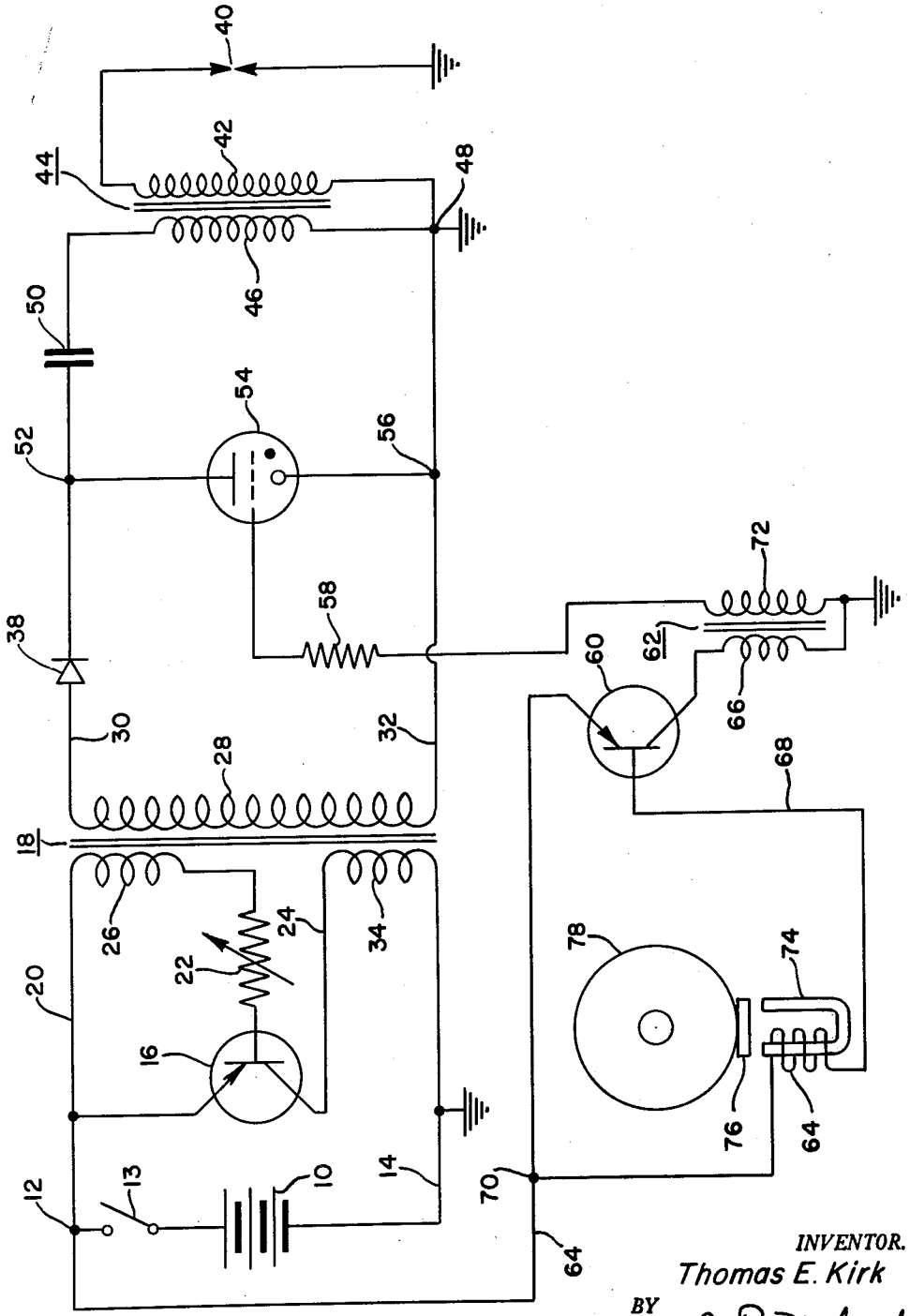
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IGNITION SYSTEM

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INVENTOR.
Thomas E. Kirk
BY
C. R. Meland
His Attorney

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IGNITION SYSTEM

Thomas E. Kirk, Anderson, Ind., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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This invention relates to ignition systems for internal combustion engines.

