

[54] **IGNITION APPARATUS AND SYSTEM**

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[22] **Filed:** Apr. 25, 1974

[21] **Appl. No.:** 463,853

[52] **U.S. Cl.**..... 123/148 E; 123/146.5 A

[51] **Int. Cl.²**..... F02P 3/02

[58] **Field of Search**..... 123/145, 146.5 A, 148 E,
123/148 O, 148 CD

[56]

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3,241,538	3/1966	Hugenholtz	123/148 E
3,297,009	1/1967	Sasaki et al.	123/148 E
3,783,314	1/1974	Kostan	123/148 E
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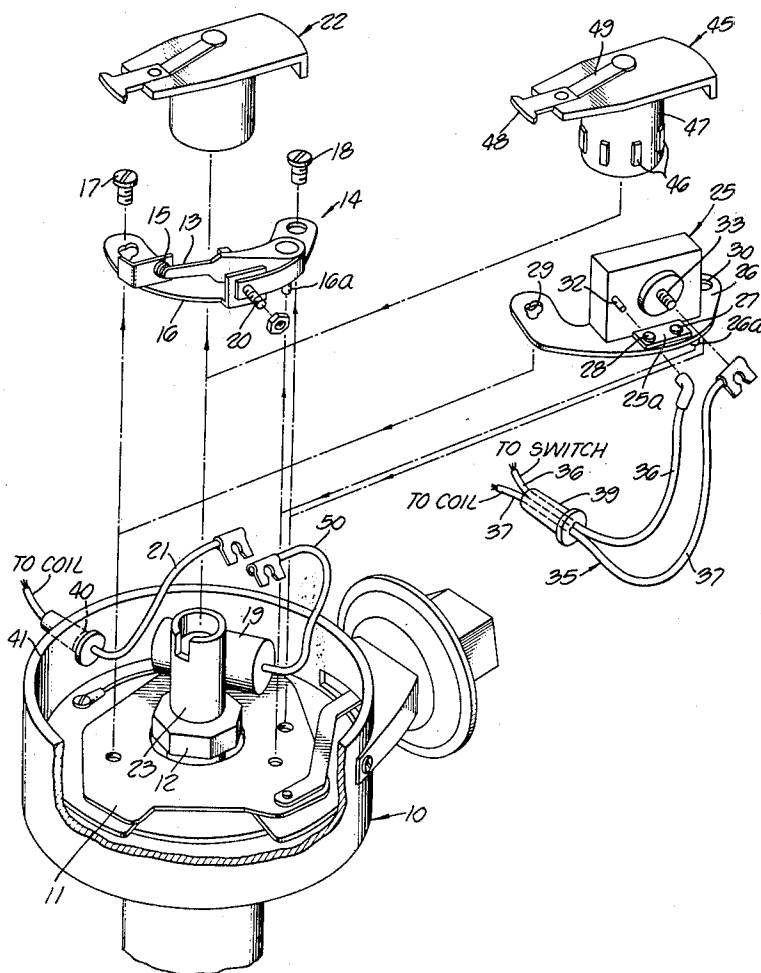
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[57]

ABSTRACT

There is disclosed herein a new form of electronic ignition apparatus and system including an integral sensor/electronics module, and adapter plate therefor, which can be mounted within a conventional distributor in direct replacement of conventional breaker points not requiring any modification to the distributor or vehicle wiring system. The apparatus also includes a rotor, similar to a conventional distributor rotor, but which includes a plurality of permanent magnets secured thereto or imbedded therein. Upon rotation of the rotor, timing signals are generated by the sensor as a function of rotor position, and the electronic module provides electronic switching pulses suitable for switching the primary of the ignition coil of a vehicle. Several rotor and adapter plate configurations are described for enabling conversion of different existing vehicles from a conventional breaker point type ignition system to an electronic ignition system.

