United States Patent [19]

Adams et al.

[11] **3,853,108**

[45] **Dec. 10, 1974**

[54] **SOLID STATE IGNITION**

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[73] Assignee: **Solitron Devices, Inc.**, Tappan, N.Y.

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[21] Appl. No.: **340,015**

[52] **U.S. Cl.**..... **123/148 E**, 310/70, F02p/3/06

[58] **Field of Search**..... 335/229; 123/148, 148 E; 310/70

[56] **References Cited**

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3,291,108	12/1966	Schneider et al.	123/148 E
3,328,614	6/1967	Falge et al.	123/148 E
3,390,668	7/1968	Hufton	123/148 E

FOREIGN PATENTS OR APPLICATIONS

162,290	2/1958	Sweden	335/229
765,448	1/1957	Great Britain	335/229

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Assistant Examiner—James W. Cranson
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[57] **ABSTRACT**

A magnetically-pulsed, semiconductor controlled ignition system with a signal means comprising balanced transistors interconnected to supply trigger signals of substantially constant magnitude regardless of operating conditions such as engine speed and ambient temperature, said means being temperature compensated.

14 Claims, 6 Drawing Figures

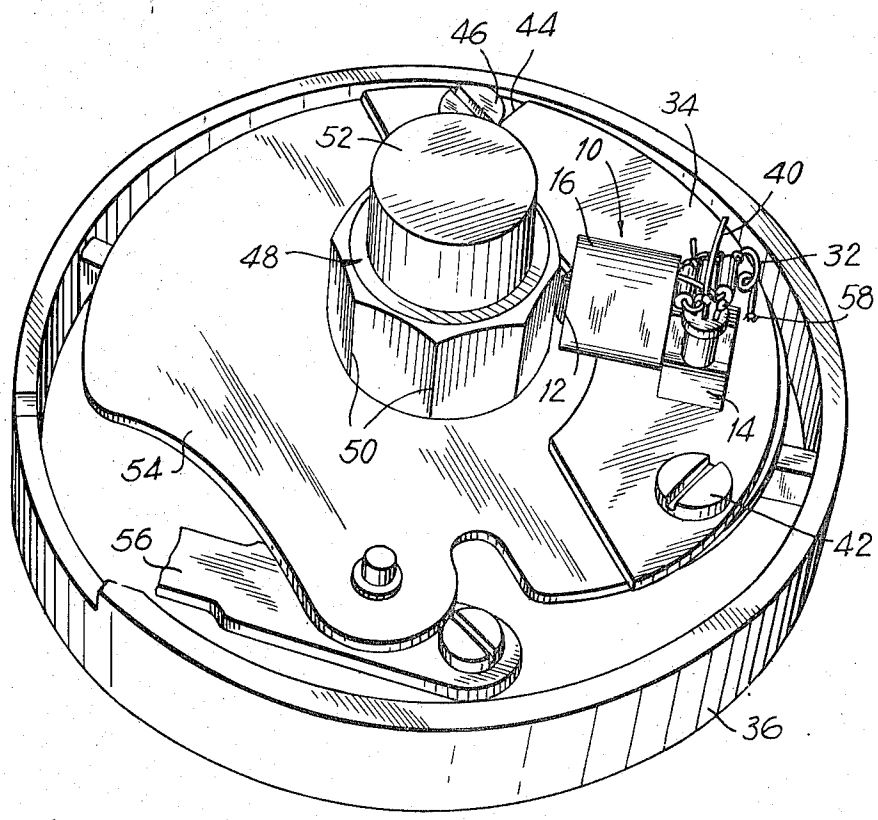


FIG. 1

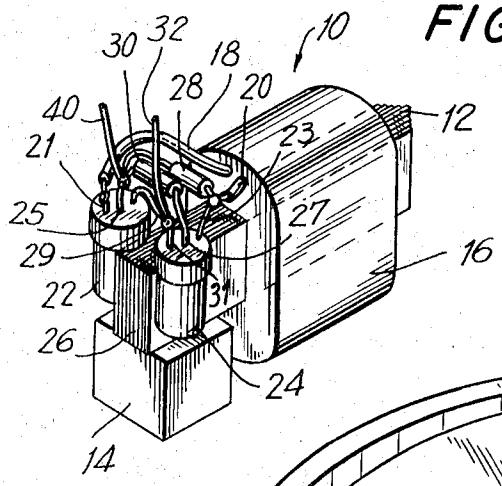


FIG. 2

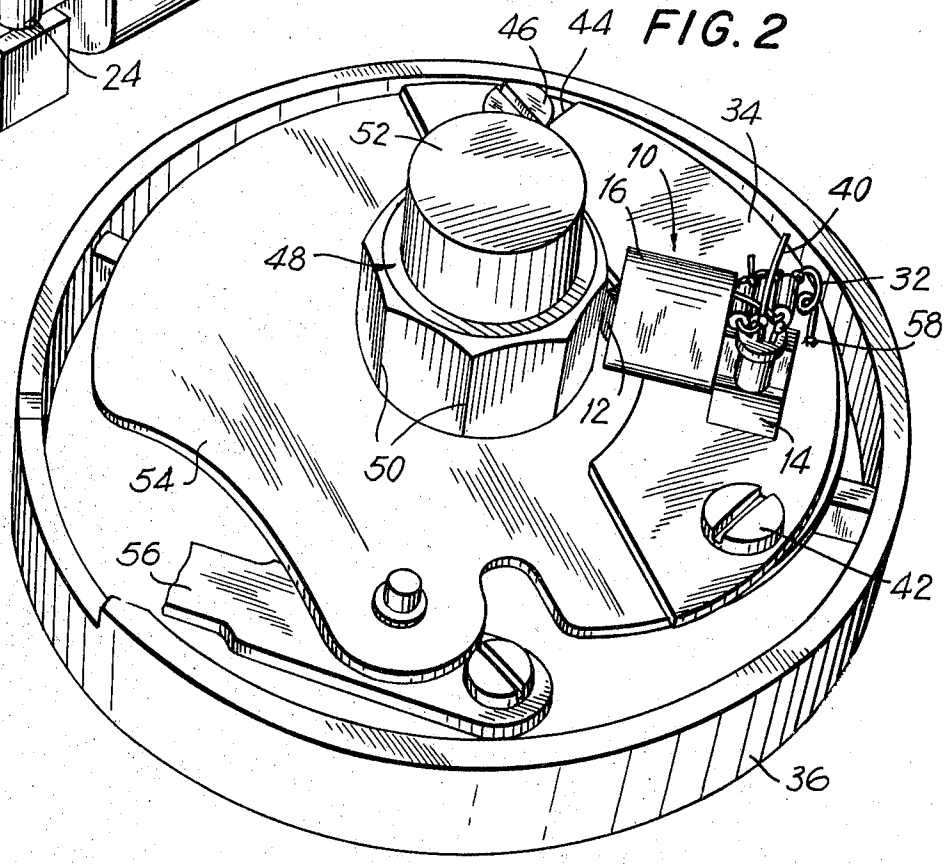
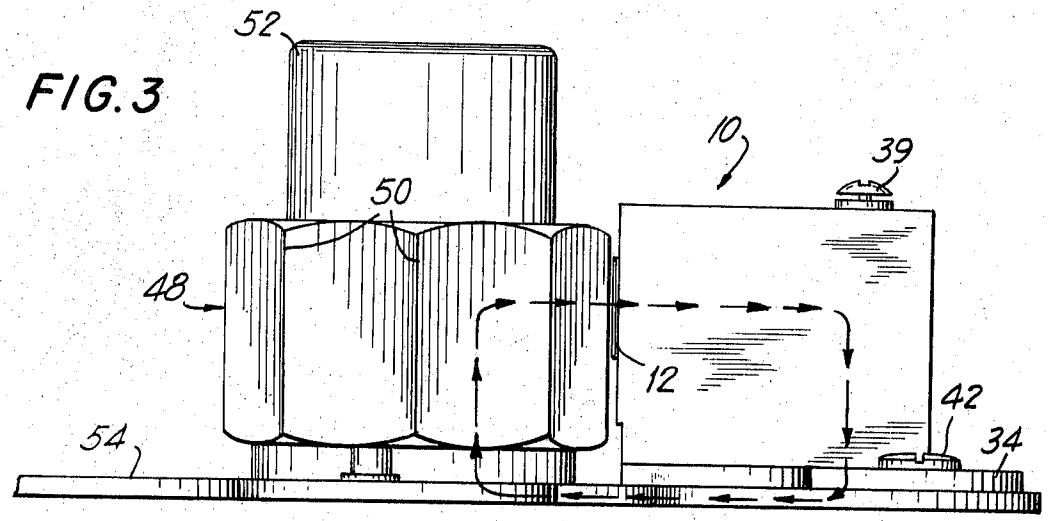