One of the objects of this invention is to provide an ignition system wherein the discharging of a condenser supplies the ignition power and wherein a circuit is provided for controlling this discharge that is controlled in synchronism with operation of the engine and without the use of breaker contacts.

Another object of this invention is to provide an ignition system of the condenser discharge type wherein the condenser discharges through an electronic switch means and wherein the conduction of the electronic switch means is controlled by a semi-conductor.

Still another object of this invention is to provide an ignition system of the condenser discharge type wherein the condenser discharges through an electronic switch such as a thyratron tube and wherein the conduction of this tube is controlled by a semi-conductor connected with a pick-up coil that has pulses of voltage induced therein that occur in synchronism with operation of the engine.

A further object of this invention is to provide an ignition system for firing the combustible mixture of an internal combustion engine that includes a condenser that discharges through an electronic switch such as a thyratron tube, the conduction of the tube being controlled by a pulse transformer which is energized directly from a battery through semi-conductor means.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

The single FIGURE drawing is a schematic circuit diagram of an ignition system made in accordance with this invention.

Referring now to the drawing, the reference numeral **10** has been used to designate a storage battery or other type of direct current power supply which is used to power the ignition system of this invention. The storage battery **10** is connected with the junction **12** through ignition switch **13** and with the lead wire **14**. The voltage available at the storage battery is stepped up by a transistor oscillator circuit which includes the transistor **16** and the transformer generally designated by reference numeral **18**. It can be seen that the emitter electrode of transistor **16** is connected with the lead wire **20** whereas the base electrode of transistor **16** is connected with a variable resistor **22**. The collector electrode of transistor **16** is connected with the lead wire **24**.

The transformer **18** has a control winding **26** which is connected between lead wire **20** and one side of the variable resistor **22**. This transformer has a secondary winding **28** connected with lead wires **30** and **32** and has a tertiary or primary winding **34** which is connected between lead wires **14** and **24**.

The lead wire **30** is connected with a diode **38** which may be of the PN junction semi-conductor type. The lead wire **32** is connected directly to ground as is apparent from the drawing.

The reference numeral **40** has been used to designate a spark discharge device such as a spark plug for igniting the combustible mixture of an internal combustion engine which is powered by the ignition system of this invention. It can be seen that one side of the spark plug or spark discharge device **40** is connected directly to ground whereas the opposite side of the spark gap **40** is connected to the secondary winding **42** of an ignition transformer **44**. The secondary winding **42** is connected to one side of the primary winding **46** of this ignition transformer as at **48**.

The ignition system of this invention includes a capacitor **50** which is connected between the primary winding **46** of the ignition transformer **44** and the junction **52**. A gas filled thyratron tube designated by reference numeral **54** is connected between the junction **52** and the junction **56**. It is seen that the plate of the thyratron **54** is connected with the junction **52** whereas the cathode of the thyratron **54** is connected with junction **56**. The grid of the thyratron tube **54** is connected to one side of a resistor **58**.

The conduction of the thyratron tube **54** is controlled by a timing circuit which includes the transistor **60**, the pulse transformer **62** and the pick up coil **64**. It is seen that the transistor **60** has an emitter electrode which is connected with junction **12** via the lead wire **65**. The collector electrode of transistor **60** is connected to one side of the primary winding **66** of the pulse transformer or control transformer **62**. The base electrode of transistor **60** is connected to one side of pick-up coil **64** via the lead wire **68**. The opposite side of the pick-up coil **64** is connected with the junction **70** on lead wire **65** and is therefore seen that the pick-up coil **64** is connected across the emitter and base electrodes of transistor **60**. The secondary winding **72** of transformer **62** is tied to one side of the primary winding **66** and to ground as is apparent from the drawing. The opposite side of the secondary winding **72** is connected to one side of the resistor **58**.