16 Claims, 7 Drawing Figures



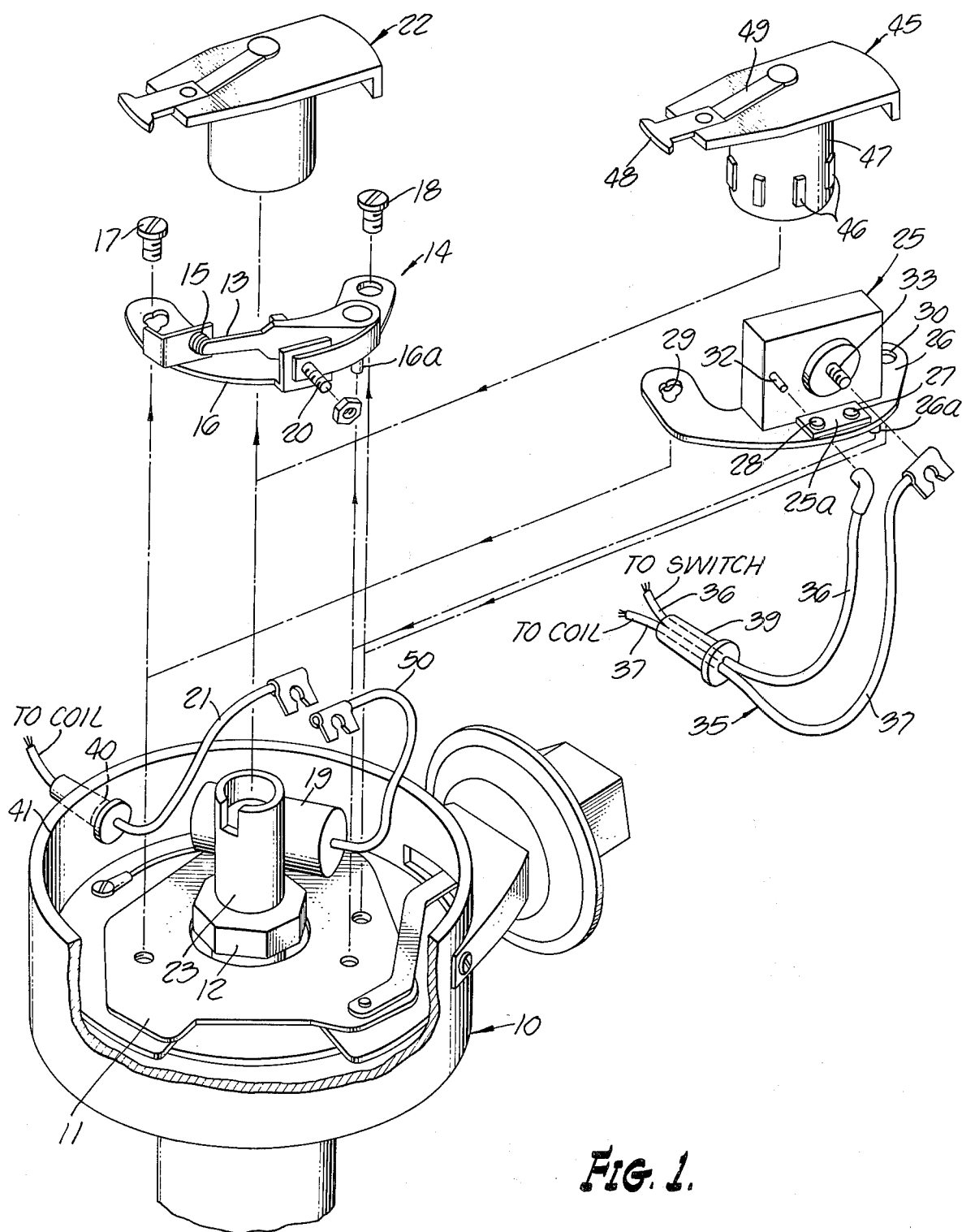
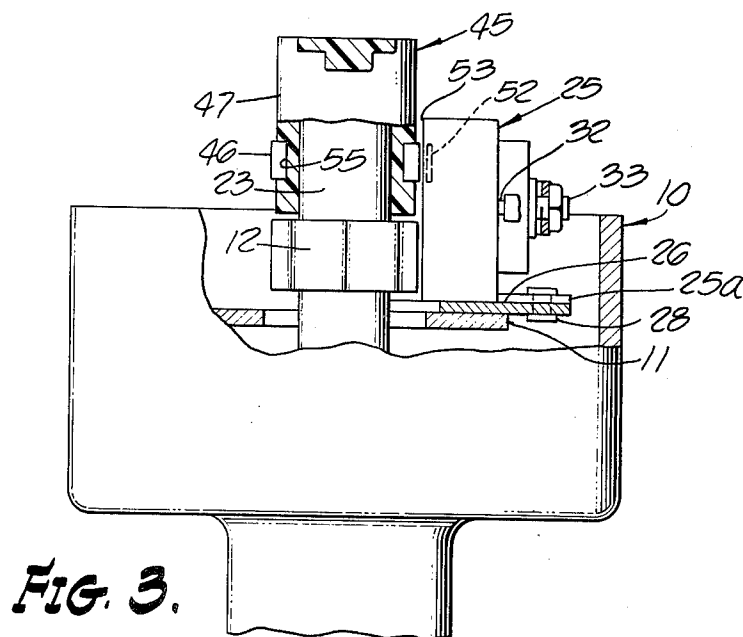
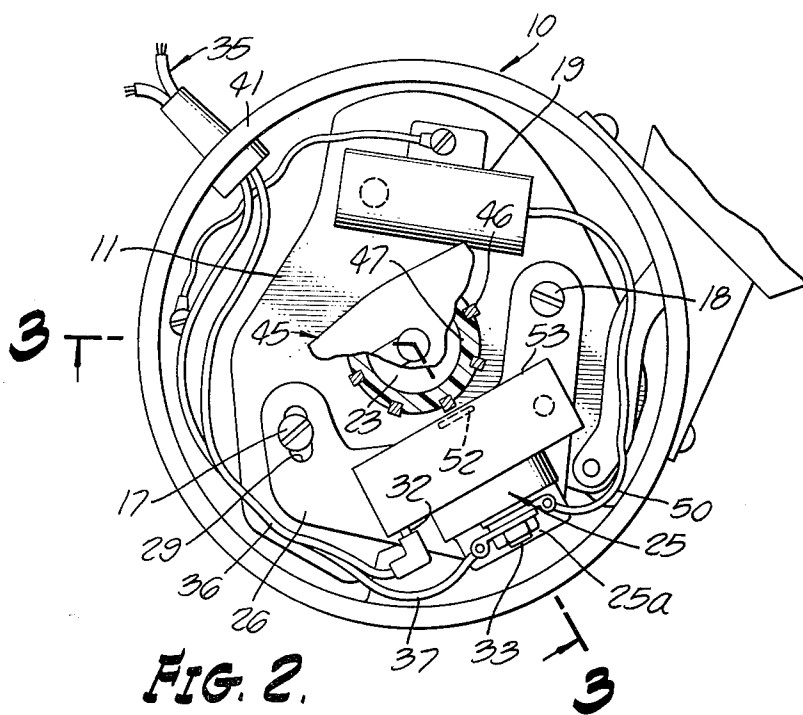


FIG. 1.



