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IGNITION SYSTEM APPLYING INDUCED VOLTAGE TO THE COIL PRIMARY

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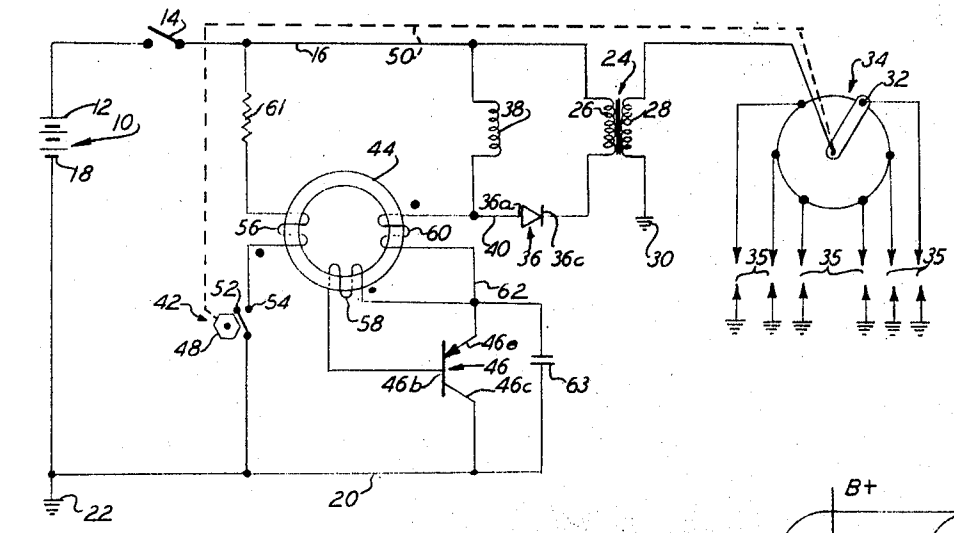


FIG. 1

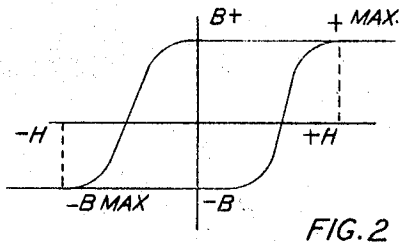


FIG. 2

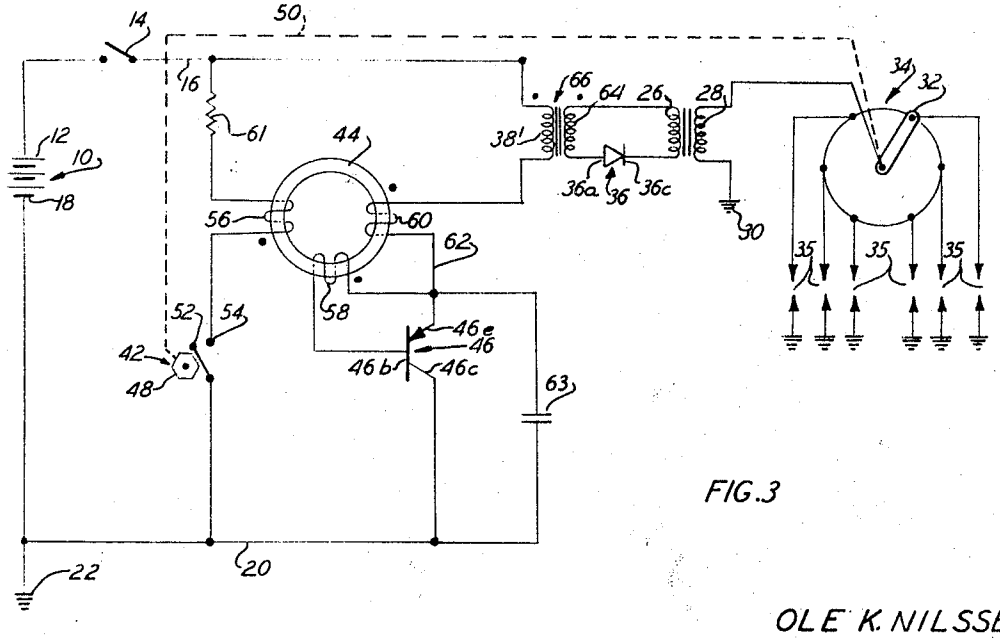


FIG. 3

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IGNITION SYSTEM APPLYING INDUCED VOLTAGE TO THE COIL PRIMARY

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ABSTRACT OF THE DISCLOSURE

This disclosure describes an ignition system permitting current to build up in an inductor and then applying the voltage induced in the inductor when the current is stopped to the primary winding of an ignition coil. The ignition pulse resulting in the coil secondary winding is transmitted to an appropriate spark plug. The inductor can be in parallel with the coil primary winding with a rectifier in one of the connecting leads blocking battery voltage and current from the coil primary while passing induced voltage and current to the coil primary. A control circuit comprising a saturable switching core and a transistor permits the current buildup in the inductor for a time period independent of engine speed.

