July 5, 1966 W. Y. PETERS 3,259,118

ENGINE IGNITION SYSTEM

Filed March 18, 1963

FIG_1

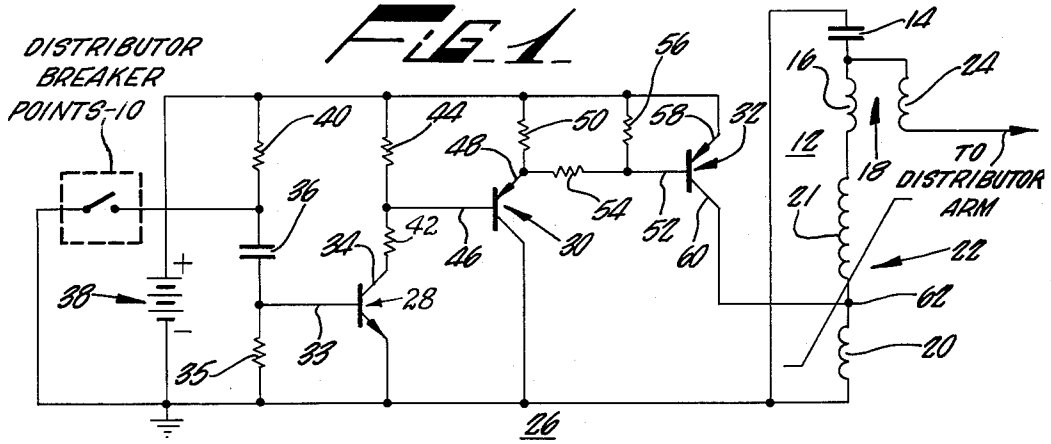
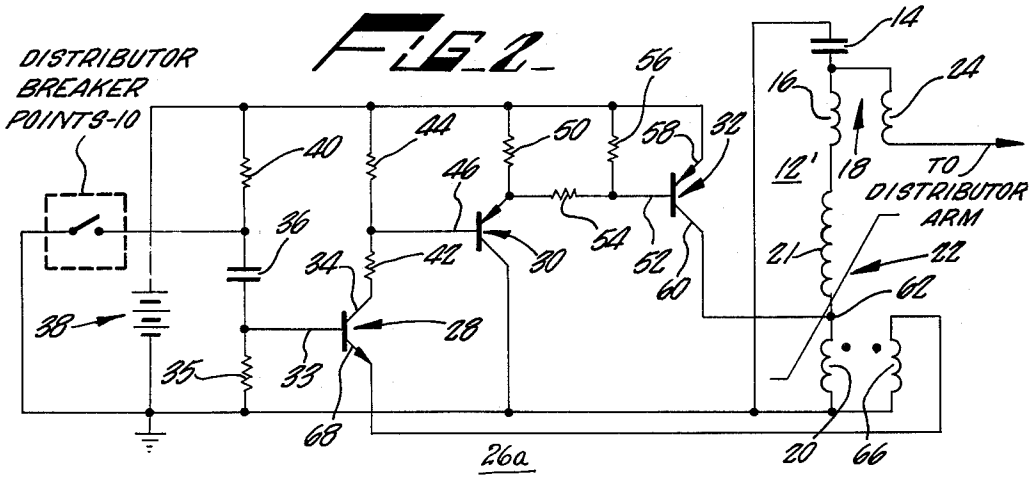