FIG. 3



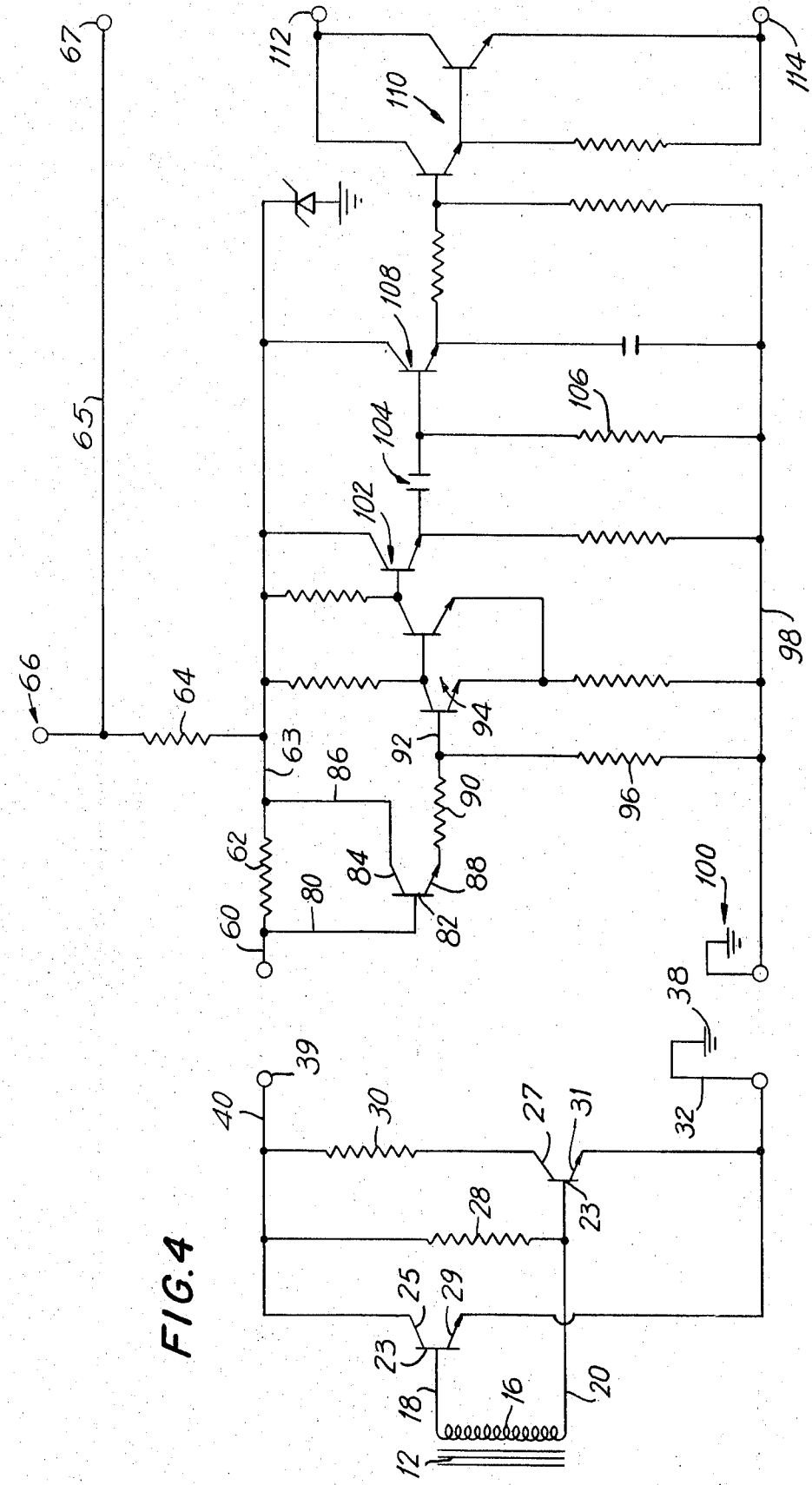

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FIG. 5

FIG. 4

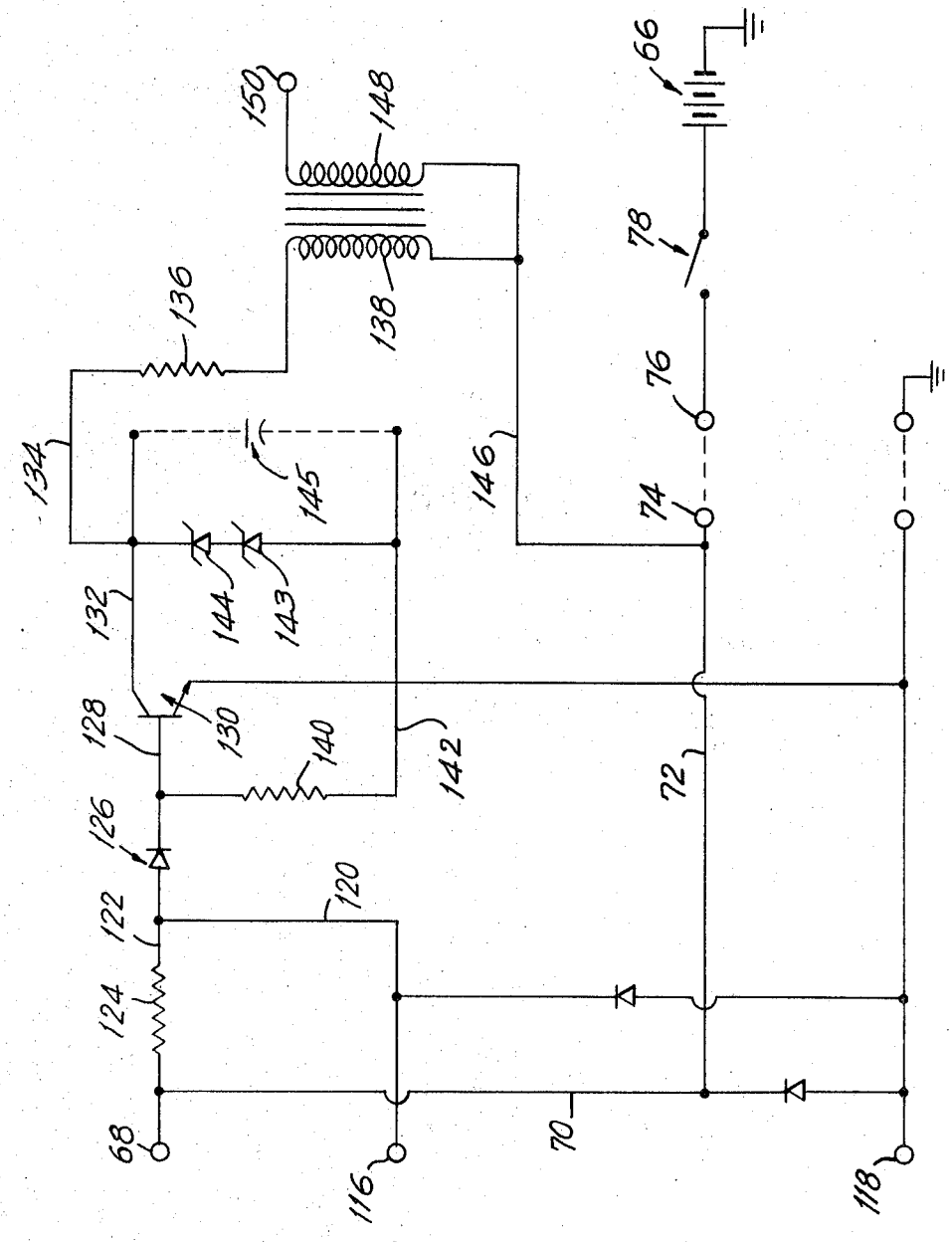

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FIG. 6

SOLID STATE IGNITION

BACKGROUND OF INVENTION

In order to provide a more even cyclic combustion and reduce the unburned hydrocarbons to make a better performing and cleaner automobile engine it has been found that a significant contribution to this art is provided by an ignition system that will produce higher spark energy levels.