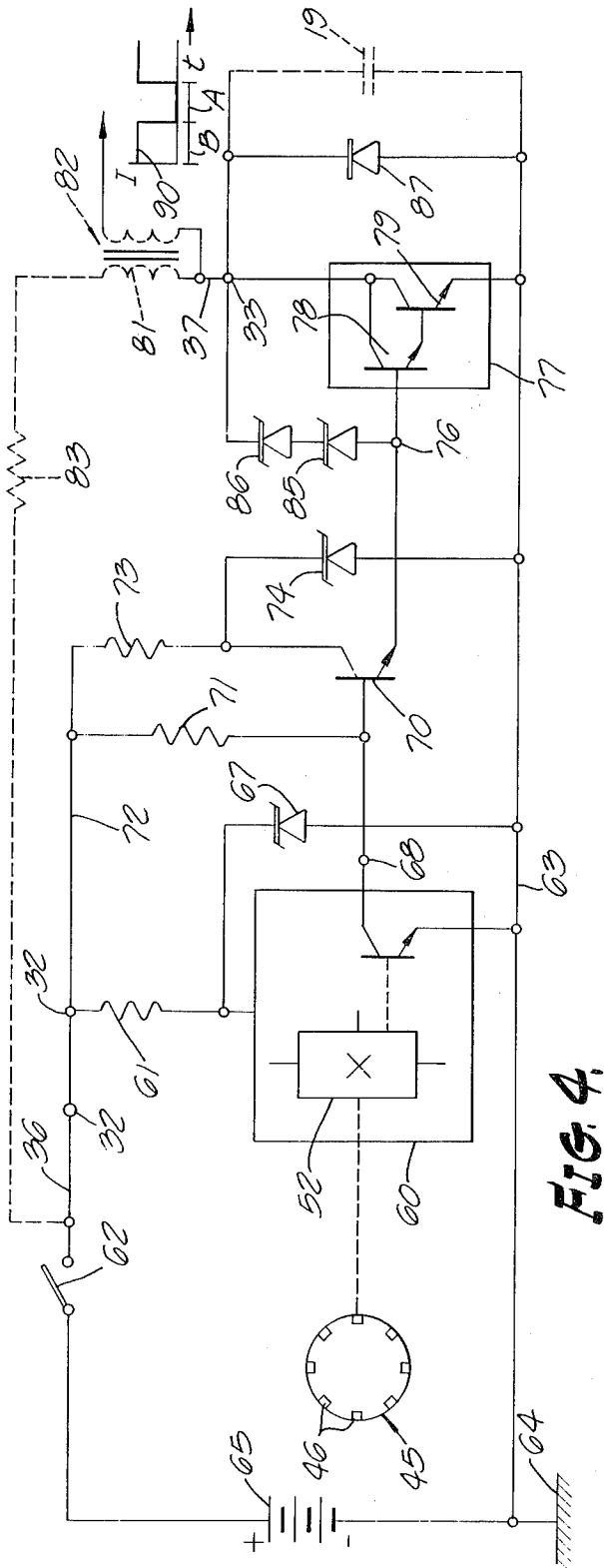


FIG. 4.

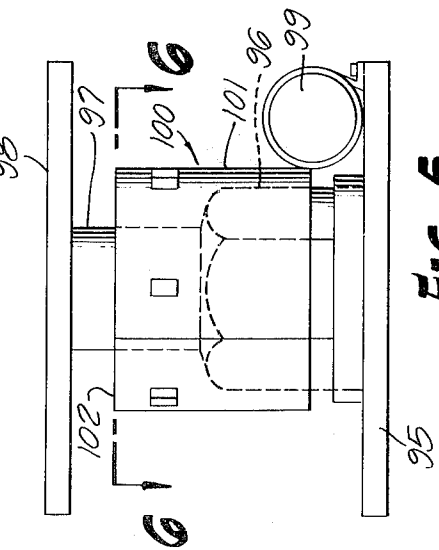


FIG. 5.

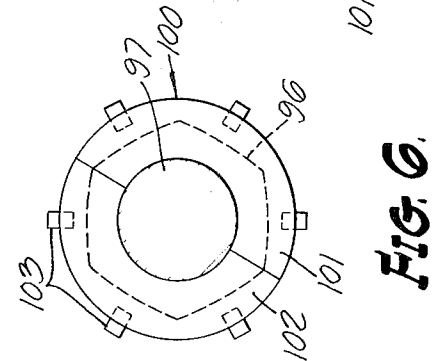


FIG. 6.

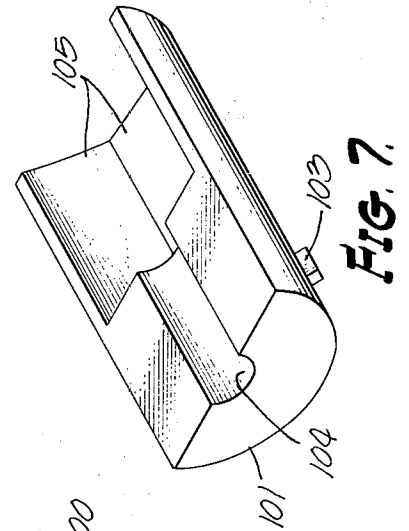


FIG. 7.

IGNITION APPARATUS AND SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to ignition systems, for vehicles, and more particularly to an improved form of ignition device and system for facilitating the conversion of conventional ignition breaker point devices systems to a breakerless electronic system. Various types of ignition systems and devices are in use today in vehicles. The most common is the breaker point assembly used in the distributor of an automobile or truck and which includes a pair of breaker points which are caused to open and close upon rotation of a distributor cam in synchronism with engine rotation. These breaker points are electrically connected to open and close the primary winding of an ignition coil. A rotor and distributor cap also are used, and the rotor rotates in synchronism with the distributor cam shaft to distribute suitable firing pulses to the spark plugs of the engine.

Various transistor ignition systems have been devised. The early developments utilized a transistor to switch the electrical current through the primary winding of the ignition coil thus removing the electrical switching load from the breaker points which resulted in an extended lifetime for the breaker points. However, the breaker points were still retained to provide the timing synchronism with the engine rotation. The breaker points controlled the base drive current to the switching transistor to cause the transistor to turn on and off in synchronism with the engine rotation.

Further improvements replaced the breaker points entirely, using magnetic or optical means to generate timing pulses in synchronism with the engine rotation. These electrical timing pulses were then amplified and used to control the base drive current to the power switching transistor. These electronically timed or "breakerless" systems, as they have become to be known, provided improved timing and virtual maintenance free operation not afforded by the breaker point controlled transistor systems.

Optically controlled systems utilized a light source and light sensor arrangement in conjunction with a light interrupting device, usually denoted as a shutter wheel, which rotated in synchronism with the engine. Exemplary systems using a light source and sensor arrangement are shown in U.S. Pat. No. 3,581,725 and in U.S. Pat. No. 3,234,742.

Magnetically controlled systems utilized a magnetic source and magnetic sensor arrangement. The magnetic field impinging on the sensor was caused to change in magnitude in synchronism with the engine rotation. Two distinct types of magnetically timed systems evolved. The first was a "variable reluctance" type of sensor. An example is found in Kaisha Japanese Pat. No. 13122/1963, published July 24, 1963. In this type of system the air gap in a magnetic circuit is alternately increased and decreased, in synchronism with the engine rotation, causing the magnetic flux in the circuit to alternately decrease and increase respectively. A pick-up coil is so placed in the circuit that the magnetic flux in the circuit passes through the pick-up coil. A voltage is developed across the pick-up coil which is directly proportional to the rate of change of magnetic flux in the circuit. This type of pulse generating system has one large drawback. The production of timing pulses is not only a function of engine position but also engine speed. There is a minimum speed re-

quired to generate a timing pulse of sufficient voltage amplitude to operate the electronic amplifier and transistor switch. Hence, these systems perform poorly, or not at all, under low speed, starting conditions. Also the timing pulses generated by some types of systems do not duplicate the signals produced by the breaker points in that the ratio of "on" time to "off" time or, "dwell time," varies with engine speed making it impossible to optimize ignition performance over the entire engine speed range.

A second approach to the generation of magnetically produced timing pulses is the use of a Hall cell for the magnetic sensor in place of a pick-up coil. The Hall cell generates a voltage, the amplitude of which is directly proportional to the magnitude of the magnetic flux passing through it and completely independent of the rate of change of the magnitude of that flux. Various means were devised to produce a change in the amplitude of the magnetic flux passing through the Hall cell in synchronism with the rotation of the engine. An example is found in U.S. Pat. No. 3,297,009.