FIG_2



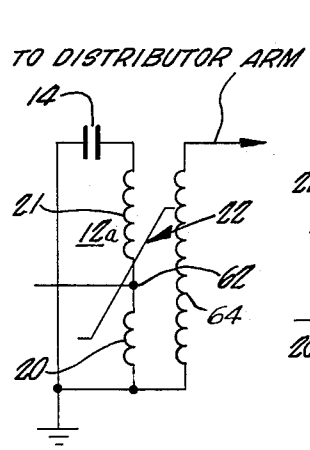


FIG_1A

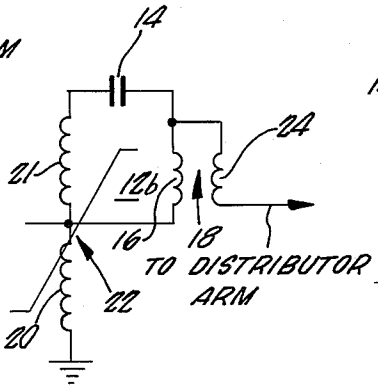


FIG_1B

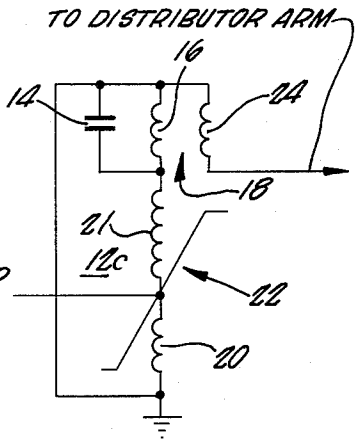


FIG_1C

United States Patent Office 3,259,118 Patented July 5, 1966

3,259,118

ENGINE IGNITION SYSTEM

William Y. Peters, Tucson, Ariz., assignor to Jasper N. Cunningham, Los Angeles, Calif.

Filed Mar. 18, 1963, Ser. No. 265,744
13 Claims. (Cl. 123—148)

The present invention relates to an improved ignition system for use with internal combustion engines.

An integral part of all internal combustion engine systems is the ignition system. The ignition system functions in synchronism with the operation of the engine to develop high voltage signals in a predetermined sequence at the cylinders of the engine. The high voltage signals, in turn, develop a spark at each cylinder of the engine for igniting the combustible mixture therein, thereby imparting a driving force to the engine. Thus, it is of prime importance to optimum engine operation that the ignition system continue to function efficiently over all engine speeds and over long periods of operation.

In conventional ignition systems, such as those commonly employed with present day auto engines, however, the spark producing voltage signals decrease in magnitude with increasing engine speed. Further, high currents are allowed to flow through the mechanical breaker points of the ignition system causing the points to pit, corrode, and wear out rapidly. The corrosion and wearing of the points directly affect the efficiency of the ignition system and hence the operation of the associated internal combustion engine.

In an attempt to overcome these problems, improved ignition systems have been developed which employ a transistor switching circuit. The transistor switching circuit effectively isolates the breaker points from the spark producing circuitry of the ignition system, reduces the required current flow through the breaker points, and insures the generation of high voltage spark producing signals independent of engine speed.

The improved ignition systems employing transistor switching circuits thereby provide a substantial degree of improvement over the conventional ignition systems. However, in practice, such improved ignition systems are troubled by high "kickback" voltages developed across the transistor switching circuit having the generation of the high voltage output signals by the ignition system. The kickback voltages generally exceed the rated back voltage of the transistors comprising the transistor switching circuit causing them to burn out.

Attempts to overcome the problems caused by kickback voltages in ignition systems employing transistor switches have heretofore included the design of special transistors capable of withstanding the kickback voltages and the use of a series of transistors connected such that a minimum kickback voltage is developed across any one transistor. Both of these approaches are quite expensive and in practice have proven somewhat unsatisfactory.

The present invention, on the other hand, possesses all of the advantages of the ignition systems employing transistor switching circuits without the accompanying problems of undesired kickback voltages.

More particularly, to accomplish this, the present invention, in a basic form, includes a slightly under-damped series resonant circuit comprising a capacitor and the primary and secondary windings of a saturable core transformer connected in a series loop. The capacitor is charged and discharged under the control of a normally open switching means to produce a series of high voltage signals in an output means coupled to the series loop circuit. The switching means is connected to a direct current source and is arranged to momentarily close in response to the operation of a timing device, such as a pair

of breaker points, to couple to the direct voltage source across the primary winding of the saturable core transformer.

Briefly, in operation, the voltage coupled to the saturable core transformer produces a current in the secondary winding which charges the capacitor substantially to the potential of the direct current source and sets the direction of magnetization of flux in a first direction within the saturable core of the saturable core transformer. When the capacitor is substantially charged to the potential of the source, increased current flow through the primary winding produces a reversal of the direction of magnetization of flux within the saturable core to a second direction and by transformer action produces an increase in the voltage across the secondary winding and the capacitor until the core of the transformer becomes saturated. When the core of the transformer becomes saturated, transformer action ceases and the capacitor rapidly discharges through the series loop inducing a high voltage output signal at the output means coupled thereto. Due to the saturation of the core in the second direction, current flow from the capacitor in discharging, is in a direction which merely aids the existing direction of magnetization of the saturable core. Thus, a low impedance discharge path is provided for the capacitor to allow the capacitor to rapidly discharge to produce a desired high voltage output signal. In addition, due to the direction of saturation of the core, little if any magnetic coupling occurs within the saturable core during the discharge of the capacitor. Thus, the capacitor discharges without producing an excessive kickback voltage across the switching means. Accordingly, the switching means, which may include a transistor in a non-conducting state, is not adversely effected during the discharge of the capacitor.