The usual ignition system, the one most generally used today, for an internal combustion engine includes an ignition coil and an engine driven ignition distributor. Such distributor is connected to the engine crankshaft so as to drive a cam within the distributor. This cam operates a set of breaker points that upon opening and closing interrupt and connect a source of current to a primary winding of the coil. The interruption of the charging current to the primary winding causes the transference of a high potential to the secondary winding to produce a spark potential in the spark plug. The contact points aforementioned are biased normally to a closed position. As the engine speed increases the charging time of the coil between point openings decreases such that spark energy is reduced. Also the spring action of the contact points causes flutter or dithering of the points to the detriment of performance of the system.

This prior art ignition system has been improved upon recently by incorporating a transistorized circuit between the contact points and the coil to control the supply of current and interruption of same to the coil. Marked improvement of engine performance is achieved by such by increasing spark potential at all engine speeds due to precise control of the current flow. In such systems arcing at the points has been reduced to a point that it does not cause wear of the contact surfaces. However, the wear of the cam surface on its follower block connected to the points still persists.

In order to eliminate this problem it has been proposed to replace the cam-operated points by a pulse generator employing a pulse wheel adapted to the cam and a magnetic pick-up device associated in spatial relation therewith whereby rotation of the wheel disturbs a magnetic field to cause voltage or current pulses to be delivered from the pick-up device. Such a prior art device is depicted by U.S. Pat. No. 3,272,930. Another form of such pulse generating means without the need of provisioning the cam with a special pulse wheel is seen by U.S. Pat. No. 3,289,020.

The introduction of such improvements are not, however, free of problems. For example, the pulses produced by the magnetic device are of a low amplitude having an alternating current potential wave form whose positive and negative excursions change in amplitude with the rotational speed of the cam due to the different rate of change of magnetic flux linked to a pick-up coil in the magnetic pick-up device. In addition, it has been found that even with such pulse generating systems, as comprise magnetic pick-up means, amplification of the pulse signal deemed necessary to operation of the ignition system has made such a system extremely sensitive to spurious signals such as are derived from mechanical vibration and electrical transient impulses. As a result the prior art is suggestive of means to reduce or eliminate this problem by integrating the potential signal pulses of the magnetic pick-up means whereby the spurious signals, generated as above, are greatly attenuated. Such a prior art device is depicted by U.S. Pat. No. 3,357,116 disclosing a device giving an integrated output signal substantially constant in amplitude regardless of engine speed.

Another development noticed within the prior art is the incorporation in the amplification means for such a magnetic pick-up device a circuit that has temperature compensated diodes. This is seen by U.S. Pat. No. 3,653,367. Even though the purpose of these diodes is not explained by this prior art disclosure, it may be surmised that the purpose is to render the amplifier stable for widely varying operating temperatures. It should also be noted, however, that with such a system there is a need to have an additional signal to bias the ignition system on.

SUMMARY OF INVENTION

This invention is addressed to the improvement of an ignition system for an internal combustion engine that inexpensively provides a magnetic pulse generating means with self-contained temperature compensated amplifier means of precise operating characteristics that eliminate need for concern about spurious signals and widely varying ambient temperatures.

It is a principal object of the invention to provide control means for an ignition system that converts an engine spark distributor from a breaker point operation to timing sensor operation without the necessity of undertaking permanent alterations to the distributor, provisioning the distributor with new leads or the substitution of parts other than the breaker point assembly and condensor therefor.

A more specific object of this invention is to provide an amplified magnetic pick-up device that is directly interchangeable with conventional breaker contacts that is adapted to be pulsed by the lobes of the original distributor cam such that stabilized voltage and/or current signals, suitable for triggering a semiconductor type primary coil current switching unit, will be generated upon rotation of the cam.

