June 18, 1963 M. MILES 3,094,656

ELECTRIC TACHOMETER SENDER

Filed Nov. 23, 1959

FIG. 2.

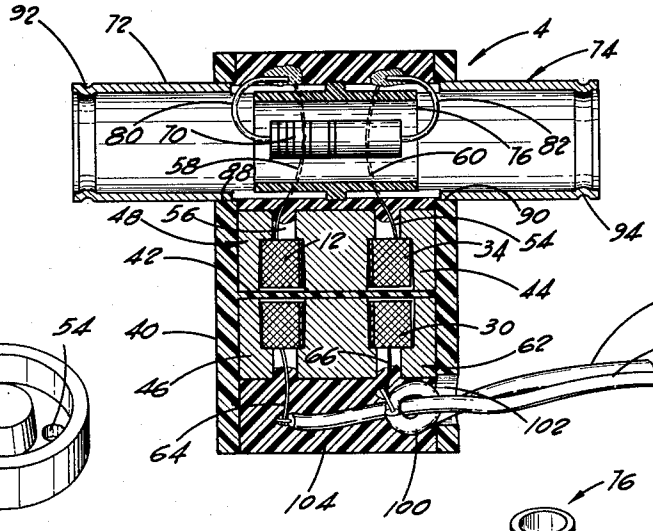

FIG. 3.

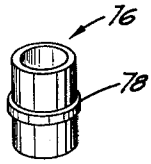

FIG. 4

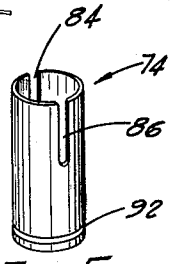

FIG. 5

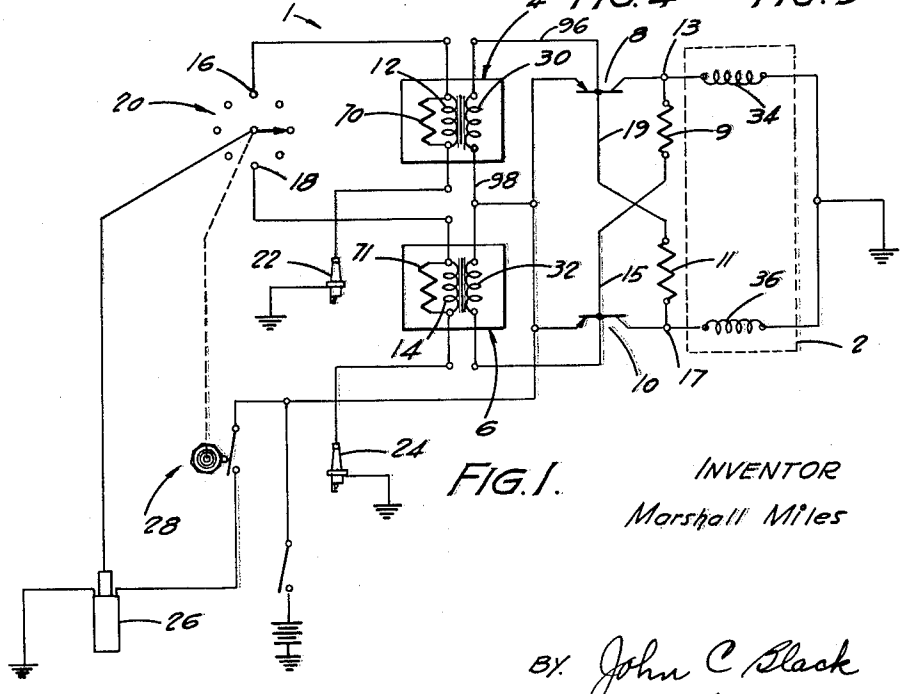

FIG. 1.

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ELECTRIC TACHOMETER SENDER

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This invention relates generally to an improved energizing circuit means for electrical tachometers.

The circuit means has been especially adapted for use with a tachometer receiving unit of the pulse motor type. Prior art senders for the pulse motor type tachometers have generally been characterized by a mechanical switch such as that shown in U.S. Patent 2,649,559, issued to Wargo on August 18, 1953. These mechanical switching devices must be specially designed for each particular vehicle distributor. It is a common practice among vehicle manufacturers to change the distributor design each year. As a result, the switching devices must be modified frequently. In addition, mechanical commutating devices have wear problems.

Accordingly, it is an object of the present invention to provide an improved non-mechanical switching arrangement for operating the pulse motor receiver unit. In the preferred embodiment, the primary windings of a pair of transformers are series connected in the circuits of two of the vehicle spark plugs. The transformer secondary windings control a transistorized bistable device which at all times energizes one or the other circuit of the pulse motor in cyclical fashion.

