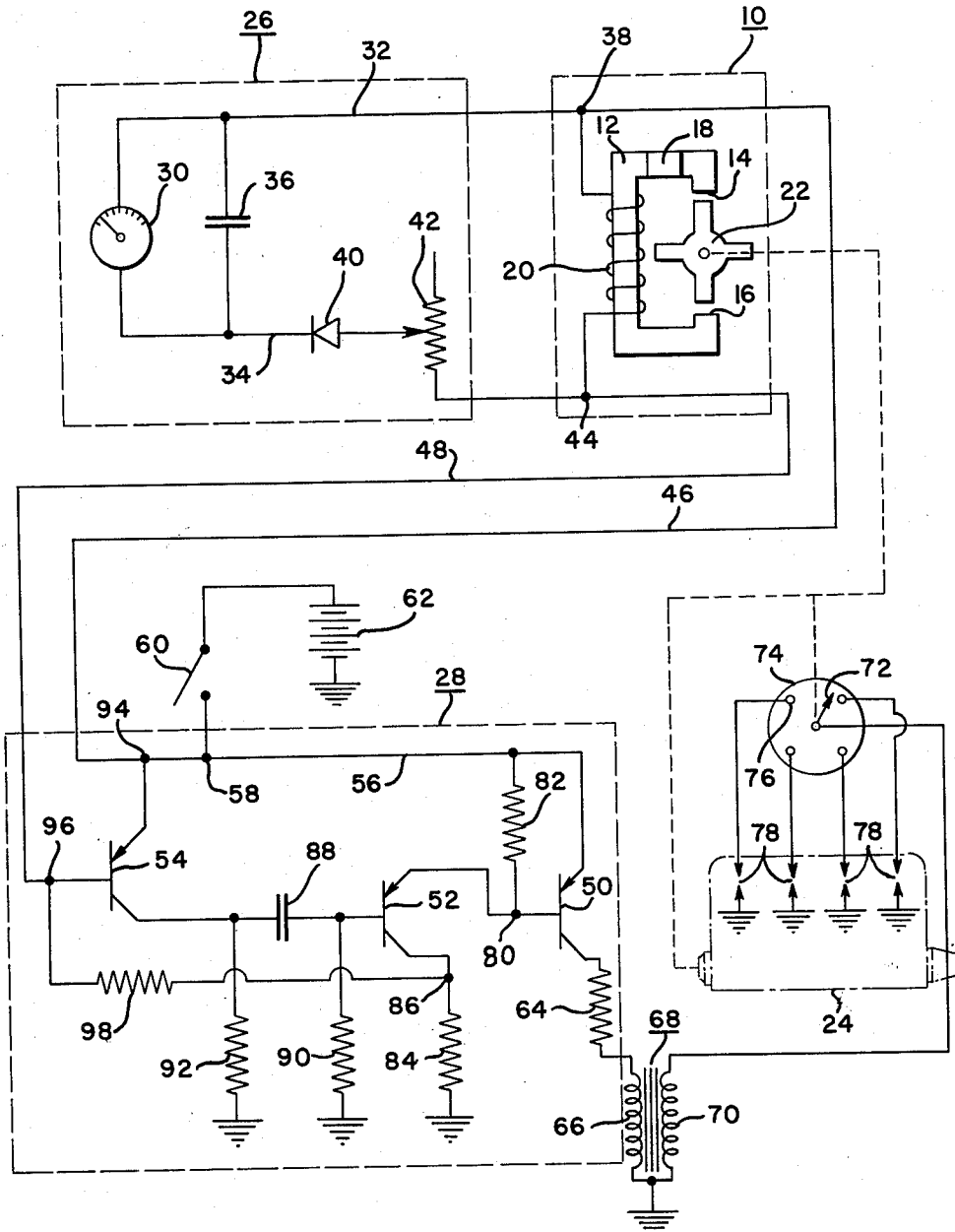


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INTERNAL COMBUSTION ENGINE IGNITION  
SYSTEM AND TACHOMETER  
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## INTERNAL COMBUSTION ENGINE IGNITION SYSTEM AND TACHOMETER

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This invention relates to a combined ignition system and tachometer for internal combustion engines which is capable of controlling the ignition timing of the engine and indicating the speed of rotation of the crank shaft of the engine.