A still more particular object is to provide an amplified magnetic pick-up device with a bias transistor balanced as to the transistor amplifier to track therewith whereby the amplifier is temperature compensated over a wide temperature range while providing higher gain than heretofore possible.

BRIEF DRAWING DESCRIPTION

FIG. 1 is a perspective view of a magnetic sensor and amplifying means according to this invention;

FIG. 2 is a perspective view of the magnetic sensor installed to the plate of a distributor means;

FIG. 3 is a side view of the magnetic sensor means on the distributor plate adjacent the distributor cam;

FIG. 4 is a schematic of the circuit of the magnetic sensor means;

FIG. 5 is a schematic of the triggering circuit for an ignition system to be operated by the magnetic sensor; and

FIG. 6 is a schematic of an ignition coil switching circuit controlled by the triggering circuit.

DETAILED DESCRIPTION

With more particular reference now to FIG. 1 there is shown a magnetic sensor 10 according to this invention before a housing is formed thereover as by use of an epoxy. This sensor comprises a plurality of steel

plates **12** attached, as by bonding to a permanent magnet **14** and around which a wire coil package **16** is affixed, as by bonding also. The steel plates are of different lengths, as shown, to form a triangle at one end. This permits the desired mass for a pick-up arm for the magnetic field to be discussed hereinafter while at the same time enhancing the rate of change in the reluctance of such magnetic circuit as the path for same moves to either side of the apex of the triangular end, to also be discussed in greater detail hereinafter.

At the other end of the pole piece formed by plates **12** wires **18** and **20** extend from the coil package **16** and are respectively connected to the base terminals **21** and **23** of transistors **22** and **24.** These transistors are formed to have a flat side which are each bonded to pole piece end **26** above the magnet **14.** A resistor **28** connects base terminal **23** to collector terminal **25** of transistor **22** which is also connected by resistor **30** to collector terminal **27** of transistor **24.** Emitter terminal **29** of transistor **22** is connected to emitter terminal **31** of transistor **24** and via a lead **32** to a plate **34** (See FIG. **2**) within the distributor housing **36** to a ground **38** (See FIG. **4**). A lead **40** connects collectors **25** and **27** to a terminal **39** of a power source and provides the output signal current from the sensor.

Plate **34** is provided with a hole for receipt of a pivot bolt **42** and slot **44** for a locking bolt **46.** It may therefore be realized that the apex of the triangular end of the lamination of plates **12** may be adjusted towards or away from a cam **48** having lobes **50.** The cam is affixed, as by keying (not shown), to a shaft **52** connected to be driven by an engine (not shown). The plate **34,** is, therefore, attached to a movable distributor plate **54,** whose movement is controlled by an arm **56** by means (not shown) and in a manner well known to those skilled in the art.

The epoxy housing has been left off the structures of FIGS. **1** and **2** in order to show the physical details of the parts therein. However, it is shown in FIG. **3** to be encasing all of the sensor **10** except for a very minute portion of the laminated plates at the apex thereof. In affixing sensor **10** to plate **34** the portion of the plate underlying sensor **10** is sandblasted in one form of manufacturing found to be practical to enable a lasting bond between the epoxy housing and the plate **34.** This has proven to be a bond which permanently over the useful life of the sensor prevents movement of the sensor on the plate **34.** Additionally, as a fail-safe feature one or more small holes may be drilled in the plate under the desired location of the sensor into which the epoxy forms to permanently locate sensor **10.** Prior to the potting of the epoxy housing lead **32** is attached to the plate **34,** as at **58,** within the area of the epoxy housing after having been looped or otherwise provided with means to flex without destroying the bond at **58,** as may result because of different thermal expansion characteristics of the epoxy and plate **34** in one embodiment whereby service life is increased for the sensor assembly.