However, connecting the primary of a transformer into the high voltage side of an ignition system gives rise to serious insulation problems. The problem is even more complicated because of the requirement for an unusually compact transformer construction. In addition, it is necessary that the cost of the transformer be unusually low without sacrificing operational characteristics. In the highly competitive field of electrical tachometers, even relatively minor additions in cost can price a device out of the market.

It is therefore another primary object of the present invention to provide an improved, low cost transformer capable of withstanding high potential differences between the primary and secondary windings while maintaining good coupling in order to avoid excessive power losses. This object is accomplished by the provision of a tubular insulating shell. A central transverse membrane having a thickness in the order of .020" is provided in the shell. A primary and a secondary core and coil assemblies are mounted on either side of the membrane in engagement therewith. The terminals of the primary and secondary coils extend outwardly from the assemblies in spaced relation. The primary and secondary cores form a generally toroidal low reluctance flux path broken only by the very thin membrane. As a result, exceptionally good coupling is provided while at the same time a reliable insulation between the high voltage primary coil and the low voltage secondary coil is assured. By means of this generally H-shaped shell-membrane construction, a long external electrical leakage path is provided between the secondary winding and the primary winding terminals to prevent high voltage breakdown of the transformer.

Other objects and the many features of the invention will be evident upon a perusal of the following description taken in conjunction with the drawings in which:

FIG. 1 is a schematic diagram of the improved tachometer circuit;

FIG. 2 is a sectional elevation view of the improved transformer; and

FIGS. 3, 4, and 5 are perspective views of certain of the transformer components.

The improved tachometer comprises a sender **1** and a pulse motor receiver unit **2**. The sender includes a pair of transformers **4** and **6** and a pair of transistors **8** and **10**. A vehicle ignition system distributor **20** having breaker points **28** is connected in a well known manner with an ignition coil. The transformers include primary windings **12** and **14** connected between spark plugs **22** and **24** and diametrically opposed contacts **16** and **18** of the distributor. Transformer secondary windings **30** and **32** are connected across the transistors **8** and **10**. The turns ratio of the transformer windings may conveniently be one to one for standardization of components.

The receiver unit **2** is a pulse motor driven tachometer of the type shown in U.S. Patents 2,649,559 and 2,871,433, issued to Wargo on August 18, 1953, and January 27, 1959, respectively. Briefly, the receiving unit **2** has two sets of field coils disposed in equally spaced circumferential arrangement. A switching means is operated to energize one set of coils, then the other, in sequence. An armature disposed for rotation between the coils is advanced one step for each energization of each set of coils. Hence, the armature will rotate at a speed corresponding to the frequency of energization of the coil sets divided by the number of coils in the set. The armature is connected to a conventional speed indicating mechanism. Since the frequency of the pulses energizing the coils **34** and **36** is dependent upon the rotational speed of the distributor, the speed indicating mechanism may be calibrated to indicate the speed of the engine to which the distributor **20** is connected.

By connecting the two transformers **4** and **6** to two contacts in the distributor **20**, it is possible to use the same tachometer for indicating the engine speed for all engines having two or more cylinders.

The improved transformer **4** is best shown in FIG. 2. The transformer includes a hollow cylindrical shell **40** preferably made of a high dielectric molding compound, for example, polypropylene. The hollow portion of the shell **40** is closed by a very thin membrane **42** having a thickness in the order of .020". A primary winding assembly **44** is received in the shell **40** against the upper surface of the membrane **42**. A secondary winding assembly **46** is received in the shell **40** against the opposite surface of the membrane. The assembly **44** includes a core element **48** preferably formed of a magnetic powder in resin to assure low eddy current losses. The core **48** includes an annular recess **50** receiving the primary winding coil **12**. The core also includes a pair of axially directed spaced bores **54** and **56** receiving the terminal leads **58** and **60** of the coil **12**.

The assembly **46** is generally similar to assembly **44**. The assembly **46** includes a core **62** and a coil **30** with terminals **64** and **66**. The shell and the cores are preferably filled with a high dielectric filling compound such as Biwax No. B2013 manufactured by Biwax Corporation of Skokie, Illinois. The compound is preferably made flush with the ends of the shell. The bores, such as **56**, and certain areas above the core **48** have not been shown with the sealing compound for the sake of clarity. However, it will be appreciated that all spaces within the shell **40** are preferably sealed flush with the edge of the shell.

A resistor **70** shunts the primary coil **12** of the transformer **4** and serves the purpose of dissipating the energy stored in the primary coil **12** as current flows therethrough. This dissipation of energy is achieved subsequent to extinguishing the spark in the plug **22**. The resistor **70** also serves the function of permitting normal engine operation in the event of an open circuit in the primary winding **12** of the transformer **4**. That is, the resistor **70** com-

pletes the circuit from the secondary winding of the coil 26 to the spark plug 22. A similar resistor 71 shunts the coil 14 of the transformer 6.