BRIEF SUMMARY OF THE INVENTION

Most present day ignition systems for internal combustion use breaker points to control directly the electrical current through the ignition coil primary winding. The sudden change in current occurring when the breaker points open induces voltage in the coil secondary winding that is distributed to the appropriate spark plug. In some of the proposed electronic systems, a capacitor is charged by any of a variety of means and then discharged through the coil primary winding to produce the ignition voltage.

Ignition systems using breaker points directly must provide a long current buildup time to avoid inducing a spark during current buildup. Such systems waste thereby a considerable amount of electrical energy. Capactive discharging systems tend to resonate while discharging, which produces multiple ignition sparks per discharge cycle. Multiple sparks of course reduce spark plug life and can cause undesirable engine combustion characteristics.

The ignition system of this invention permits very rapid charging times because no current passes through the coil primary winding during the charging cycle. This feature alone provides significant savings in electrical energy. When combined with a control circuit permitting current buildup for a predetermined time period that is independent of engine speed, system economy becomes extremely high. In addition, the ignition voltage and current wave forms are substantially equivalent to those produced by ignition systems using breaker points to control directly the current through the coil primary winding which is the type of wave form present day internal combustion engines have been designed to use.

In an ignition system of this invention having a source of electrical energy and an ignition coil with primary and secondary windings, an ignition voltage is produced in the coil secondary winding by connecting an inductor with the electrical energy source and connecting in series with the inductor a control means switchable from conduction to nonconduction in timed relationship to rotating components of the engine. Circuitry couples the inductor means with the coil primary winding to apply to the coil primary winding the voltage induced in the inductor when the control means switches.

The inductor can be connected in parallel with the coil primary winding, and a rectifier can be located in one

of the leads connecting the inductor with the coil primary in a manner blocking battery current from the coil primary but passing induced current from the inductor. A transistor having its emitter and collector terminals in series with the inductor can be used in the control means. A saturable switching core then can be associated with the transistor and with a set of breaker points to turn on the transistor for a predetermined time period that is independent of engine speed. The time period is selected so the inductor attains an energy level adequate for proper ignition at the lowest anticipated battery voltage.

DESCRIPTION OF THE DRAWING VIEWS

FIGURE 1 is a schematic diagram of an ignition system of this invention having the inductor in parallel with the coil primary winding and having a set of breaker points, a saturable switching core, and a transistor in the control means. FIGURE 2 shows the hysteresis loop of the saturable switching core, and FIGURE 3 is a schematic diagram of the ignition system in which the inductor comprises a transformer having its secondary winding connected through a rectifier to the ignition coil primary winding.

DETAILED DESCRIPTION

Construction

Referring to FIGURE 1, a battery **10** has its positive terminal **12** connected through an ignition switch **14** to a positive buss lead **16**. The negative terminal **18** of battery **10** is connected to a negative buss lead **20** and to ground at **22**.

An ignition coil **24** having a primary winding **26** and a secondary winding **28** has one terminal of secondary winding **28** connected to ground at **30**. The other terminal or secondary winding **28** is connected to a rotating arm **32** of a distributor assembly **34**. Arm **32** sequentially connects secondary winding **28** with one of a plurality of spark plugs **35**.

One terminal of coil primary winding **26** connects with buss lead **16** and the other terminal connects with the cathode **36***c* of a diode **36**. An inductor **38** has one terminal connected to buss lead **16** and the other terminal connected to a lead **40** that connects with the anode **36***a* of diode **36**. Thus, inductor **38** is in parallel with coil primary **26**, and diode **36** serves as a rectifier in one of the leads connecting inductor **38** with coil primary **26**.

A cam and breaker point assembly **42**, a saturable switching core **44**, and a transistor **46** are the principal components of a circuit controlling the current through inductor **38**. Cam **48** of assembly **42** is driven by rotating components (not shown) of the engine. Dotted line **50** represents the conventional mechanical connection between cam **48** and arm **32** of distributor assembly **34** so arm **32** also rotates with engine components. A set of breaker points **52** and **54** are associated with cam **48** and are moved into and out of touch thereby.

Switching core **44** has a primary winding **56**, a secondary winding **58**, and a tertiary winding **60**. Primary winding **56** has its undotted terminal connected through a resistor **61** to buss lead **16** and its dotted terminal connected to breaker point **54**. Breaker point **52** is connected to buss lead **20**. Tertiary winding **60** has its dotted terminal connected to lead **40** and its undotted terminal connected to a lead **62** that in turn connects with emitter **46***e* of transistor **46**. Collector **46***c* of transistor **46** connects with buss lead **20**.

Secondary winding **58** has its dotted terminal connected with lead **62** and its undotted terminal connected to base **46***b* of transistor **46**. A capacitor **63** is connected between lead **62** and lead **20**.

Connections in FIGURE 3 are similar to those in FIG-

URE 1 except the terminal of coil primary **26** connected in FIGURE 1 to buss lead **16** is connected to the dotted terminal of the secondary winding **64** of a transformer **66**. Lead **40** is removed and the undotted terminal of secondary winding **64** is connected to anode **36***a*. The primary winding **38'** of transformer **66** serves as the inductor and has its dotted terminal connected to lead **16**. The undotted terminal of primary winding **38'** is connected to the dotted terminal of winding **60**.