In a second form, the present invention includes means for sustaining oscillations within the series circuit to produce a controlled oscillatory voltage output in the output means in response to each operation of the timing device. To accomplish this, a feedback circuit is included for periodically closing the switching means to aid in each recharge of the capacitor.

The above, as well as other features of the present invention, may be more clearly understood by reference to the following detailed description when considered with the drawings, in which:

FIGURE 1 is a schematic representation of a basic form of the present invention;

FIGURES 1A–C are schematic representations of modified winding arrangements for use in the form of the present invention illustrated in FIGURE 1; and

FIGURE 2 is a schematic representation of a second form of the present invention.

The ignition system illustrated in FIGURE 1 is arranged to produce a high voltage output signal for selective distribution to any one of the cylinders in an associated internal combustion engine in response to the operation of a timing means synchronized to the operation of the engine. By way of example, the timing means represented in FIGURE 1 is a pair of breaker points **10**—the ignition system being arranged to produce a high voltage output signal in response to each opening of the breaker points. The breaker points **10** may be of any conventional design coupled to open and close in synchronism with the operation of the associated engine and are represented, by way of example only, by the open switch.

As represented, the ignition system of FIGURE 1 includes a slightly under-damped series resonant circuit **12** comprising a capacitor **14**, a primary inductive winding **16** of a spark coil transformer **18** and the primary and secondary windings **20** and **21** of a saturable core transformer **22** coupled in a series loop.

Briefly, a saturable core transformer is a transformer which includes a core of magnetic material having a substantially rectangular hysteresis characteristic. The core has a resonant flux that is substantially equal to the saturation flux. Current flow in a first direction in the primary or secondary winding of the transformer switches the core to a first state of saturation and sets the direction of magnetization of the core in a first direction, while current flow in an opposite direction switches the core to a second state of saturation and sets the direction of magnetization in an opposite or second direction. Once the core is set in one of its saturated states additional current flow in the same direction merely aids the existing direction of magnetization and little if any magnetic coupling occurs within the transformer.

In the winding arrangement illustrated in FIGURE 1, the number of turns in the primary winding **20** is substantially less than the number of turns in the secondary winding **21**. For example, a ratio of the order of 1:50 has been found suitable. Also, as illustrated, a junction of the primary winding **20** and the capacitor **14** is coupled to a source of reference potential represented as ground while a secondary winding **24** of the transformer **18** is coupled to a junction of the winding **16** and the capacitor **14** and to a distributor arm of a distributor (not shown) for selectively distributing the high voltage pulses developed in the secondary winding **24** to the spark plugs of the associated internal combustion engine. The high voltage signals are developed in the secondary winding **24** in response to the initial discharge of the capacitor **14** after each opening of the breaker points and are followed by a series of signals of substantially reduced and decreasing magnitude caused by the charging and discharging of the capacitor **14** while the breaker points are open.

The selective charging and discharging of the capacitor **14** is controlled by a switch unit **26** which, in turn, is controlled by the opening of the breaker points **10**. The switch unit **26**, as illustrated, includes, by way of example only, an NPN type transistor **28** and a pair of PNP type transistors **30** and **32**. The transistor **28** is arranged in a grounded emitter configuration and includes a base terminal **33** and a collector terminal **34**. The base terminal **33** is connected to a junction of a resistor **35** and a capacitor **36**, the resistor **35** being coupled to a grounded negative pole of a battery **38** and the capacitor **36** being coupled to the positive pole of the battery **38** through a resistor **40**. The collector terminal **34** of the transistor **28** is coupled through a pair of series connected resistors **42** and **44** to the positive pole of the battery **38**.

The transistor **30** is arranged in a grounded collector configuration and includes a base terminal **46** coupled to a junction of the resistors **42** and **44** and an emitter terminal **48** coupled through a resistor **50** to the positive pole of the battery **38**.