One of the objects of this invention is to provide a combined ignition timer and tachometer which is comprised of static circuit components and which includes an ignition control unit and a tachometer unit both of which are controlled by a control unit that has a voltage output which is a function of engine crank shaft position and speed of rotation.

Still another object of this invention is to provide a combined ignition system and tachometer for an internal combustion engine wherein the output voltage of a magnetic pick-up is fed to an ignition control unit and to a tachometer unit.

A further object of this invention is to provide a combined ignition system and tachometer for an internal combustion engine wherein a breakerless control unit is operative to control a transistorized ignition unit and a tachometer unit.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

In the drawing:

The single figure drawing is a schematic circuit diagram of a combined ignition system and tachometer made in accordance with this invention.

Referring now to the drawing, the reference numeral 10 designates a voltage generating magnetic pick-up device which includes a magnetic core 12 having pole faces 14 and 16. A permanent magnet 18 is provided for forcing magnetic flux through the magnetic core 12 and it is seen that a pick-up coil 20 is wound on one leg of the magnetic core 12.

The magnetic pick-up 10 includes a rotor 22 which is formed of magnetic material and which has four radially extending teeth which can swing into alignment with the pole faces 14 and 16 as the rotor 22 rotates. The rotor 22 is driven by the crankshaft of an internal combustion engine 24 through a suitable drive line and its rotative position with respect to pole faces 14 and 16 bears a definite relationship to crankshaft position.

As the rotor 22 rotates, an A.C. voltage is induced in the coil winding 20. Thus as the radially extending teeth are swinging into alignment with the pole faces 14 and 16, a pulse of voltage is generated of one polarity and as the radially extending teeth then move out of alignment with the pole faces 14 and 16, a voltage of an opposite polarity is produced.

It will be appreciated that the voltage generating magnetic pick-up 10 is shown schematically in the drawing and it could take various shapes and forms. As one example, the actual physical construction of the magnetic pick-up 10 may be as shown in application S.N. 126,406, filed on June 16, 1961, and assigned to the assignee of this invention.

In addition to the magnetic pick-up device 10, the system of this invention includes a tachometer unit 26 and

a transistor control unit 28 for controlling the ignition timing of the engine 24. The tachometer unit 26 includes a D.C. volt meter 30 which is connected with conductors 32 and 34. A capacitor 36 is connected across the conductors 32 and 34 and it is seen that the conductor 32 is connected with one side of the pick-up coil 20 at junction 38. The conductor 34 is connected to one side of a diode 40, the opposite side of this diode being connected with an adjustable resistor 42. It is seen that one side of the adjustable resistor 42 is connected with an opposite side of the pick-up coil 20 at junction 44.

The junctions 38 and 44 are connected with conductors 46 and 48 which apply an ignition timing control signal to the transistor ignition control unit 28. The transistor ignition control unit 28 can take various forms and in the embodiment shown, it is comprised of static circuit elements. These circuit elements include PNP transistors 50, 52 and 54.

The emitter electrode of transistor 50 is connected with a conductor 56 which is connected with junction 58. It is seen that the lead wire 56 is common to the junction 58 and the lead wire 46 coming from the magnetic pick-up 10. The junction 58 is connected to one side of an ignition switch 60 which is connected to one side of a direct current voltage source 62 which is the battery in a motor vehicle electrical system. The battery 62, of course, is supplied with charging current by a generator which is not shown and when the motor vehicle is running, the voltage appearing between junction 58 and ground in a motor vehicle system is the output voltage of the generator providing this voltage is higher than battery voltage.