With such an assembly as the one described a concise magnetic circuit shown in FIG. **3** is provided. Also, due to the use of a number of laminations forming a pole piece, the pole piece is relatively large so as to provide a low reluctance path capable of transferring a high flux density to a position within the coil. The triangular end of the pole piece provides for precise control of this magnetic circuit by sharply varying the air gap between lobes **50** of cam **48** and the end of the pole piece as the lobe approaches and moves away from the apex of this triangular end. Therefore, the inductance change induces in coil **16** an alternating current potential wave form the pulses of which occur in timed relation with the engine driven cam lobes **50.** The gradual closing and opening of the air gap between lobes **50** and the pole piece formed of laminations **12** precisely creates a desired inductance change for coil **16** whereby defined pulses (of a defined width) are accomplished.

In that the distributor housing **36** is affixed to the engine, usually connected to one side of a power source such as a battery, only one lead **60** (See FIG. **5**) need be connected to terminal **39.** This in present day engines is all that is provided into a distributor, and, therefore, there are no new leads needed to adapt the sensor **10** to distributors used with todays internal combustion engines. Lead **60** connects to the triggering circuit. More particularly, with reference to FIG. **5** there is shown a preferred form of the triggering circuit having lead **60** connected to resistor **62** and lead **63;** and via resistor **64;** lead **65** terminals **67, 68;** leads **70** and **72;** terminals **74, 76;** ignition switch **78** to a battery **66** (See FIG. **6**). A lead **80** connects lead **60** to the base **82** of an emitter follower transistor having its collector **84** connected by lead **86** to lead **63,** and its emitter **88** connected to resistor **90** connected by lead **92** to a Schmidt trigger **94.** A resistor **96** is connected between lead **92** and a lead **98** connected to ground, as at **100.** With such a circuit as aforedescribed the emitter follower transistor provides impedance matching for operation of the Schmidt trigger. The Schmidt trigger **94** provides a signal of a precise strength to emitter follower transistor **102** for biasing it on to step down the impedance.

The signal from the emitter of transistor **102** is provided to capacitor **104** and a pulse wave form is thereby made possible whose duration is controlled by capacitor **104** and resistor **106** for controlling a transistor **108.** If the wave form is such to bias transistor **108** on a signal is provided for amplifier **110,** connected between terminals **112** and **114** that are connected to terminals **116** and **118** (See FIG. **6**). Terminal **116** is connected by a lead **120** to a lead **122** between a resistor **124** and a diode **126.** Lead **128** is connected to the diode **126** and a base of a switching transistor **130** having its collector connected by lead **132, 134** and resistor **136** to primary winding **138.** A resistor **140** and a lead **142** connects zener diodes **143, 144** and capacitor **145** in a circuit around transistor **130** whereby reverse spike protection is afforded to the semiconductor means. Primary winding **138** is connected by a lead **146** to lead **72,** and a secondary winding **148** is connected to a terminal **150** connected via a distributor cap and rotor on shaft **52** (not shown) to spark plugs for the engine.

While the embodiment of the present invention, as herein disclosed, constitute a preferred form, it is to be understood that other forms may be adopted particularly in the substitution of integrated circuitry and CMOS technology for the discrete particle construction disclosed.

What is claimed is as follows:

1. An ignition system including a sensor means operatively associated with a circuit including devices to amplify, define and switch current in accordance with

a pulse from said sensor means and ignition coil means for delivering a high potential spark from said ignition system as called for by said semiconductor means said ignition system comprising the improvement to said sensor means of:

a permanent magnet;

a pickup arm connected to said magnet at one pole surface thereof having a plurality of plates of progressively lesser length at one end to form a triangle on said end whose apex is along a centerline for said pickup arm;

a coil around said arm having leads extending therefrom to sense inductance change in said arm and provide an alternating current potential wave form as said inductance rises and falls; and

electronic means (adjacent said arm and connected to each of the leads from said coil and to each other to track together and provide a temperature compensated source of signals for said circuit) comprising transistors affixed to said pick-up arm having their respective bases connected to each of said leads, their collectors connected to each other by a resistance means and to one side of a power source, a resistor connected between the collector of one transistor and to the lead to the base connection of one of said transistors and having their emitters connected together with a lead therefrom to the other side of said power source.

2. The improvement of claim **1** wherein said sensor is potted in epoxy bonded and located thereby on a plate.

3. The improvement of claim **2** wherein said plate is movably related to a distributor plate to adjustably locate said sensor in an engine distributor with respect to an engine driven cam having lobes equal in number to the required sparks for said ignition system for operation of an engine thereby.