The transistor **32** includes a base terminal **52** coupled through a resistor **54** to the emitter terminal **48** of the transistor **30** and through a resistor **56** to the positive pole of the battery **38**. The transistor **32** also includes an emitter terminal **58** coupled to the positive pole of the battery and a collector terminal **60** coupled to a junction point **62** of the primary and secondary windings **20** and **21**, respectively, of the saturable core transformer **22**.

As illustrated, the distributor breaker points **10** are coupled in series between a junction of the capacitor **36** and the resistor **40** and ground.

The biasing means for the transistors **28, 30** and **32**, including the associated resistors and the battery **38**, is arranged such that the transistors are normally in a nonconductive state with the breaker points closed. In this state, the capacitor **36** is in a discharged condition.

When the points open, a current flows rapidly through the capacitor **36** to provide a base current for the transistor **28**. The transistor **28** immediately switches to a conductive state to draw base current from the transistor **30**. The transistor **30** thus switches to a conductive state to in turn draw base current from the transistor **32**. Thus, in response to an opening of the breaker points **10**, the transistors **28, 30** and **32** immediately switch to a conductive state to pass a current signal to the junction point **62** in the resonant circuit **12**.

Current flow in the base circuit of the transistor **28** charges the capacitor **36**. As the capacitor **36** charges, the base current flowing in the transistor **28** decreases to a magnitude until base current is insufficient to maintain the transistor **28** in a conductive state. The transistor **28** then returns to its normally nonconductive state and in turn causes the transistors **30** and **32** to switch to their nonconductive states.

While the transistor **32** is in a conductive state, current flows from the battery **38** through the emitter-collector circuit of the transistor **32** to the circuit **12**. Current passing through the secondary winding **21** charges the capacitor **14** substantially to the supply voltage of the battery **38** and magnetizes the core of the saturable core transformer **22** in a first direction. When the capacitor **14** is substantially charged to the potential of the source **38**, current flow through the primary winding **20** produces a reversal of the direction of magnetization within the saturable core to a second direction and by transformer action with the secondary winding **21** produces an increase in the voltage across the capacitor **14** until the core of the transformer becomes saturated. When the core of the transformer becomes saturated, the capacitor **14** rapidly discharges through the primary winding **16** of the transformer **18** to produce a high voltage output signal in the secondary winding **24**.

The values of elements comprising the circuit **12** are preferably selected to provide a slightly under-damped discharge path for the capacitor **14**. Thus, with the switch unit **26** effectively open, the capacitor **14** discharges substantially to ground potential while the breaker points **10** are open to produce a high voltage output voltage signal in the secondary winding **24**. Since the discharge path for the capacitor **14** is slightly underdamped the high voltage output signal is followed by a series of signals of substantially reduced and rapidly decreasing magnitude.

When the breaker points **10** close, the capacitor **36** rapidly discharges to ground and the switch unit **26** assumes its aforementioned initial condition ready for another cycle of operation with the opening of the breaker points.

It is to be noted that during the initial discharge of the capacitor **14** after the opening of the breaker points **10** substantially zero voltage is developed across the transistor **32**. This is due to the turns ratio of the transformer **22** as well as the selective setting of the direction of magnetization of the saturable core prior to the initial discharge of the capacitor **14**. In particular, the current flow through the primary winding **20** prior to discharge of the capacitor **14** switches the core of the transformer **22** to one of its saturated states and sets the direction of magnetization of the saturable core in a second direction. Current flow from the capacitor **14**, in discharging, is in a direction which merely aids the existing direction of magnetization of the saturable core. Therefore, there is little if any magnetic coupling within the saturable core transformer **22** and only a small voltage drop developed across the primary winding **20** appears across the transistor **32**. Consequently, any voltage signal developed across the switching unit during the initial discharge of the capacitor **14** is insufficient in magnitude to have any undesired effects upon the transistors **28, 30** or **32** when in a nonconductive state. Further, due to the damping of the discharge path the voltage signals following the initial discharge are of insufficient magnitude to damage the transistors of the switching unit **26**.

It is also to be noted that due to the selective saturation of the core prior to the initial discharge of the capacitor, the transformer **22** provides a low impedance path for the

rapid discharge of the capacitor. The rapid discharge of the capacitor, in turn, produces a rapid reversal of flux within the transformer **18** to generate an output pulse of increased magnitude.