Thus, the optically timed systems and the Hall cell magnetically timed systems duplicate the operation of the breaker point timing function in that they produce electrical pulses which are dependent only on the engine position whereas the magnetic pick-up coil systems produce pulses which are a function of both engine speed and position.

From the time that the first breaker point controlled transistor systems appeared, the advantages of a completely electronic "breakerless" system were obvious. However, the requirement of providing an economical means of installing electronic pulse generating means in the many types of existing automotive distributors was not an easy one. Odd contours and shapes, limited access for electrical connections and stringent size limitations hampered the appearance of such "breakerless" systems. This feat has only recently been accomplished on any kind of commercial scale and that was only on an original equipment basis.

There remains one primary drawback to all of the above existing systems. All of them, including the breaker point controlled systems, involve the installation, external to the distributor housing, of the electronics amplifier and transistor switch package. This package contains virtually all of the electronics circuitry with the exception of the pulse generating means. This package is typically 10 to 20 times larger than the pulse generating means. A conventional breaker point system cannot be readily converted to any of these systems. The installation of this electronic package involves considerable effort to mount it mechanically and involves considerable modification to the existing vehicle wiring system. Many automotive mechanics are not capable of making the necessary wiring modifications. The time involved to install these systems is typically 4 to 5 hours. The labor cost involved and the fact that ordinary mechanics cannot repair such systems has greatly retarded their acceptance, especially for retro-fit applications, even though vehicle owners accept the fact that such installations would significantly reduce fuel consumption and undesirable exhaust emissions.

The present invention represents a completely new concept in the configuration of electronic ignition systems. At a time when the state-of-the-art has just reached the point where electronic pulse generating

devices can be installed within the distributor housing, the present invention provides for the installation of the entire electronics circuitry, pulse generating means, amplifier and power transistor switch within the distributor housing. This feature has a substantial impact relative to the ease with which it can be installed on a vehicle, both in a retro-fit and an original equipment situation. The mechanical installation is identical to installing a new rotor and set of breaker points, something that every automotive mechanic has done many times. The use of adapter plates of various configurations allows the installation of the same module into existing distributor configurations. The additional electrical hook-up involves a single wire being connected to a readily recognizable point in the automotive wiring system. No alterations need to be made to the existing vehicle wiring. No holes or fastening devices need to be added to the vehicle. All initial adjustments and timing are done in the same manner as with conventional breaker point systems. If desired, the electronic system can be removed and the breaker points reinstalled with the same effort as changing a set of breaker points in the conventional system. The entire system can be installed and adjusted quickly and is a practical system for installation in existing vehicles.

The ability to mount the entire system within the distributor housing is made possible by imbedding permanent magnets or "source" elements substantially within the outline dimensions of the existing rotor. By doing this, none of the available mounting space, on the existing distributor breaker plate, is used by the magnetic "source." In conjunction with this, the "sensor," or Hall cell, is molded into, and made an integral part of, the electronics module. These features, combined with micro-miniature packaging, make possible the installation of the entire system within the distributor housing.

Some ignition systems have been described wherein a timing source and sensor are mounted on a type of adapter plate for facilitating the mounting thereof within the distributor. Examples are found in U.S. Pat. Nos. 3,581,725, 3,272,930, and 3,660,623.

SUMMARY OF THE INVENTION

The present invention provides an improved distributor apparatus and system, and on which can be readily substituted within a conventional distributor for enabling conversion from the standard breaker point assembly to be made quickly and efficiently. The present apparatus includes a sensor and all associated electronics in a single module connected to a suitable adapter plate, and this assembly is directly substituted for the conventional breaker points. A two-wire cable is substituted for the usual single wire in the conventional ignition system, and provides the switching lead for the primary of the ignition coil and provides power from the ignition switch of the vehicle to the electronics module. The bracket of the module which is integrally connected to the adapter plate provides a ground return. Further, the apparatus of the present invention includes a new form of rotor substantially identical to the existing rotor of a given vehicle, but which includes a plurality of magnets imbedded into it and equally spaced around the periphery thereof. The number of magnets is equal to the number of cylinders of the vehicle. These magnets operate in conjunction with the sensor to provide timing signals which are a function of rotor position only. The system of the electronic mod-

ule includes a sensor in the form of a Hall cell, a pulse shaping circuit connected therewith for providing suitably shaped pulses, an amplifier and a solid state power switch which is connected to the primary of the ignition coil.

In replacing the breaker point assembly of a conventional ignition system of a vehicle with the electronics module, it is only necessary to remove the breaker points and the existing rotor, as well as the wire from the breaker points and the existing rotor. The sensor and electronics module with the appropriate adapter plate attached thereto is positioned on the existing advance plate of the distributor in direct replacement of the breaker points. The existing ignition capacitor is used in the same manner as before, and is connected to the electronics module along with one wire of the two-wire cable. The other wire of the two-wire cable is connected to power the electronics module from the ignition switch of the vehicle. Then, the new rotor is merely inserted in the same fashion as is a conventional rotor, the distributor cap is replaced, and the conversion is complete. The centrifugal and vacuum advance devices of the distributor function in their usual manner, and timing likewise is set in a conventional manner. The arrangement of the electronics and sensor module on the adapter plate is such that it can be readily properly positioned and spaced from the magnets of the rotor.

The entire new apparatus and system is disposed within the distributor, and no complex or cumbersome rewiring is necessary in accomplishing the conversion. The new form of rotor, which is substantially identical to the standard rotor for a given type of vehicle, but with the addition of the magnets thereto, and the arrangement of the sensor and electronics circuitry in a single module on an adapter plate allows the present apparatus and system to be mounted entirely within the distributor housing in this simple and efficient manner. In some cases, as will appear subsequently, the existing rotor is not replaced, but the new form of rotor with magnets is added.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of a conventional distributor illustrating the manner in which the breaker points and rotor thereof are removed and the assembly of the present invention substituted therefor;

FIG. 2 is a top plan view of the distributor with the sensor and electronics module and rotor of the present invention installed therein;

FIG. 3 is an elevational view of the assembly of FIG. 2;

FIG. 4 is a circuit diagram of an exemplary circuit of the present ignition system; and

FIG. 5 is an elevational view of another form of rotor according to the present invention, and FIGS. 6 and 7 are additional views thereof.