The pick-up coil **64** is wound on a U-shaped member **74** formed of magnetic material. This U-shaped member **74** is positioned closely adjacent a magnet **76** which is carried by a fly wheel **78** driven by an engine which is powered by the ignition system of this invention. As the fly wheel **78** rotates, the magnet **76** passes closely adjacent the U-shaped member **74** so that a pulse of voltage is induced in the coil **64** upon each revolution of the fly wheel **78**.

This magnetic pick-up device is well known to those skilled in the art and may take various forms, it only being necessary that a coil be connected between the emitter and base electrodes of transistor **60** which has pulses of voltage induced therein in synchronism with rotation of the fly wheel **78**.

In operation of the system illustrated in the drawing when the ignition switch **13** is closed, the battery **10** will energize the power supply circuit and the timing circuits of the system. With switch **13** closed, the transistor oscillator circuit will begin to operate to cause the transistor **16** to switch on and off. The switching on and off of the transistor **16** will cause a pulsating current to be developed which is stepped up by the transformer **18** so that a greater voltage will appear between the lead wires **30** and **32**. This voltage will be rectified by the diode **38** and will therefore cause the condenser **50** to be charged to a predetermined potential. This charging circuit is from lead wire **30**, through diode **38**, through condenser **50**, through the primary winding **46** of the transformer **44** and then back to the opposite side of the secondary winding **28** via lead wire **32**.

When it is dsired to cause a spark to jump the gap **40**, the condenser **50** must be discharged through the tube **54** and the primary winding **46** of transformer **44**. The control of the firing of the tube **54** is by the part of the system that includes pulse transformer **62**, transistor **60**

and the magnet **76** and pick-up coil **64**. When the magnet **76** passes by the ends of the U-shaped magnetic member **74**, a pulse of voltage is induced in the coil **64**. This pulse of voltage is of such a polarity and magnitude as to cause the emitter electrode of transistor **60** to become positive with respect to the base electrode of this transistor. As a result, the battery **10** will force current through the transistor **60** between the emitter and collector electrodes to cause current to flow through the primary winding **66** of the transformer **62**. This will cause a pulse of voltage to be induced in the secondary winding **72** which is applied to the tube **54** to cause it to begin conducting. With tube **54** conducting the condenser **50** now may discharge through a circuit that includes the tube **54** and the primary winding **46** of the ignition transformer **44**. This induces a voltage in the secondary winding **42** which causes the spark gap **40** to fire.

It can be seen from the foregoing that the spark gap **40** will fire whenever a voltage pulse is induced in the pick-up coil winding **64** and that these pulses will occur once for every revolution of the fly wheel **78**. It is also apparent from the foregoing that these pulses are a result of the discharging of the condenser **50** which discharges through the tube **54**. It is pointed out that the transistor **60** will only conduct when a pulse of voltage is induced in a coil winding **64**. At all other times, the emitter and base electrodes of the transistor have substantially the same potential so that this transistor will be shut off except when a pulse of voltage is induced in the pick-up coil **64**.

While the embodiments of the present invention as herein disclosed, constitute a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. An electrical ignition system for igniting the combustible mixture of an engine comprising, a spark discharge device, a source of direct current power, a capacitor, a charging circuit for said capacitor, a dischraging circuit for said capacitor causing a spark at said spark discharge device and including electronic switch means, means for controlling the conduction of said electronic switch including a semi-conductor switch means, and a means having no breaker contacts for controlling the conduction of said semi-conductor switch means in synchronism with operation of said engine.

2. An ignition system for igniting the combustible mixture of an engine comprising, a spark discharge device, a source of direct current power, a condenser, a charging circuit connecting said source of direct current power with said condenser, a discharging circuit for said condenser which is operative when energized to cause a spark at said spark discharge device and including an electronic switch means, a semi-conductor switch means, breakerless means for controlling the conduction of said semi-conductor switch means in synchronism with operation of said engine, and means connecting said semi-conductor switch means and said electronic switch means whereby the conduction of said electronic switch means is controlled by said semi-conductor switch means.

