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FLYWHEEL GENERATOR FOR CHARGING THE CAPACITOR OF A CAPACITOR DISCHARGE IGNITION SYSTEM

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FIG. 1

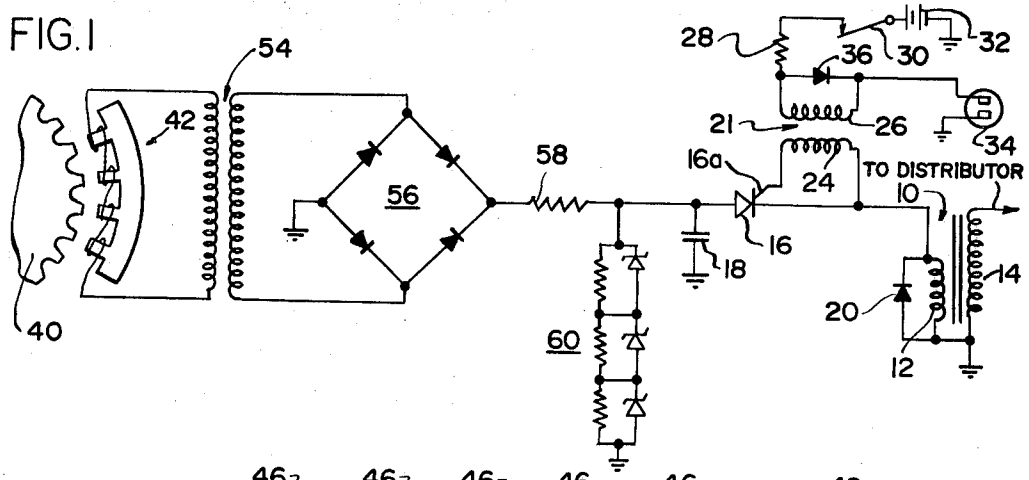


FIG. 2

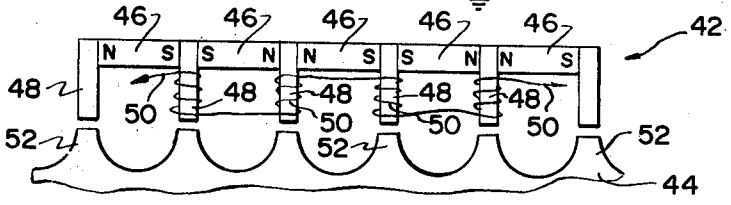
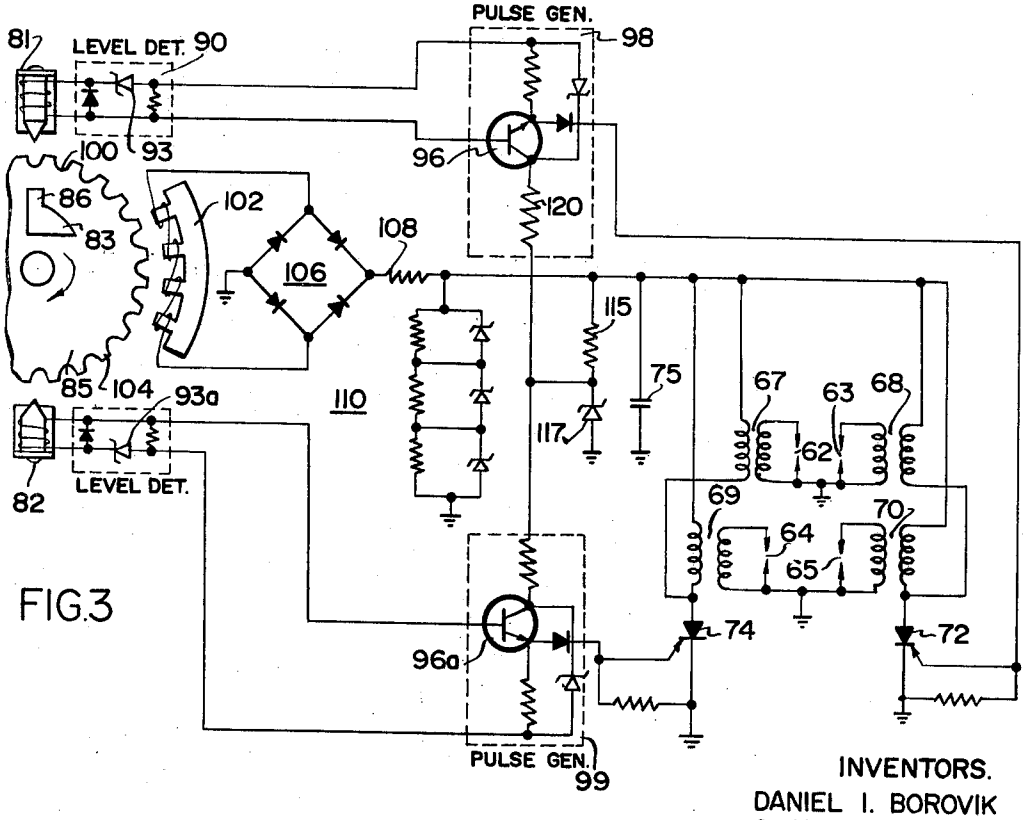