DETAILED DESCRIPTION OF THE INVENTION

Turning to FIG. 1, a conventional automobile distributor 10 is shown (with distributor cap removed and not shown) having a conventional vacuum advance plate 11 disposed therein. A conventional breaker point cam 12 is shown which, in the conventional ignition system, serves to operate a movable breaker point 13 of a breaker point assembly 14. The breaker point assembly 14 also includes a stationary breaker point 15, and a mounting bracket 16 which normally is secured to the

advance plate 11 by means of screws 17 and 18. A key pin 16a facilitates proper alignment of the bracket 16 with the plate 11. A capacitor 19 used in the conventional ignition systems is shown within the distributor 10, and normally is physically and electrically connected to a stud 20 of the breaker point assembly 14 along with a wire 21 which connects the breaker point assembly 14 to the primary winding of the ignition coil of the vehicle. Also shown in FIG. 1 is the conventional rotor 22 which normally is disposed on and keyed to the shaft 23 so as to cause the rotor 22 to rotate in synchronism with the engine speed of the vehicle. The exploded view of FIG. 1 illustrates the manner in which the breaker point assembly 14 and the rotor 22 are removed from the distributor 10 in making the conversion from a breaker point ignition system to that of the present invention.

In this regard, FIG. 1 also illustrates the electronic module 25 which includes the Hall sensor, and a suitable adapter plate 26 therefor. The module 25 has a metal tab 25a physically connected thereto, and this tab is secured to the adapter plate 26 by rivets 27 and 28. The tab 25a also serves as an electrical conductor for connecting the circuit in the module 25 to ground through the adapter plate 26 and plate 11. The tab 25a also serves to conduct heat generated in the electronics module to the adapter plate 26 from which it is dissipated. The adapter plate 26 includes apertures 29 and 30 for enabling the same to be mounted in place of the breaker point assembly 14 by the screws 17 and 18, respectively. In some cases, the aperture 30 and screw 18 are not needed. A key pin 26a facilitates alignment. The sensor and electronics module 25 which will not be described in greater detail subsequently, includes a power input terminal 32 by which operating power is supplied thereto, and an output terminal 33 which is connected to the primary winding of the ignition coil and ignition capacitor. A two-wire cable 35 is provided having a first insulated wire 36 which is connected between the terminal 32 of the module 25 and the ignition switch of the vehicle, and a second insulated wire 37 which is connected between the output terminal 33 of the module 25 and the primary winding of the ignition coil of the vehicle. A suitable grommet 39 also is provided for allowing the cable 35 to be inserted through and be insulated from aperture 40 of the sidewall 41 of the distributor 10 in place of the standard wire 21.

In addition to the foregoing, FIG. 1 illustrates the new form of rotor 45 of the present invention. This rotor is identical to the standard rotor 22 of a given vehicle, with the exception of the addition of equally spaced magnets 46 into the wall 47 thereof. For best performance, these magnets should produce the strongest magnetic field possible. In a preferred embodiment they are rare earth magnets, such as samarium cobalt magnets manufactured by Hitachi Magnetics. As will be apparent to those skilled in the art, the precise form of the rotor will be different for different vehicles inasmuch as different rotor configurations are used conventionally. Another exemplary form of rotor will be discussed later in the discussion of FIGS. 5 through 7. The rotor 45 (and also the cam 12) shown in FIG. 1 are for an eight-cylinder vehicle and, thus, eight magnets 46 are equally spaced about the periphery of the wall 47 of the rotor 45. As will be discussed later, these magnets, in combination with a Hall cell sensor in the module 25, serve to provide timing signals

as a function of the position of the rotor 45 as the same is rotated by the shaft 23 of the distributor assembly. The rotor 45 includes a radially disposed contact 48 and a center contact 49 the same as the conventional rotor 22 for distributing impulses to the eight spark plugs of the engine through ignition wires and the distributor cap (not shown) in a conventional manner.

FIGS. 2 and 3 illustrate the module 25, cable 35 and rotor 45 installed within the conventional distributor 10. Installation, and, thus, conversion from the breaker point ignition system, merely involves removal of the breaker point assembly 14, the standard rotor 22 and the single-wire 21 of the conventional system. The two-wire cable 35 is then inserted through the aperture 40 in the wall 41 of the distributor 10, and the adapter plate 26 attached to the module 25 is secured to the advance plate 11 in direct replacement of the breaker point assembly 14. The adapter plate 26 is secured to the plate 11 by the screws 17 and 18. The wire 50 of the capacitor 19 and the wire 37 of the two-wire cable 35 are attached to the output terminal 33 of the module 25. The wire 36 is attached to the terminal 32 of the module. The other ends of the wires 36 and 37 are respectively connected to the ignition switch and to the primary of the ignition coil of the vehicle. The rotor 45 is inserted on to the shaft 23, and the distributor cap (not shown) is reattached to the distributor 10 in a conventional manner.

The module 25 contains the Hall cell sensor 52 as best seen in FIGS. 2 and 3. In an exemplary embodiment, the sensor and entire electronic circuit of the present ignition system are encapsulated in a suitable plastic material to form the module 25. The sensor, in the form of a Hall cell, may be approximately ten thousandths of an inch square and disposed approximately thirty-five thousandths of an inch below the inwardly facing surface 53 of the module 25. The aperture 29 of the adapter plate 26 for the module 25 is elongated to enable adjustment of the position of the sensor 52 with respect to the periphery of the magnets 46 of the rotor 45. It is desired that the periphery of the magnets 46 be as close as possible to the surface 53 (and, thus, the sensor 52) to maximize timing accuracy but, of course, they should not touch. An exemplary spacing between the surface 53 and outer surface of the magnets is five thousandths of an inch, and a plastic feeler gauge can be used to set this spacing.

The magnets 46 may be disposed within the wall 47 of the rotor 45 in any suitable manner. For example, these magnets 46 may be epoxied within slots 55 formed in the peripheral wall 47 of the rotor. These magnets likewise may be imbedded or recessed within the wall 47. Typically, the magnets 46 are mounted so as not to protrude more than ten thousandths of an inch or to be recessed more than five thousandths of an inch with presently available rare earth magnets.

The configuration of the adapter plate 26 can be changed to allow the same to readily fit in place of various different breaker point assemblies 14. That is, it may have a different shape, other apertures, and the like to enable a standard module 25 to be used with different distributors. In some instances, the plate 26 is omitted and the tab 25a is directly attached to a breaker plate the same as the plate 11 of the distributor being connected. In this case, the original plate 11 is removed from the distributor 10 and discarded, and the breaker plate attached to the tab 25a constitutes both

an adapter plate and replacement breaker plate. Likewise, the rotor configuration can be different as are conventional rotors.