A modified form of the winding arrangement illustrated in FIGURE 1 is represented in FIGURE 1A. The winding arrangement **12***a* of FIGURE 1A includes a ternary winding **64** over the windings **20** and **21** of the saturable core transformer **22**. The ternary winding **64** is coupled to the distributor arm (not shown) and to ground. In the winding arrangement of FIGURE 1A the opening of the points **10** induces a high voltage output signal in the winding **64**. Therefore, the winding arrangement, as represented, does not require the use of the step-up transformer **18** illustrated in FIGURE 1.

A second alternative form of the winding arrangement is illustrated in FIGURE 1B. As represented, the circuit **12***b* includes the secondary winding **21**, the capacitor **14**, and the primary winding **16** of the step-up transformer **18**. The primary winding **20** is removed from the series loop circuit as well as the discharge path for the capacitor **14** and functions independently thereof to provide the aforementioned selective setting of magnetization within the saturable core transformer.

A third alternative form of the winding arrangement for the basic ignition system of the present invention is illustrated in FIGURE 1C. As represented, the capacitor **14** is placed directly across the primary winding **16** of the transformer **18**. In this arrangement the capacitance of the capacitor **14** and the inductance of the primary winding **16** are arranged such that when the switching unit **26** closes in response to an opening of the breaker points **10** the current signal applied to the resonant circuit **12***c* rapidly charges the capacitor **14** while producing a minimal voltage signal in the winding **16**. The capacitor **14** in such an arrangement discharges through the primary winding **16** to provide an oscillatory output signal of a desired voltage.

In order to insure a more complete combustion of fuel mixture within each cylinder of an associated internal combustion engine it is often desired to produce oscillatory high voltage output signals in a predetermined sequence at each of the cylinders in the internal combustion engine. A preferred form of the present invention for providing such operation is illustrated in FIGURE 2. The basic arrangement of the circuit illustrated in FIGURE 2 is very similar to that illustrated in FIGURE 1. Therefore, like reference numerals will be used to indicate like elements and the description of FIGURE 2 will be limited to the structural and operational distinctions between the embodiments illustrated in FIGURES 1 and 2.

As represented, the oscillatory ignition system of FIGURE 2 includes a feedback arrangement for developing a voltage signal which, when applied to the switching unit **26***a*, periodically switches the switching unit between its nonconductive and conductive states while the breaker points **10** are open to produce a series of high voltage signals in the secondary winding **24** of the step-up transformer **18**.

A preferred form of such a feedback arrangement is illustrated as including a ternary winding **66** on the saturable core transformer **22**. The ternary winding **66** is coupled between ground and the emitter terminal **68** of the transistor **28**. As indicated by the dot notation associated with the primary winding **20** and the ternary winding **66**, voltages of like polarity are produced in the primary and the ternary windings. The magnitude of the voltage signal induced in the ternary winding **66** is sufficient, when of a proper polarity, to positively bias the emitter terminal **68** relative to the base terminal **33** of the transistor **28**, thereby causing the switching unit **26***a* to switch to a nonconductive state. Similarly, when the switching unit is in a nonconductive state the voltage signal induced in the ternary winding **66**, when of a proper polarity, is sufficient to bias the switching unit to a conductive state.

In operation, then, the switching unit **26***a* is normally biased to a nonconductive state. When the breaker points **10** are open, the switching unit switches to a conductive state to effectively couple the voltage signal developed by the battery **38** across the primary winding **20**. The voltage coupled to the winding **20** produces a current flow in the series loop circuit which functions as described in connection with FIGURE 1 to ultimately charge the capacitor **14** to a voltage above the voltage supplied by the battery **38** and to set the direction of magnetization in the saturable core in a second direction. The current flow in the primary winding **20** which causes the desired setting of the direction of magnetization within the saturable core also induces a voltage within the ternary winding **66**. The voltage induced in the winding **66** is of sufficient magnitude and proper polarity to cause the transistor **28** to return to a nonconductive state, thereby switching the unit **26** to a nonconductive state. When this occurs the capacitor **14** rapidly discharges to produce a high voltage output signal in the secondary winding **24** of the step-up transformer **18**.

Due to the relative direction of magnetization of the saturable core, the discharge current merely aids in the existing direction of magnetization in the saturable core transformer. Therefore, little if any magnetic coupling occurs within the saturable core transformer and a substantially zero voltage is developed across the effectively open switching unit **26***a*.