A pair of tubular metallic ferrules 72 and 74 define the primary winding terminals. The outer ends of the ferrules 72 and 74 are provided respectively with grooves 92 and 94 for receiving conventional automotive ignition wire clips (not shown). The ferrules are press fit on a generally tubular fiber connector 76. The connector has a central outstanding flange 78 separating and insulating the ferrules from each other. The shunting resistor 70 is positioned coaxially within the connector 76.

To assemble the terminals, the lead wires 80 and 82 at opposite ends of the shunting resistor are bent around the ends of the connector and positioned in flush engagement with the external periphery of the connector. The ferrules 72 and 74 are provided with slots 84 and 86 for receiving the leads 80 and 82. The ferrule and connector assembly is then inserted through transverse bores 88 and 90 in the shell 40. The leads 80 and 82 are then bent outwardly away from the periphery of the connector 76. The primary coil leads 58 and 60 are wound around the leads 80 and 82 respectively. The leads are then soldered to their respective ferrules.

The secondary coil leads 64 and 66 are soldered to a pair of terminal wires 96 and 98. The terminal wires 96 and 98 are knotted at 100. The knotted portion will not pass through the terminal aperture 102 thereby to provide a strain relief for the secondary winding terminals 64 and 66. The entire assembly is now filled with a sealing compound 104. The compound is poured into the spaces in liquid form and subsequently hardens.

The operation of the tachometer will now be described in detail. The breaker points 28 intermittently interrupt the primary circuit of the ignition coil 26 in a well known manner to produce high voltage ignition pulses through the spark plugs 22 and 24 as well as the other spark plugs (not shown) connected to each of the other distributor contacts. Each time the spark plugs 22 and 24 fire, a high current pulse passes through the primary windings 12 and 14 respectively. Each pulse in the primary windings 12 and 14 produces a pulse in the corresponding secondary windings 30 and 32. The pulses in the secondary windings 30 and 32 are applied to the transistors 8 and 10.

The transistors 8 and 10 together with their coupling resistors 9 and 11 form an Eccles-Jordan bistable circuit. That is, one of the transistors 9 or 10 is conducting at all times through the respective receiver unit coil 34 or 36. The resistors 9 and 11 provide the transistor base bias.

Assume that the transistor 8 is in the non-conducting state and transistor 10 is conducting. A pulse in the output winding 30 of the transformer 4 is applied to the base of the transistor 8 to cause momentary conduction through the transistor. Current passed through the coil 34 lowers the negative potential at junction 13 and at the base 15 of the transistor 10. With the base 15 more positive, the transistor 10 ceases to conduct. The potential at junction 17 and at the base 19 of the transistor 8 becomes more negative, and the transistor 8 becomes stabilized with appreciable current flowing through the coil 34. A subsequent pulse in the secondary coil 32 of the transformer 6 in a similar manner energizes the coil 36 and deenergizes the coil 34.

While there has been described what is at present believed to be the preferred embodiment of the invention, it will be understood that various changes and modifications may be made therein; and it is contemplated to cover in the appended claims all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A transformer comprising a unitary shell structure of high dielectric material including a thin membrane and hollow portions closed by the membrane and extending therefrom in opposite directions, a first core received in one of the hollow portions and engaging one side of the membrane, a substantially identical second core received in the other hollow portion and engaging the other side of the membrane, an annular recess in each core facing the membrane, first and second coils received in the recesses of the first and second cores, and a high dielectric sealing compound filling the space in the shell structure not occupied by the cores and coils, the membrane and adjacent cores forming a low reluctance magnetic path for flux produced by current in one of the coils, the membrane, the hollow portions and the sealing compound forming a high resistance leakage path withstanding high potential differences existing between the coils.

2. A transformer comprising a unitary shell structure of high dielectric material including a membrane having a thickness in the order of .020" and hollow portions closed by the membrane and extending therefrom in opposite directions, a first core received in one of the hollow portions and engaging one side of the membrane, a substantially identical second core received in the other hollow portion and engaging the other side of the membrane, an annular recess in each core facing the membrane, first and second coils received in the recesses of the first and second cores, and a high dielectric sealing compound filling the space in the shell structure not occupied by the cores and coils, the membrane and adjacent cores forming a low reluctance magnetic path for flux produced by current in one of the coils, the membrane, the hollow portions and the sealing compound forming a high resistance leakage path withstanding high potential differences existing between the coils.

3. The transformer of claim 2 together with a pair of terminal wires for each coil, a pair of spaced longitudinal bores in each core each receiving a respective terminal wire therethrough, the sealing compound substantially filling the bores.

4. The transformer of claim 3 together with one of the hollow portions having transverse bores therein, a pair of tubular metallic ferrules received in the transverse bores, a tubular insulating connector positioned in the one hollow portion and connected at opposite ends thereof to the ferrules, each of the terminal wires in the one hollow portion connected to a respective ferrule, and a coil shunting resistor received in the insulating connector and having terminals connected to the ferrules.

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