4. The improvement of claim **3** wherein said electronic means comprises transistors affixed to said pick-up arm having their respective bases connected to each of said leads, their collectors connected to each other by a resistance means and to one side of a power source, a resistor connected between the collector of one transistor and to the lead to the base connection of one of said transistors and having their emitters connected together with a lead therefrom to the other side of said power source.

5. The improvement of claim **1** wherein said other side of said power source is provided by the distributor plate and the one side of said power source is provided by a single lead to the interior of the distributor means whose opposite end of said lead connects to said one side of said power source externally thereof.

6. The improvement of claim **5** wherein said single lead connects to said other side of said power source in series with said circuit and an ignition switch.

7. The improvement of claim **6** wherein said circuit includes an emitter follower receiving the pulse from said sensor connected to operate a Schmidt trigger in turn connected to an emitter follower stepping down impedance of the signal from said Schmidt trigger which is then connected to and passed by a resistance capacitance network for a time as expressed by $RC = T_{sec}$, said network delivering a pulse wave form to a transistor also connected to the RC network to be controlled thereby to in turn control a Darlington amplifier for delivery of a signal from said circuit.

8. The improvement of claim **7** and further characterized by the inclusion with the ignition coil means of electronic means for receiving the signal of said Darlington amplifier and switching said power source on and off with respect to a primary winding of said ignition coil means whereby said coil may be charged, and discharged, as by switching said power source off creating a high potential in a secondary winding thereof, respectively.

9. The improvement of claim **8** wherein said electronic means includes a switching transistor and a circuit with devices protecting against reverse spikes and over potential.

10. The improvement of claim **1** wherein the triangular end of said pickup arm has a surface on a plane to either side of the apex of a greater angle with the center line thereof than surfaces to either side of a cam lobe adjacent thereto by which a magnetic circuit is completed from said one pole surface via said arm and cam lobe to an opposite pole surface of said magnet.

11. A distributor means for an internal combustion engine comprising:

a housing;

a movable distributor plate within said housing;

a rotable shaft extending through said plate;

a cam with a plurality of lobes connected to said shaft above said distributor plate;

an adjustable plate adapted to be movable to a predetermined position and thereafter fixed in location on said distributor plate;

a magnet secured to said adjustable plate to have one pole on said adjustable plate and its opposite pole upwardly thereof;

a pickup arm affixed to said magnet on said opposite pole and extending towards said cam to have a slight clearance between its end and said lobes of said cam;

a pickup coil about said arm between said magnet and the end of said arm adjacent but having slight clearance from said lobes, said coil having a substantial air gap from said adjustable plate and leads projecting therefrom;

(electronic) transistor means behind said pickup coil on said pickup arm, said transistor means operatively connected to said leads and having a lead connected to said adjustable plate and another lead attached to a terminal; and

means to enclose said pickup arm, said magnet, said (electronic) transistor means and said leads leaving said terminal exposed locating all with respect to each other and bonding all to said adjustable plate to thereby permit adjustment of said plate to provide proper predetermined clearance of said arm and said cam lobes.

12. A means to provide pulses by sensing an inductance change in a pickup arm completing a magnetic circuit, said means comprising:

a pickup coil about said arm; and

a pair of transistor means attached to said coil to be controlled by alternating current potentials from said coil including means connecting one transistor of said pair of transistor means to another transistor to provide a constant bias at the base of said one transistor (to provide temperature compensation for delivery of pulses over an extremely wide range).

13. The structure of claim 12 and further characterized in that said pickup arm is comprised of laminations that are of varying length to form an angled end extending beyond the coil opposite the end attached to said magnet whereby a low reluctance path is created giving the maximum inductance within the coil as the air gap narrows at the apex of the angled end and not at the side surfaces thereof whereby the highest potential in the coil only occurs when said circuit is via the apex of said arm and sharply lower to each side thereof.

14. The structure of claim 13 and further comprising a distributor means for mounting said plate therein such that said apex is located with respect to a rotating cam means of said distributor means.

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