Since the discharge path for the capacitor **14** is underdamped, the capacitor **14** discharges and begins to charge in an opposite direction. When the charging is complete, the capacitor then begins to discharge and recharge in its initial direction of charge. As the capacitor begins to discharge, current flows in the secondary winding **21** to set the direction of magnetization within the saturable core in its first direction and induce voltage signals of like polarity in the primary and ternary windings. The voltage induced in the ternary winding **66** is of sufficient magnitude and proper polarity to cause the transistor **28** to switch to a conductive state, thereby causing the switching unit **26***a* to also switch to a conductive state. Thus, while the capacitor **14** is recharging, the switching unit **26***a* is conductive and is not adversely affected by voltage signals induced in the saturable core transformer **22** in switching to its second direction of magnetization.

With the switching unit **26***a* in a conductive state current flows from the battery **38** to aid in the recharge of the capacitor **14**. When the capacitor has charged substantially to the voltage applied by the battery **38**, current flow through the primary winding **20** produces a resetting of the direction of magnetization of the saturable core transformer **22** to its second direction and an increase in the voltage across the capacitor **14** by a transformer action. The flow of current through the primary winding **20** also induces a voltage in the ternary winding **66** which causes the transistor **28** to switch to a nonconductive state, thereby causing the switching unit **26***a* to become nonconductive. The ignition system is then ready to begin again its discharging operation which is repeated at a relatively high frequency to produce a series of high voltage signals in the secondary winding **24** while the breaker points **10** are open. When the breaker points **10** close, the oscillatory output is retarded. The entire operation then repeats itself when the breaker points again open.

What is claimed is:

1. A switch controlled capacitor discharge circuit, comprising:

a series resonant circuit including a capacitor and the primary and secondary windings of a saturable core transformer;

output means coupled to the series circuit for developing a voltage signal in response to a changing current flow in the series circuit;

a direct signal source;
and switching means for momentarily coupling the direct signal source across the primary winding of the saturable core transformer.

2. A switch controlled capacitor discharge circuit, comprising:
a saturable core transformer having a primary and a secondary winding connected in series;
a series loop circuit including a capacitor and the secondary winding of the saturable core transformer;
output means coupled to the series loop circuit for developing a voltage signal in response to changing current flow in the series loop circuit;
a direct signal source;
switching means for coupling the direct signal source across the primary winding of the saturable core transformer;
and feedback means responsive to opposite directions of current flow in the primary winding of the saturable core transformer for effectively opening and closing the switching means such that an oscillatory output signal is developed by the output means.

3. The apparatus defined in claim 2 wherein the number of turns in the primary winding is substantially less than the number of turns in the secondary winding.

4. A switch controlled capacitor discharge circuit, comprising:
a series loop circuit including a capacitor and the primary and secondary windings of a saturable core transformer;
output means coupled to the series loop circuit for developing a voltage signal in response to changing current flow in the series loop circuit;
a direct signal source;
switching means for coupling the direct signal source across the primary winding of the saturable core transformer;
and feedback means responsive to opposite directions of current flow in the primary winding of the saturable core transformer for effectively opening and closing the switching means such that an oscillatory output signal is developed by the output means.

5. A switch controlled capacitor discharge circuit, comprising:
a series loop circuit including a capacitor and a primary and a secondary winding of a saturable core transformer;
output means coupled to the series loop circuit for developing a voltage signal in response to changing current flow in the series loop circuit;
a direct voltage source;
a signal controlled switch means for coupling the direct voltage source across the primary winding of the saturable core transformer;
means for biasing the switch means to a normally open state; means for switching said switch means to a closed state in response to an input signal applied thereto;
and feedback means responsive to a predetermined direction of current flow in the primary winding of the saturable core transformer for biasing the switch means to its normally open state such that an oscillatory output voltage signal is developed by the output means.

6. In an engine ignition system having a timing switch means arranged to operate in synchronism with the operation of an associated engine, the combination of:
a saturated core transformerd having primary and secondary windings connected in series;
a series resonant circuit comprising a capacitor and the secondary winding of the saturable core transformer;
output means coupled to the series circuit for developing a voltage signal in response to changing current flow in the series circuit;
a direct signal source;

and normally open input switching means coupled to the direct signal source and the series circuit for momentarily closing in response to the operation of the timing switch means to couple the direct signal source across the primary winding of the saturable core transformer.

