube having an amplifier stage forming an input for the meter, an electrical transformer having a primary of very low inductance adapted to be connected in series with an ignition coil of the engine ignition system, a voltage limiter connected to the transformer secondary, a voltage doubling and rectifying circuit connected to the voltage output of the transformer secondary as limited by said voltage limiter, means for filtering the output voltage of the voltage doubling and rectifying circuit, a voltage limiter connected to limit the output voltage of the voltage doubling and rectifying circuit, means for applying the limited output voltage of the voltage doubling and rectifying circuit as a plate voltage on the amplifier stage of said frequency meter tube, and means for applying voltage pulses from the transformer secondary as a control grid voltage in the amplifier stage of the frequency meter tube.

3. For use with an internal combustion engine having an ignition circuit supplied with interrupted current, an electrical tachometer comprising, in combination, an electronic frequency meter including an electronic input amplifier, a power supply and electrical isolation transformer having a high inductance secondary and having a primary of relatively low inductance adapted to be interconnected with the engine ignition circuit, rectifying and filtering circuit means connected to the transformer secondary to supply therefrom a filtered direct current voltage, voltage limiting means connected to limit the output voltage of the rectifying and filtering circuit means to a substantially constant value, means connected to apply the regulated output voltage of the rectifying and filtering circuit as a plate voltage on the frequency meter amplifier, and means interconnected between the transformer secondary and the meter input amplifier to apply voltage pulses from the secondary as a grid voltage on the amplifier.

4. For use with an internal combustion engine having an ignition circuit supplied with interrupted current, an electrical tachometer comprising, in combination, an electrical frequency meter including an electronic input amplifier having a control grid therein, a power supply and electrical isolation transformer having a primary of very low inductance adapted to be connected in series with the engine ignition circuit and a secondary of relatively high inductance, rectifying and filtering circuit means connected to the transformer secondary to supply a continuous direct current voltage, voltage limiting means connected in association with the rectifying and filtering circuit means to limit the output voltage of the latter to a substantially constant value, means for applying the regulated output voltage of the rectifying and filtering circuit means to the frequency meter input amplifier as a plate voltage on the latter, and means for applying the voltage pulses induced in the transformer secondary to the frequency meter amplifier control grid to control the frequency meter input.

5. For use with an internal combustion engine having an ignition circuit supplied with interrupted current, an electrical tachometer comprising, in combination, an electronic frequency meter including an electronic input amplifier having a control grid therein, a power supply and electrical isolation transformer having a primary adapted to be interconnected with the engine ignition circuit, voltage limiting means including a gaseous discharge tube connected to the secondary of the transformer to limit the output voltage thereof; voltage doubling, rectifying, and filtering circuit means including a vacuum tube connected with the output of the transformer secondary to supply a filtered direct current voltage; voltage limiting means including a gaseous discharge tube connected to the output of the voltage doubling and filtering circuit means to limit the output voltage thereof, means connected to the voltage doubling and filtering circuit means to apply the regulated output voltage thereof to the frequency meter input amplifier to form a substantially constant potential plate bias on the latter, and means connected between the transformer secondary and the frequency meter amplifier control grid to control the frequency meter input from voltage pulses in the secondary.

6. In combination with an internal combustion engine ignition circuit supplied with interrupted current, an electrical tachometer comprising, an electronic frequency meter including an input stage having an input terminal and means for controlling the current flow from the terminal, a transformer having a primary adapted to be connected with the engine ignition circuit, rectifying and filtering circuit means connected to the transformer secondary to supply a direct current voltage, voltage limiting means connected with the rectifying and filtering circuit means to limit the output voltage thereof to a substantially constant value, conductor means connected to apply the regulated output voltage of the rectifying and filtering circuit means to said frequency meter input terminal, and means electrically interconnected between the ignition circuit and the current flow control means in the frequency meter input stage to cyclically energize the current control means in accordance with the electrical cycles in the ignition circuit.

7. For use with ignition systems of different voltages and ignition systems for engines having different numbers of cylinders, an electrical tachometer comprising, in combination, a transformer having a low impedance primary adapted to be connected in series with an ignition

system, means defining a plurality of connecting terminals, opposite ends of the transformer primary being connected to two of the terminals, an intermediate tap of the transformer primary connected to another of the terminals, rectifying and filtering circuit means including a vacuum tube connected to the transformer secondary, a heating element in the vacuum tube connected to another of said terminals, voltage limiting means connected with the rectifying and filtering circuit means to limit the output voltage thereof to a substantially constant value, a frequency meter including a vacuum tube having an input amplifying stage, means connecting the output of the rectifying and filtering circuit means to the frequency meter tube to apply a substantially constant plate voltage to the latter, the frequency meter amplifying stage having a control grid therein connected to receive voltage pulses from the transformer secondary, the frequency meter tube having a heating element therein connected to the heating element of the first mentioned tube and to another of said terminals, resistance means in the frequency meter precalibrating the meter for use with engines of a first given number of cylinders, and second precalibrated means connected between another of said terminals and the frequency meter precalibrating the meter for use with engines having a second given number of cylinders upon grounding of the last mentioned terminal.

8. An electrical tachometer adapted to be powered and controlled by the ignition systems of internal combustion engines having different numbers of cylinders, and comprising, in combination, an electronic frequency meter having an amplifying input stage including an input terminal and control means for controlling the current flow from the terminal, a power supply and electrical isolation transformer having a low inductance primary adapted to be connected with an engine ignition system, means forming a series of electrical terminals thereon, means connecting the transformer primary to at least two of said terminals, rectifying and filtering circuit means connected to the output of the transformer secondary, voltage limiting means connected with the rectifying and filtering circuit means to limit the output thereof to a steady direct current voltage, means connected to apply the output of the rectifying and filtering circuit means as a biasing voltage to said amplifying input terminal, means connected between the transformer secondary and the control means in the frequency meter input stage to control the latter in response to voltage pulses in the transformer secondary, resistor means connected with the frequency meter to precalibrate the latter for use with the ignition systems of engines having a first given number of cylinders, and conductor means connected between one of said terminals and the calibrating resistor means and providing a precalibration of the frequency meter for use with ignition systems of engines having a second given number of cylinders upon grounding of the last mentioned terminal.

References Cited in the file of this patent

UNITED STATES PATENTS

2,221,591	Lansdale	Nov. 12, 1940
2,226,185	Sturm	Dec. 14, 1940
2,232,959	Miller	Feb. 25, 1941