FIG. 3



INVENTORS.
DANIEL I. BOROVIK
CHARLES L. SHANO
BY Mueller, Aichele & Rauner
ATTORNEYS.

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FLYWHEEL GENERATOR FOR CHARGING THE CAPACITOR OF A CAPACITOR DISCHARGE IGNITION SYSTEM

Charles L. Shano, Phoenix, Ariz., and Daniel I. Borovik, Livonia, Mich., assignors to Motorola, Inc., Franklin Park, Ill., a corporation of Illinois

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ABSTRACT OF THE DISCLOSURE

The flywheel of an internal combustion engine has a ring gear about the periphery of it which induces a voltage in a variable reluctance pickup. A rectifying circuit connects the induced voltage to the ignition capacitor for charging the same after it has been discharged in synchronism with the engine through the ignition coil either by the operation if conventional ignition points or through an electronic trigger.

Background of the invention

This invention pertains to a capacitor discharge ignition system for an internal combustion engine and more particularly to a unique device for charging the ignition capacitor after it has been discharged.

In the past ignition systems where the ignition capacitor has been electronically discharged have been complicated by the fact that circuitry must be provided for charging the ignition capacitor from battery potential. Furthermore, it is desirable that the energy stored in the discharge capacitor of the ignition system be independent of battery voltage. This is especially true in internal combustion engines which must operate continuously in remote areas such as along natural gas or fuel oil pipelines. These engines in many instances are remotely controlled from a location some distance from the engine. They are started, for example, by a potential source coupled to the engines directly from the central station. Their reliability, however, is reduced because of the dependence of the ignition system on local batteries.

Summary of the invention

It is an object of this invention to provide a capacitor discharge ignition system for an internal combustion engine in which the ignition capacitor is independent of any battery for maintaining a charge thereon.

It is another object of this invention to provide a capacitor discharge ignition system for an internal combustion engine which is relatively simple and inexpensive to manufacture.

In one embodiment of this invention a capacitor discharge ignition system for an internal combustion engine is characterized by a flywheel which has a ring gear about the periphery thereof and which is driven past a plurality of variable reluctance pickups to induce a voltage in the pickups for charging the ignition capacitor. The variable reluctance pickups are connected in series to insure that there is sufficient induced voltage at low engine r.p.m. to charge the capacitor. A Zener diode circuit is connected across the ignition capacitor to limit the induced voltage from the pickups at high engine r.p.m. to prevent excessive charging thereof. The flywheel generator can be used in an ignition system in which the ignition capacitor is discharged by the operation of ignition points in the conventional manner, to provide a pulse for gating on an electronic switch, which discharges the capacitor through the ignition coil. The flywheel generator can also be used in an ignition system where both advance and distribution

is provided electronically. In one typical circuit, the flywheel in addition to having the ring gear around the periphery of it also carries a flux varying element. The flux varying element induces a voltage in a magnetic pickup, which rises to a given level at a rotational position of the flywheel that varies in accordance with the speed of rotation of the same. A level detector is responsive to the voltage produced by the coil at the given level to energize a pulse generator which operates a semiconductor trigger to discharge the ignition capacitor through the ignition coil.