The collector electrode of transistor 50 is connected to one side of a resistor 64. The opposite side of this resistor is connected to one side of the primary winding 66 of an ignition transformer generally designated by reference numeral 68. The secondary winding 70 of the ignition transformer is connected to one side of the primary winding and this common connection is grounded as shown. The opposite side of the secondary winding is connected with a rotor contact 72 which rotates relative to a distributor cap 74 having fixed electrodes or contacts 76. The fixed contacts or electrodes 76 feed the spark plugs 78 on the engine 24 in a manner well known to those skilled in the art. The rotor contact 72 is driven by the engine 24 and is driven in synchronism with the rotor 22 of the magnetic pick-up 10. The rotor 72 and distributor cap 74 may be of the type shown in the above-mentioned co-pending application, S.N. 126,406.

The emitter electrode of transistor 52 is connected with the base electrode of transistor 50 and with a junction 80. A resistor 82 is connected between junction 80 and the lead wire 56. The collector electrode of transistor 52 is connected to ground through resistor 84 and is connected with junction 86. The base electrode of transistor 52 is connected with the collector electrode of transistor 54 through a capacitor 88. The base electrode of transistor 52 is also connected to ground through a resistor 90. A resistor 92 connects the collector electrode of transistor 54 to ground.

The emitter electrode of transistor 54 is connected with junction 94 which is common to lead wires 46 and 56. The base electrode of transistor 54 is connected with junction 96 and this junction is connected with conductor 48 coming from the magnetic pick-up 10 and is connected with junction 86 through a resistor 98.

When the engine 24 is being cranked or when it is running, pulses of A.C. voltage are generated in the pick-up coil 20 which are indicative of engine crank shaft position and speed. These pulses are applied across the emitter and base electrodes of transistor 54 to switch this

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transistor on and off. The magnetic pick-up 10 is arranged such that as the radially extending teeth of the rotor 22 are moving toward a position where they are aligned with pole faces 14 and 16, a voltage is induced which causes junction 44 to be positive and junction 38 negative. This applies a reverse bias to the transistor 54 to maintain it turned off. In this connection, it is noted that when ignition switch 60 is closed, the positive side of the direct current source 62 is also effective to bias the transistor 54 to a turned "off" condition since the emitter and base electrodes will have substantially the same potential as the positive side of the battery 62.

The transistor 52 is connected with battery 62 so as to be biased to conduct in its emitter-collector circuit since there is a base circuit for this transistor through the resistor 90. Thus, when the ignition switch 60 is closed, the emitter of transistor 52 is positive with respect to the base electrode so that the transistor 52 is conductive in its emitter-collector circuit.

The emitter-collector circuit of transistor 52 forms a base circuit for transistor 50. Thus when transistor 52 is turned on in its emitter-collector circuit, the transistor 50 will likewise be turned on in its emitter-collector circuit so that current can then flow from the power conductor 56, through transistor 50 and then through the primary winding 66 of the ignition coil 68. When transistors 52 and 50 are turned on, the capacitor 88 is charged through the emitter to base circuit of transistor 52 and through the resistor 92.

It was pointed out above that an A.C. voltage is induced in the pick-up coil 20 as the rotor 22 rotates. At one point in this cycle, the junction 38 will be positive with respect to the junction 44. This will apply a forward bias to the transistor 54 to cause it to turn on in its emitter-collector circuit. When transistor 54 turns on in its emitter-collector circuit, the capacitor 88 is in effect connected between the base and emitter-electrodes of transistor 52. The potential on the capacitor is such as to drive the base electrode of transistor 52 positive with respect to its emitter. This causes the transistor 52 to turn off. This substantially opens the base circuit for transistor 50 and the transistor 50 will therefore turn off. When transistor 50 turns off, a large voltage is induced in the secondary winding 70 which is transferred to one of the spark plugs 78 via the rotor contact 72 and one of the fixed distributor cap electrodes 76.

In summary, it can be seen that when transistor 54 is non-conductive, transistors 52 and 50 are conductive. When transistor 54 is conductive, transistors 52 and 50 are turned off. It is also seen that the transistor 54 is turned off when the voltage that is induced in the coil winding 20 is of such a polarity that junction 38 is negative and junction 44 positive. Transistor 54 is, of course, biased to conduct when this potential on the junctions 38 and 44 is reversed. It will also be remembered that transistor 54 is biased to its non-conductive state as the rotor 22 is swinging into a position where it becomes aligned with pole faces 14 and 16 and is biased to its conductive state as the radial teeth of the rotor 22 are swinging out of alignment with the pole faces 14 and 16.