FIG. 4 illustrates an exemplary circuit or system for use with a Hall cell 52 which is an integral element of circuit 60, and rotor 45 having the magnets 46 thereon. This integrated circuit 60 is similar in function to that shown and described in U.S. Pat. No. 3,581,725, and serves to convert the slow rise and fall time output of the Hall cell to a square pulse train having a frequency and pulse width over the entire operating speed of the engine down to zero rpm, determined by the timing signals from the Hall cell to, in turn, operate a solid state switch in series with the primary winding of the conventional ignition coil. FIG. 4 diagrammatically illustrates the relationship between the rotor 45 and the Hall cell sensor 52. This sensor is a silicon Hall generator included within an integrated circuit 60. This integrated circuit also includes an amplifier, trigger and output stage integrated with its own voltage regulator onto a monolithic silicon chip, and may be a Sprague ULS 3006M.

The integrated circuit 60 receives operating power through a resistor 61 connected to line 72 which is connected to input terminal 32 of the module 25. This terminal 32 is connected through wire 36 to the ignition switch 62 of the vehicle. The circuit 60 is connected to a common conductor 63 which, in turn, is connected to ground 64. This ground connection is provided by the tab 25a and adapter plate 26 connected to the advance plate 11 of the distributor 10. The battery (12 volt) of the vehicle is indicated at 65 and is connected between ground 64 and the ignition switch 62 in a conventional manner. A Zener diode 67 is connected across the circuit 60 by connecting the same between the common connection of resistor 61 and circuit 60 and the common conductor 63.

The circuit 60 includes an output driver stage having a pair of transistors (only one of which is shown) whose collectors are connected to output terminals. Either one or both of these output terminals may be used as output terminal 68 of the circuit 60. This output terminal 68 supplies the square pulse train and is connected to the base of a transistor amplifier 70. The base of the amplifier 70 is connected through a resistor 71 to line 72 which is connected to the terminal 32. The collector of the transistor 70 is connected through a resistor 73 to the line 72. A Zener diode 74 is connected between the collector of the transistor 70 and the common line 63. Zener diode 67 isolates the circuit 60 from wide voltage variations and harmful transient spikes which appear on line 72, and Zener diode 74 performs a similar function for the transistor amplifier 70.

The emitter of the amplifier 70 is connected to an input terminal 76 of an integrated Darlington power transistor circuit 77. This circuit may be a TRW SVT 6001, and includes a pair of transistors 78 and 79 connected in a Darlington configuration. The emitter of the transistor 79 is connected to the common conductor 63, and the collectors of the transistors 78 and 79 are connected together and to output terminal 33 of the module 25. This terminal 33 is connected by the line 37 to the primary winding 81 of the existing ignition coil 82 of the vehicle. Also shown in series with the winding 81 is the existing ballast resistor of the vehicle which is connected between the other end of winding 81 and the ignition switch by means of the existing ve-

hicle wiring. A pair of Zener diodes 85 and 86 are connected in series between the terminal 76 connected to the base of the transistor 78 and the terminal 33 connected to the collectors of the transistors 78 and 79. The existing capacitor 19 normally used with the breaker point assembly 14 is connected across line 63 and terminal 33, and a diode 87 is connected in parallel between the line 63 and the terminal 33. Zener diodes 85 and 86 clip the voltage generated across the switch 77 when it turns off to maintain the switch 77 within a safe voltage rating and to protect the same from large voltage transients occasioned by the sudden decrease of current in the inductance of the primary winding 81 of the ignition coil 82. Diode 87 protects the switch 77 from reverse voltage resulting from the resonant circuit found by primary winding 81 and capacitor 19 when transistor 77 turns off.

The Hall cell sensor 52 of the circuit 60 provides timing signals as a function of the position of the rotor 45 by virtue of the provision of the magnets 46 on the periphery thereof. These timing signals have a relatively slow rise and fall time. The electronics of the circuit 60 function as a pulse shaper for generating square pulses having a frequency and pulse width determined by the signals from the Hall cell sensor 52. The square pulses are necessary to prevent a portion of the energy, stored in the ignition coil, from being dissipated as heat in transistor 77 rather than being delivered to the spark plug. These pulses are amplified by the amplifier transistor 70, and are applied to the output switch 77. This switch functions to switch the primary winding 81 of the ignition coil 82. A waveform 90 associated with output terminal 33 illustrates the switching pulses. It should be noted that the ratio between "on" time B and "off" time A is constant with the present system, and is equal to the ratio of the distance between the magnets to the width of the magnets. The waveform of the present system is equivalent to that of an idealized breaker point system over the entire operation speed range of the engine.

Considering the circuit operation in more detail, when one of the magnets is in close proximity to the Hall cell, the output transistor(s), connected to terminal 68, are turned on, pulling the voltage at the base of transistor 70 to the ground potential 64. This turns transistor 70 off and, thus, turns off Darlington power switch 77. The resultant interruption of current flow in the primary winding 81 of ignition coil 82 causes a high voltage to be generated in the secondary winding. When the magnet moves away from the Hall cell, the output transistor turns off, base current is supplied to transistor 70 through resistor 71 and transistors 70 and 77 turn on again. When the next magnet comes into proximity with the Hall cell sensor, the cycle is repeated. For accurate operation, the Hall cell width (the dimension of the Hall cell in the direction of rotor rotation) must be much smaller than the distance between adjacent magnets in the rotor. In a preferred embodiment, the Hall cell operates on only one polarity of magnetic field, thus all of the magnets must have the same magnetic pole facing outward from the distributor shaft. Alternately, a bipolar Hall cell and two magnets per cylinder can be used.

The circuit 60 is available in a package configuration of 0.25 inch by 0.4 inch by eighty thousandths of an inch thick, and the Hall cell sensor is integral therein approximately twenty-five thousandths of an inch from

an outer surface thereof. The Hall cell is approximately ten thousandths of an inch square as noted earlier. The circuit 60 is encapsulated with the other circuit components of FIG. 4 to form the module 25, with the circuit 60 ten thousandths of an inch below the surface 53 of the module 25. This places the Hall cell sensor thirty-five thousandths (ten thousandths plus twentyfive thousandths) of an inch below the surface 53. Typical spacing between the surface 53 and the outer surface of the magnets 46 is five thousandths of an inch and, thus, the outer surface of the magnet is approximately forty thousandths of an inch from the Hall cell sensor 52 of the circuit 60 encapsulated within the module 25.