Description of the drawings

FIG. 1 is a schematic wiring diagram illustrating an ignition circuit in accordance with this invention;

FIG. 2 is an expanded side elevation view of a portion of a flywheel generator in accordance with this invention; and

FIG. 3 is a schematic wiring diagram of a second embodiment of an ignition circuit utilizing the principles of this invention.

Detailed description

Referring to the drawing, FIG. 1 illustrates an ignition system for an internal combustion engine, which includes an ignition coil **10** having a primary winding **12** and a secondary winding **14**. The secondary winding **14** may be coupled to the center post of a distributor as is well-known in the art. A silicon controlled rectifier **16** is connected in series with an ignition capacitor **18**, which is across the primary winding **12** of the ignition coil **10**. A diode **20** is connected across primary winding **12** and serves to reduce the amplitude of current reversals in the ignition coil secondary winding **14**. This reduces the amount of electromagnetic radiation produced by the ignition coil and results in a corresponding reduction in radio interference and noise.

Silicon controlled rectifier **16** is triggered in synchronism with the internal combustion engine by pulses applied to the gate **16***a* thereof. These pulse are coupled to the gate **16***a* by means of a transformer **21** having a secondary winding **24** coupled between the gate **16***a* and the cathode of rectifier **16**. Transformer **21** has a primary winding **26** which is connected through resistor **28** and ignition switch **30** to the battery **32**. The opposite end of the primary winding **26** is connected to ground by intermittently operable breaker points **34**. Breaker points **34** may be the well-known mechanical type breaker points synchronized with engine operation. A diode **36** connected across primary winding **26** of transformer **21** damps out reverse current transients.

When capacitor **18** is charged to the desired firing potential and silicon controlled rectifier **16** is fired by a pulse supplied to the gate **16***a*, capacitor **18** discharges through primary winding **12** of ignition coil **10**. This produces a high voltage pulse in secondary winding **14**, which is applied to the distributor for igniting the fuel in the cylinders of the internal combustion engine. Transients which could possibly fire the silicon controlled rectifier **16** at the wrong time are damped out by the diode **36**.

In accordance with the principles of this invention, a unique generator is used to charge the capacitor **18** subsequent to it being discharged by the silicon controlled rectifier **16** through the ignition coil **10**. The generator includes the engine flywheel **40**, which is coupled to and driven by the internal combustion engine. Position in a spaced relation to the flywheel **40** is a variable reluctance pickup **42**. About the circumference or periphery of the flywheel **40** is a ring gear **44** having a plurality of teeth. As shown in FIG. 2, the variable reluctance pickup includes a plurality of magnets **46** interposed between core laminations **48**. Windings **50** are wound around the core laminations **48** so the induced voltage is additive and in

a manner to connect the individual magnetic pickups in series. The individual laminations **48** are spaced so that the change of reluctance in each winding caused by flywheel rotation is in phase so that the output of the generator is the arithmetic sum of the voltage induced in each winding. As the flywheel **40** rotates, the teeth **52** of the ring gear **44** causes the reluctance of the flux path through the core laminations **48** to vary in a manner that produces a sinusoidal voltage in the windings **50**. The output from the pickup **42** is coupled by transformer **54** to a full wave rectifier **56**. The output of the rectifier **56** is coupled by resistor **58** to the ignition capacitor **18**. In some operations, the transformer **54** can be eliminated, and the generator may be such that a half wave rectifier can be used without deviating from the scope of this invention.

It is necessary that the storage capacitor by fully charged from the firing of one cylinder of the engine to the firing of the next cylinder. This means the flywheel generator must develop enough energy to charge capacitor **18** in a portion of a revolution of the flywheel. This can vary, for instance, from one charge per revolution for a one cylinder engine, to two for a two or four cylinder engine, to four per revolution for an eight cylinder engine. Because the output voltage is dependent on the velocity of the teeth past the pickup, it is necessary, in order to get sufficient charging potentials at a low flywheel r.p.m., to connect the pickups in series as shown in FIG. 2. At high engine speed, however, it is necessary to limit the voltage output of the generator to avoid damaging the ignition capacitor **18** with overvoltage. To accomplish this, a voltage limiting network **60** comprising three Zener diodes connected in series is connected across the ignition capacitor **18**. In a typical operating installation the charge on capacitor **18** is in the area of 400 volts. It is, therefor, desirable to have the voltage limiting network calibrated to maintain the charge on the capacitor **18** substantially in this area.