7. In an engine ignition system having a timing switch means arranged to operate in synchronism with the operation of an associated engine, the combination of:
a series loop circuit comprising a capacitor and the primary and secondary windings of a saturable core transformer;
output means coupled to the series loop circuit for developing a voltage signal in response to current flow in the series loop circuit;
a direct signal source;
and normally open input switching means coupled to the direct signal source and the series loop for momentarily closing in response to the operation of the timing switch means to couple the direct signal source across the primary winding of the saturable core transformer.

8. In an engine ignition system having a timing switch means arranged to operate in synchronism with the operation of an associated engine, the combination of:
a saturable core transformer having a primary and a secondary winding connected in series;
a series loop circuit comprising capacitor and the secondary winding of the saturable core transformer;
output means coupled to the series loop circuit for developing a voltage signal in response to current flow in the series loop circuit;
a direct signal source;
normally open input switching means for closing in response to the operation of the timing switch means to couple a direct signal source across the primary winding of the saturable core transformer;
and feedback means responsive to opposite directions of current flow in the primary winding of the saturable core transformer for effectively opening and closing the input switching means such that an oscillatory output signal is developed by the output means.

9. In an engine ignition system having a timing switch means arranged to operate in synchronism with the operation of an associated engine, the combination of:
a series loop circuit comprising a capacitor and the primary and secondary windings of a saturable core transformer;
output means coupled to the series loop circuit for developing a voltage signal in response to current flow in the series loop circuit;
a direct signal source;
normally open input switching means for closing in response to the operation of the timing switch means to couple a direct signal source across the primary winding of the saturable core transformer;
and feedback means responsive to opposite directions of current flow in the primary winding of the saturable core transformer for effectively opening and closing the input switching means such that an oscillatory output signal is developed by the output means.

10. In an ignition system having a timing switch means arranged to operate in synchronism with the operation of an associated engine, the combination of:
a capacitor;
a saturable core transformer having a primary and a secondary winding coupled in series with the capacitor to form a series loop circuit;
a direct voltage source;
a signal control switch means for closing to couple the direct voltage source across the primary winding;
means for biasing the switch means to a normally

open state to switch to a closed state in response to the operation of the timing switch means;

output means coupled to the series loop circuit for developing a voltage signal in response to changing current flow in the series loop circuit;

and feedback means responsive to a predetermined direction of current flow in the primary winding for biasing the signal control switch means to an open state.

11. In an engine ignition system having a timing switch means arranged to operate in synchronism with the operation of an associated engine, the combination of:

a capacitor;

a saturable core transformer having a primary and a secondary winding coupled in series loop circuit with the capacitor;

a direct voltage source;

normally open input switching means for momentarily closing in response to the operation of the timing switch means to couple the direct voltage source across the primary winding of the saturable core transformer;

and output means including a ternary winding on the saturable core for developing a voltage signal in response to changing current flow in the series loop circuit.

12. In an ignition system having a timing switch means arranged to operate in synchronism with the operation of an associated engine, the combination of:

a saturable core transformer having a primary and a secondary winding coupled in series;

a series circuit including a capacitor, the secondary winding of the saturable core transformer, and the primary winding of a spark coil transformer;

a direct current source;

and input switching means coupled to a junction of

the primary and secondary windings for momentarily coupling the direct current source across the primary winding of the saturable core transformer in response to the operation of the timing switch means.

13. In an ignition system having a timing switch means arranged to operate in synchronism with the operation of an associated engine, the combination of:

a saturable core transformer having a primary and a secondary winding coupled in series;

a spark coil transformer having a primary winding coupled to form a series loop with the primary and secondary windings of the saturable core transformer and having a secondary winding for producing an output signal;

a capacitor connected across the primary winding of the spark coil transformer;

a direct current source;

and input switch means coupled to a junction of the primary and secondary windings of the saturable core transformer for momentarily coupling the direct current source across the primary winding of the saturable core transformer in response to the operation of the timing switch means.

References Cited by the Examiner

UNITED STATES PATENTS

2,651,005	9/1953	Tognola	315—209
2,886,719	5/1959	Bohn	315—209 X
2,894,161	7/1959	Sheheen	315—209
2,896,123	7/1959	McNulty	315—209 X
2,898,392	8/1959	Jaeschke	315—209
3,087,090	4/1963	Konopa	315—209

LLOYD McCOLLUM, *Primary Examiner.*

J. M. THOMSON, W. E. RAY, *Assistant Examiners.*