Operation

Windings **56**, **58** and **60** are arranged on core **44** so conventional current into an undotted terminal of a winding produces a negative magnetizing force tending to switch core **44** toward a negative flux density level. Conversely, conventional current into a dotted terminal of one of the windings produces a positive magnetizing force tending to switch core **44** toward a positive level of flux density. When the flux density in core **44** is becoming more negative, a negative voltage appears at the dotted terminals of the windings and of course when the flux density is becoming more positive, a positive voltage appears at the dotted terminals.

With breaker points **52** and **54** in touch with each other, the current in winding **56** switches core **44** into its negative saturation state (the point —B Max. shown in FIGURE 2). During switching of core **44** toward the —B Max. point, the voltage appearing at the undotted terminal of secondary winding **58** keeps transistor **46** turned off.

When cam **48** moves breaker point **52** out of touch with breaker point **54**, the magnetizing force —H disappears from core **44** and the flux density in core **44** moves from —B Max. to the point B—. This change induces a voltage in winding **58** that turns on transistor **46**. A current then begins building up in inductor **38** and winding **60**. Since the current is entering winding **60** at the dotted terminal, a positive magnetizing force is applied by winding **60** that switches core **44** toward the point marked +B Max. in FIGURE 2. The switching induces additional current in winding **58** to increase conduction of transistor **46**.

The induced voltage at the dotted terminal of winding **58** disappears when core **44** reaches positive saturation at the point +B Max. and transistor **46** turns off. Current in inductor **38** stops suddenly and the self-inductance of inductor **38** induces a current with a voltage that is positive at the lead **40** side of winding **38**. The induced current passes through diode **36** and is applied to coil primary winding **26**. Coil **24** transforms the current and voltage into a higher voltage that is applied to an appropriate spark plug **35**. Diode **36** prevents current in coil primary winding **26** while transistor **46** is conducting.

When the current in winding **60** stops, core **44** moves from +B Max. to the point B+. Transistor **46** remains off during this switch because a negative voltage is induced in winding **58**. Subsequently, cam **48** moves breaker point **52** into touch with breaker point **54** and current begins again in primary winding **56**. The magnetizing force produced thereby switches core **44** from the point B+ to the point —B Max. and the above ignition cycle is repeated. Note that a current exists in inductor **38** only while transistor **46** is conducting and transistor **46** conducts only during the time period needed to switch core **44** from the point —B Max. to the point +B Max.

In FIGURE 3, windings **38'** and **64** are arranged on transformer **66** so a voltage across winding **38'** positive at the dotted terminal thereof transforms into a voltage across winding **64** positive at the dotted terminal of winding **64**. Anode **36***a* then is negative with respect to cathode **36***c*. Thus, when transistor **46** is conducting and a current is building up in winding **38'**, diode **36** blocks the

induced voltage in winding **64** from coil primary winding **26**. However, when transistor **46** turns off, the voltage across winding **38'** becomes positive at the undotted terminal. Diode **36** then is forward biased and it applies the voltage and current appearing across winding **64** to coil primary winding **26**. Coil **24** transforms the voltage and current into an ignition spark.

Thus, this invention provides an ignition system using the voltage induced in an inductor to produce a voltage in the coil primary winding that in turn produces an ignition spark. Only the induced voltage from the inductor is applied to the coil primary winding; a rectifier blocks battery voltage from the coil primary while current builds up in the inductor. A switching core coupled to a transistor permits the current to build up in the inductor for a time period that is independent of engine speed. Very little electrical energy is wasted, therefore, and the ignition system of this invention has an extremely high electrical efficiency.

What I claim is:

1. In an ignition system for any internal combustion engine having a source of electrical energy and an ignition coil with primary and secondary windings, means for producing an ignition voltage in the coil secondary winding comprising

an inductor means,

control means in series with said inductor means, said control means being switchable from conduction to nonconduction in timed relationship to rotating components of the engine, said control means comprising a transistor having its emitter and collector terminals in series with the inductor means, a set of breaker points actuated by the engine, and a saturable switching core having primary, secondary and tertiary windings thereon, said primary winding being in series with said breaker points, said secondary winding connecting with the base terminal of the transistor and said tertiary winding being in series with the emitter and collector terminals of the transistor, said windings being arranged to turn on the transistor when the breaker points are actuated and turn off the transistor when the switching core saturates, and

circuit means coupling the inductor means directly with the coil primary winding, said circuit means applying to the coil primary winding the voltage induced in the inductor means when the control means switches, said circuit means comprising a rectifier means in one of the leads connecting the inductor means with the coil primary winding for blocking significant amounts of battery current from the coil primary winding while passing induced current to the primary winding.

2. The ignition system of claim **1** in which the inductor means is in parallel with the coil primary winding.

3. The ignition system of claim **1** in which the inductor means comprises a transformer having its primary winding in series with the control means and the circuit means couples the transformer secondary winding to the coil primary winding.

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