In operation, initial cranking of the engine during starting causes the flywheel **40** to induce a voltage in variable reluctance pickup **42** to charge the ignition capacitor **18**. During cranking the points **34** are closed grounding the primary **26** of transformer **21**. Subsequent opening of the points generates a pulse in secondary winding **24** of the transformer to trigger silicon controlled rectifier **16**. Triggering of the silicon controlled rectifier **16** discharges the ignition capacitor **18** through the ignition coil **10** to produce a firing pulse for the engine. It can be seen therefore that compared to other more complicated networks for charging the ignition capacitor **18**, the charging circuit of this invention is extremely simple and therefore relatively inexpensive to manufacture.

FIG. 3 illustrates another type of a capacitor discharge ignition system using the flywheel generator of this invention for charging the ignition capacitor. The circuit shown is for use with a four cylinder engine with a four stroke cycle. Thus two cylinders will go through their power stroke for each revolution of the engine flywheel. It is to be understood, however, that this ignition system can be adapted to engines of other numbers of cylinders within the scope of the invention. Each of the cylinders of the engine is provided with a spark gap or spark plug **62–65** and separate ignition coils **67–70**. The secondary windings of each of the coils are connected across their respective spark gaps.

A silicon controlled rectifier **72** connects the parallel connected primary windings of the ignition coils **68** and **70** in series across the ignition capacitor **75**. Similarly, a silicon controlled rectifier **74** connects the parallel connected primary windings of ignition coils **67** and **69** in series across the ignition capacitor **75**. Of the two cylinders associated with the ignition coils **67** and **69**, one is ready to be fired and the other is on its exhaust stroke. Thus, only the cylinder to be fired is affected by the pulse through the ignition coils **67** and **69**. This is also true of the ignition coils **68** and **70**. Accordingly, two cylinders at a time are fired, one of which is on exhaust stroke and consequently is not affected.

In this system, two magnetic pickup units **81** and **82** are used in association with a single flux varying element **83** on the engine flywheel **85**. As the flywheel **85** rotates, the flux varying element **83** will cause a change in flux in the windings **81** and **82** to generate a potential therein. The flywheel **85** rotates in a direction of the arrow in FIG. 3 so the pointed end of the flux varying element **83** passes by the pole pieces of the magnetic pickups **81** and **82** first. The space between the flux varying element **83** and the magnetic pickups **81** and **82** will decrease at a gradual rate until the stepped portion **86** of the flux varying element passes by the pole piece at which time the gap closes rapidly. At slow speeds, i.e., low flywheel r.p.m., sufficient potential to cause the level detectors **90** and **91** respectively to conduct will not be generated in the magnetic pickups **81** and **82** until the stepped portion **86** passes by them. That point at which the level detectors conduct is when the generated potential in the magnetic pickups **81** and **82** exceed the breakdown voltage of Zener diodes **93** and **93***a*. At higher speeds, and faster rotation of the flywheel **85**, a potential great enough to cause the level detectors to conduct can be generated in the magnetic pickups **81** and **82** prior to the reaching of the stepped portion **86**. The effect therefore of the shape portion is to provide electronic spark advance for the engine. An ignition system of this type is described in greater detail in Patent No. 3,356,896, issued Dec. 5, 1967 and assigned to the assignee of this application.

Conduction of the level detectors **90** and **91** applies a pulse to the base of NPN transistors **96** and **96***a* of the pulse generators **98** and **99**. Conduction of the pulse generators **98** and **99** alternately trigger silicon controlled rectifiers **72** and **74** to discharge the ignition capacitor **75**.