It will be appreciated that the transistor ignition unit 28 could use NPN transistors rather than PNP transistors and in such an arrangement, the polarities of the applied voltages would have to be reversed. It will also be appreciated that the transistor ignition unit could take various forms other than that shown in the drawing.

The operation of the electrical tachometer 26 will now be described. When the voltage induced in the pick-up coil 20 is such that junction 44 is positive, a current will flow from junction 44, through resistor 42, through diode 40, through the coil of meter 30, and then through lead wire 32 to the junction 38. The polarity of this voltage is such as to turn "off" the transistor 54 and at the same time cause a current to flow through the meter 30. As the voltage which is induced in the coil winding 20

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reverses, there is no current flow through the meter 30 since the diode 40 blocks any such current flow.

It will be appreciated from the foregoing that the meter 30 is supplied with a pulsating D.C. current the frequency of which is a function of the speed of rotation of the rotor 22 and therefore is a function of crank shaft speed of the engine 24. This meter will indicate an average value and the meter can be calibrated for example in revolutions per minute of the crank shaft of engine 24. The capacitor 36 is a filter capacitor which is connected directly across the meter and the resistor 42 is a calibrating resistor.

From the foregoing, it can be seen that a combined ignition and tachometer has been provided for an internal combustion engine which is formed entirely of static components and which uses the magnetic pick-up 10 as the prime control for both ignition timing and speed indication.

While the embodiments of the present invention as herein disclosed, constitute a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In combination, an internal combustion engine, magnetic pick-up means including a coil winding and rotor means driven by said engine, an ignition coil having a primary winding and a secondary winding, means connecting said secondary winding with a spark plug on said engine, a source of direct current, semiconductor switch means connected between said source of direct current and said primary winding of said ignition coil for controlling current flow through said primary winding, an electrical tachometer, and means connecting said pick-up coil with said electrical tachometer and with said semiconductor switch means whereby the output voltage of said pick-up coil controls both the conduction of said semiconductor switch means and said electrical tachometer.

2. The combination according to claim 1 wherein the electrical tachometer unit includes a voltmeter and a diode connected in series therewith.

3. In combination, an internal combustion engine, a spark plug for said engine, an ignition coil having a primary winding and a secondary winding, a source of direct current, a breakerless ignition unit connected between said source of direct current and with the primary winding of said ignition coil for controlling the current flow through said primary winding, magnetic pick-up means having a pick-up coil and rotor means driven by said engine, an electrical tachometer unit having input conductors connected across said pick-up coil, said electrical tachometer unit including a voltmeter and a diode connected in series with said input conductors, and means connecting said pick-up coil with a pair of control terminals of said breakerless ignition unit.

4. In combination, a source of direct current, an ignition coil having a primary winding and a secondary winding, a semiconductor having a pair of current carrying terminals and a control terminal, means connecting said primary winding and the current carrying terminals of said semiconductor in series and across said source of direct current, a magnetic pick-up having an output coil and a rotatable member that is adapted to be driven by an engine, means connecting said output coil with the control terminal of said semiconductor whereby said semiconductor is turned on and off in accordance with the voltage generated in said output coil, and an electrical tachometer connected with said output coil to indicate the speed of rotation of said rotatable member.

5. In combination, a source of direct current, an ignition coil having a primary winding and a secondary winding, a magnetic pick-up having a rotatable member adapted to be driven by an engine and having an output

coil separate from said ignition coil, a semiconductor switch means having a pair of current carrying terminals and a control terminal, means connecting the current carrying terminals of said semiconductor switch means and said primary winding of said ignition coil in series and across said source of direct current, means connecting the control terminal of said semiconductor switch means with said output coil of said magnetic pick-up, an electrical tachometer, and a means connecting said electrical tachometer with said output coil of said magnetic pick-up.

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