FIGS. 5 through 7 illustrate another form of the rotor of the present invention. FIG. 5 illustrates the conventional vacuum advance plate 95, breaker point cam 96, shaft 97 and rotor mounting plate 98 for certain types of current vehicles, such as certain General Motors vehicles. Also shown is the conventional capacitor 99. These distributor assemblies use a cup-shaped rotor (not shown) which attaches to the top of the rotor mounting plate 98. Inasmuch as the rotor mounting plate 98, the cam 96 and shaft 97 are secured together, and there is no way of mounting the magnets in the existing rotor such that they will pass in close proximity to the Hall cell sensor when the distributor shaft rotates, a new form of rotor 100 is made in two halves, 101 and 102, to enable the same to be secured about the periphery of the cam 96 and shaft 97. Thus, the conventional rotor is retained. In this embodiment, the cam 96 has six faces and is used with a six-cylinder vehicle. Thus, the rotor 100 includes six magnets 103 mounted in the peripheral wall thereof. These magnets may be mounted in the same manner discussed previously, and preferably protrude no more than one thousandths of an inch or are recessed no more than five thousandths of an inch. FIG. 7 shows one section 101 of the rotor 100, and illustrates the aperture 104 which fits over the shaft 97 and hex faces 105 which fit over and are a press fit with the cam 96. The rotor halves 101 and 102 may be secured together in any suitable manner, as by an adhesive. Locking arrangements for enabling the two halves to lock together upon placement thereof on the cam 96 and shaft 97 may be used. An exemplary material for the rotor 100 is glass-filled nylon inasmuch as this rotor does not include any high voltage switching contacts (such as contacts 48 and 49 of the rotor 45 in FIG. 1).

As an example of circuit components, other than those described above, used in the system of FIG. 4, the following have been found to be suitable:

Battery 65	Standard 12V vehicle battery
Resistor 61	125 ohms
Resistor 71	2.2 K ohms
Resistor 73	80 ohms
Diode 67	6.2 volt Zener
Diode 74	22 volt Zener
Diodes 85 and 86	140 volt Zeners, each
Diode 87	1N4004

The present embodiments of this invention are to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description or abstract of the disclosure, and all changes which come within the meaning and range of equivalency of the claims, therefore, are intended to be embraced therein.

What is claimed is:

1. In distributor apparatus for an engine, an ignition timing and pulse generating assembly comprising sensor and circuit module means, said module means including a Hall cell sensor and a circuit connected with said sensor and responsive thereto for generating switching signals for an ignition coil of an engine, plate means for said module means for enabling said module means to be mounted within a distributor of said engine and for providing a heat sink for said module means, said plate means providing a common electrical conductor connected with the circuit of said module means and for providing an electrical connection with a power source for said engine, cable means for connection with said module means, said cable means having conductors for supplying power to said module means from the power source of said engine and for connecting an output of said module means with said ignition coil of said engine, and rotor means for connection with a rotary member of said distributor for rotating said rotor means in synchronism with engine rotation of said engine, said rotor means comprising a wall with a plurality of spaced permanent magnets having outer surfaces for movement closely contiguous with the sensor of said module means.
2. An assembly as in claim 1 wherein said rotor means is substantially identical in configuration and construction with the rotor for a conventional vehicle, and said magnets are imbedded in a cylindrical wall of said rotor means.
3. An ignition assembly for use in a distributor of an engine comprising sensor and circuit module means, said module means including a Hall cell sensor and circuit for generating switching signals for an ignition coil of an engine, said module means including first and second power conductors and an output terminal connected with said circuit, plate means for said module means for enabling said module means to be mounted within a distributor of said engine and for providing a heat sink for said module means, one of said power conductors of said module means being electrically connected to said plate means, said plate means comprising a plate having at least an aperture therein for allowing said plate to be attached to a member of a distributor to which a conventional breaker point assembly normally is attached, electrical conductor means coupled with said second power conductor and said output terminal of said module means for enabling respective connection with a power source of said engine and said ignition coil of said engine, and rotor means for connection with a rotary member of said distributor for rotating said rotor means in synchronism with engine rotation of said engine, said rotor means comprising a wall having disposed therein a plurality of spaced permanent magnets having outer surfaces for movement closely contiguous with the sensor of said module means.
4. An assembly as in claim 3 wherein said rotor means is substantially identical in configuration and construction with the rotor for a con-

ventional vehicle, and said magnets are imbedded in a cylindrical wall of said rotor means.

5. A rotor for use in a distributor of an engine for generating timing signals applied through an electrical circuit for generating switching signals for an ignition coil of an engine, comprising

body means having a configuration substantially the same as a conventional distributor rotor for cooperatively mating with a rotary member of a distributor, said body means being of nonmagnetic material and comprising a wall forming an inner aperture for engagement with said rotary member and having an outer wall, and

a plurality of individual magnets coupled with said outer wall and equally spaced about the periphery thereof, said magnets having outer surfaces for rotation in close proximity with an electrical sensor and for cooperating with said sensor for generating timing signals in synchronism with the speed of an engine.

6. A module assembly for mounting within a conventional distributor for providing timing and switching signals for an ignition coil of an engine, comprising

sensor and circuit module means, said module means including a Hall cell sensor and circuit for generating switching signals for an ignition coil of an engine, said module means including first and second power conductors and an output terminal connected with said circuit, and

plate means attached to said module means for enabling said module means to be mounted within a distributor of said engine and for providing a heat sink for said module means, one of said power conductors of said module means being electrically connected to said plate means, said plate means comprising a plate having at least an aperture therein for allowing said plate to be attached to a member of a distributor to which a conventional breaker point assembly normally is attached.

7. A method of converting a conventional breaker point ignition system of the distributor of an engine to an electronic sensor and switching signal system wherein the distributor includes a breaker point assembly, rotor, and electrical conductor connected with the breaker point assembly, comprising the steps of

removing said rotor from said distributor, removing said breaker point assembly and conductor from said distributor,

positioning a sensor and circuit module means, including a Hall cell sensor and circuit for generating switching signals for an ignition coil, in place of said breaker point assembly and within said distributor, said module means including a power terminal and an output terminal,

inserting cable means into said distributor, said cable means having two conductors, connecting one of said conductors between said power terminal of said module means and a power source of said engine, and connecting the other of said cables between the output terminal of said module means and an ignition coil of said engine, and

positioning rotor means having a wall with a plurality of spaced permanent magnets on a rotary shaft of said distributor, and adjusting the sensor of said module means to be closely contiguous to but out of contact with the outer surface of said magnets.