The flywheel **85** besides carrying the flux varying element **83**, which provides the firing pulses for the ignition cylinders and also electronic advance, further carries a ring gear **100** around the periphery thereof similar to the ring gear **44** of the embodiment described in conjunction with FIG. 1. Also a variable reluctance pickup **102** similar to the variable reluctance pickup **42** described in conjunction with FIG. 1 is positioned in a spaced relation to the teeth **104** of the ring gear **100**. These two elements combine to form a flywheel generator for providing a substantially sinusoidal potential, which is rectified in rectifier **106** and coupled by resistors **108** to charge the ignition capacitor **75** subsequent to discharge thereof. Also, as was shown in the ignition circuit of FIG. 1, a voltage limiting circuit **110** comprising series connected Zener diodes is coupled across the ignition capacitor **75** to limit the charge on that capacitor at high engine speeds.

The flywheel generator of this embodiment also provides another important feature. Connected across the output of the rectifier **106** are current limiting resistor **115** and Zener diode **117**. Resistor **115** and Zener diode **117** form a step down voltage network for reducing the direct current output voltage of the flywheel generator from the rectifier **106** to between 10 and 14 volts. The output of this step down network is used to provide a DC potential through the resistors **120** and **121** for the direct current circuit of pulse generators **96** and **96***a*. The flywheel generator described in conjunction with this embodiment therefore not only greatly simplifies the circuit for charging the igintion capacitor **75**, but, by providing the direct current for the pulse generators, makes the ignition system completely independent of the engine battery.

What has been described, therefore, is a relatively simple and inexpensive capacitor discharge ignition system for an internal combustion engine in which the ignition capacitor is independent of the engine battery for maintaining a charge thereon.

What is claimed is:

1. In a capacitor discharge ignition system for an internal combustion engine, including trigger circuit means for discharging the capacitor in synchronism with the engine to produce firing pulses, the combination including, a flywheel driven by the engine, a ring gear having a plurality of teeth, said ring gear being positioned about the periphery of the flywheel, pickup means positioned in a spaced relation with respect to said flywheel, said pickup means including a plurality of core laminations, a plurality of magnets interposed between said core laminations, and a plurality of windings each positioned about a core lamination, said flywheel being driven past said pickup means with said teeth of said ring gear causing the flux path through said core laminations to vary in a manner to produce a voltage in said windings, said windings being series connected and positioned about said laminations so that the voltages induced in each winding are additive, and circuit means connecting said induced voltage from said pickup means to the ignition capactor for charging the same subsequent to the discharge thereof.

2. The capacitor discharge ignition system of claim 1 wherein said circuit means includes rectifier means and voltage limiting means coupled between said rectifier means and the discharge capacitor, said voltage limiting means acting to limit the induced voltage from said pickup means at high engine r.p.m. to prevent excessive charging of the ignition capacitor.

3. The capacitor discharge ignition system of claim 1 in which the trigger means for discharging the capacitor in synchronism with the engine includes a silicon controlled rectifier having input, output and gate electrodes, and a pulse generating circuit connected to the gate electrode which is responsive to the opening of engine ignition points to energize said silicon controlled rectifier, and wherein the ignition capacitor is connected to the input of said silicon controlled rectifier, and an ignition coil is connected to the output of said silicon controlled rectifier so that said flywheel generates an induced voltage in said pickup means to charge said capacitor with the same being discharged through the ignition coil by said ignition points operating to trigger said silicon controlled rectifier.

4. The capactor discharge ignition system of claim 1 wherein said trigger circuit means includes magnetc pickup means including an inductance coil, level detector means, pulse generating means and semiconductor trigger means connected in that order to the ignition coil, and wherein said flywheel has a shaped flux varying portion thereon, said flux varying portion producing a voltage in said inductance coil which rises to a given level at a rotational position of said flywheel which varies in accordance with the speed of rotation thereof, said level detector means being responsive to the voltage produced by said inductance coil reaching the given level to energize said pulse generator means to operate said semiconductor means to discharge the ignition capacitor through the ignition coil, and said ring gear inducing a voltage in said pickup means to charge the ignition capacitor subsequent to the discharge thereof.

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LAURENCE M. GOODRIDGE, Primary Examiner

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310—70; 315—209