8. An ignition apparatus for an engine, wherein said ignition apparatus includes a distributor having a rotary member rotated in synchronism with engine rotation of the engine and having a breaker plate disposed therein, said ignition apparatus including an ignition coil for the spark plugs of the engine, the improvement comprising sensor and circuit module means mounted within said distributor, said module means including a Hall cell sensor and circuit for generating switching signals for the ignition coil of the engine, said module means including first and second power conductors and an output terminal connected with said circuit,

bracket means attached to said module means and providing a heat sink therefor, one of said power conductors of said module means being electrically connected to said bracket means, said bracket means comprising a plate secured to said breaker plate of said distributor and said plate of said bracket means having at least an aperture therein for allowing said plate of said bracket means to be adjusted with respect to the rotary member of said distributor,

electrical conductor means coupled with said second power conductor and said output terminal of said module means, said electrical conductor means including cables respectively connected to a power source of the engine and to the ignition coil, and rotor means coupled with said rotary member of said distributor, said rotor means comprising a wall having disposed therein a plurality of spaced permanent magnets having outer surfaces for movement closely contiguous with the sensor of said module means.

9. In distributor apparatus for an engine, an ignition timing and pulse generating assembly comprising sensor and circuit module means, said module means including a Hall cell sensor and a circuit connected with said sensor and responsive thereto for generating switching signals for an ignition coil of engine, plate means for said module means for enabling said module means to be mounted within a distributor of the engine, said plate means providing a common electrical conductor connected with the circuit of said module means and for providing an electrical connection with a power source for said engine,

cable means for connection with said module means, said cable means having conductors for supplying power to said module means from the power source of said engine and for connecting an output of said module means with the ignition coil of said engine, and

rotor means for connection with a rotary member of said distributor for rotating said rotor means in synchronism with engine rotation of said engine, said rotor means comprising a plurality of cooperatively mating sections, said sections being positionable on said rotary member of said distributor and having an inner surface configuration for mating and keying with said rotary member, and said mating sections of said rotor means forming a wall with a plurality of spaced permanent magnets having outer surfaces for movement closely contiguous with the sensor of said module means.

10. An ignition assembly for use in a distributor of an engine comprising

sensor and circuit module means, said module means including a Hall cell sensor and circuit for generating switching signals for an ignition coil of an engine, said module means including first and second power conductors and an output terminal connected with said circuit, 5

plate means for said module means for enabling said module means to be mounted within a distributor of the engine, one of said power conductors of said module means being electrically connected to said plate means, said plate means comprising a plate having at least an aperture therein for allowing said plate to be attached to a member of a distributor to which a conventional breaker point assembly normally is attached, 10 15

electrical conductor means coupled with said second power conductor and said output terminal of said module means for enabling respective connection with a power source of said engine and said ignition coil of said engine, and 20

rotor means for connection with a rotary member of said distributor for rotating said rotor means in synchronism with engine rotation of said engine, said rotor means comprising a plurality of cooperatively mating sections, said sections being positionable on said rotary member of said distributor and having an inner surface configuration for mating and keying with said rotary member, and 25

said mating sections of said rotor means forming a wall having disposed therein a plurality of spaced permanent magnets having outer surfaces for movement closely contiguous with the sensor of said module means. 30

11. A rotor for use in a distributor of an engine for generating timing signals applied through an electrical circuit for generating switching signals for an ignition coil of the engine, comprising 35

body means for cooperatively mating with a rotary member of a distributor, said body means comprising a wall forming an inner aperture for engagement with said rotary member and having an outer wall, said body means including a plurality of cooperatively mating sections forming said wall, said sections being positionable on said rotary member of said distributor and having an inner surface configuration for mating and keying with said rotary member, and 40

a plurality of magnets coupled with said outer wall and equally spaced about the periphery thereof, said magnets having outer surfaces for rotation in close proximity with an electrical sensor and for cooperating with said sensor for generating timing signals in synchronism with the speed of an engine. 50

12. A module assembly for mounting within a conventional distributor for providing timing and switching signals for an ignition coil of an engine, comprising 55

sensor and circuit module means, said module means including a sensor and a switching circuit for generating switching signals for an ignition coil of an engine, said module means including first and second power conductors and an output terminal connected with said circuit, and 60

bracket means attached to said module means for enabling said module means to be mounted within a distributor of said engine and for providing a heat sink for said module means, said bracket means including metal tab and plate means with the tab 65

means being physically connected with said module means, said plate means of said bracket means having at least an aperture therein for allowing said plate means to be attached to said distributor.

13. A module assembly as in claim 12 wherein said tab and plate means comprise a tab and a plate which are physically, electrically and thermally connected together, and said plate is configured to be attached to a member of a distributor to which a conventional breaker point assembly normally is attached.

14. A module assembly as in claim 12 wherein said tab and plate means comprise a tab and a plate which are physically, electrically and thermally connected together, and said plate comprises a distributor breaker plate.

15. An ignition timing and pulse generating assembly for use in a distributor of an engine comprising sensor and circuit module means for providing switching signals to an ignition coil of an engine, said module means including a Hall cell sensor and a switching circuit for generating switching signals for the ignition coil of the engine, said module means including power conductor means and output terminal means connected with said switching circuit, 25

plate means physically coupled with said module means, said module means and plate means being configured to allow said plate means and module means to be mounted within a distributor of the engine, 30

conductor means for coupling said output terminal means of said module means with the ignition coil of the vehicle, and

rotor means having a configuration substantially the same as a conventional distributor rotor for connection with a rotary member of the distributor for rotating said rotor means in synchronism with engine rotation, said rotor means comprising a wall with a plurality of substantially equally spaced permanent magnets having outer surfaces for movement closely contiguous with the sensor of said module means. 40

16. An ignition timing and pulse generating assembly for mounting within a conventional distributor of an ignition system of an engine, wherein said distributor has a rotary member rotated in synchronism with engine rotation and wherein the ignition system includes an ignition coil for the spark plugs of the engine, the ignition assembly comprising 45

sensor and circuit module means, said module means including a Hall cell sensor and a circuit connected with said sensor and responsive thereto for generating switching signals for the ignition coil of the engine, and said module means including first and second power conductors and an output terminal connected with said circuit, the first and second power conductors being adapted to be coupled with a power source of the engine and the output terminal being adapted to be connected with the ignition coil of the engine, 50

plate means for said module means for enabling said module means to be mounted entirely within a distributor of the vehicle, said plate means providing a heat sink for said module means, and 60

rotor means for connection with the rotary member of said distributor for rotating said rotor means in synchronism with engine rotation, said rotor means comprising a substantially circular outer wall with a plurality of spaced individual permanent magnets having outer surfaces for movement closely contiguous with the sensor of said module means. 65

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