3. An electric ignition system for igniting the combustible mixture of an engine comprising, a spark discharge device, a battery, power transforming means connected with said battery, a condenser, a charging circuit connected between said condenser and said power transforming means for charging said condenser, a discharging circuit for said condenser operative when energized to cause a spark at said spark discharge device and including an electronic switch means, semiconductor switch means connected with said battery, breakerless means operating in synchronism with said engine for controlling the conduction of said semi-conductor switch means, and means connecting said electronic switch means and semiconductor switch means whereby said semi-conductor switch means controls the conductivity of said electronic switch means.

4. An electrical ignition system for igniting the combustible mixture of an engine comprising, a spark discharge device, a source of direct current power, a condenser, a charging circuit connecting said condenser and said source of direct current power, a discharging circuit operative to energize said spark discharge device and including an electronic switch means, said electronic switch means having a control electrode, a transistor having emitter, base and collector electrodes, means coupling the emitter to collector circuit of said transistor with the control electrode of said electronic switch means, a pick-up coil adapted to have pulses of voltage induced therein in synchronism with operation of said engine, and means connecting said pick-up coil across the emitter and base electrodes of said transistor whereby the conduction of said transistor in its emitter-collector circuit is varied as a function of the pulses of voltage developed in said pick-up coil.

5. An electrical ignition system for igniting the combustible mixture of an engine comprising, a source of direct current power, a spark discharge device, a condenser, an ignition transformer having a primary winding and a secondary winding connected with said spark discharge device, a charging circuit for said condenser connected with said direct current power supply including the primary winding of said ignition transformer, a discharging circuit for said condenser including the primary winding of said ignition transformer and a thyratron tube, said tube having a grid, a transistor having emitter, collector, and base electrodes, breakerless means for applying pulses of voltage across the emitter and base electrodes of said transistor in synchronism with operation of said engine so as to control the conductivity of said transistor between its emitter and collector electrodes, and means coupling the collector electrode of said transistor with the grid of said thyratron tube.

6. An electrical ignition system for igniting the combustible mixture of an engine comprising, a source of direct current power, an ignition transformer having a primary winding and a secondary winding, a spark discharge device connected with the secondary winding of said ignition transformer, a condenser, a charging circuit for said condenser connected with said direct current power source and including the primary winding of said ignition transformer, a discharging circuit for said condenser including the primary winding of said ignition transformer and an electronic switch means, semi-conductor switch means, breakerless means for controlling the conduction of said semi-conductor switch means in synchronism with operation of said engine, and means connecting said semi-conductor switch means and said electronic switch means whereby said electronic switch means has its conductivity controlled by the conduction of said semi-conductor switch means.

7. An electric ignition system for causing the firing of a combustible mixture of an engine comprising, a spark discharge device, a source of direct current power, a condenser, a charging circuit for said condenser connected with said source of direct current power, a discharging circuit for said condenser for energizing said spark discharge device including a thyratron tube having a control grid, a transistor having emitter, collector and base electrodes, a control transformer having a primary winding and a secondary winding, means connecting the grid electrode of said thyratron tube with the secondary winding of said control transformer, means connecting the primary winding of said control transformer in series with the emitter to collector circuit of said transistor, and means connected between the emitter and base electrodes of said transistor for controlling its conductivity in synchronism with operation of said engine.

8. An electronic ignition system for igniting the combustible mixture of an engine comprising, a battery, power transforming means connected with said battery including a transistor, a condenser, a spark discharge device, a

charging circuit for said condenser connected with the output terminals of said power transforming means, a discharging circuit for said condenser adapted to energize said spark discharge device and including electronic switch means, said electronic swich means having a control electrode, a transistor having emitter, base, and collector electrodes, a control transformer having a primary winding and a secondary winding, means connecting the control electrode of said electronic switch means with the secondary winding of said control transformer, means connecting the emitter to collector circuit of said transistor in series with said battery and with the primary winding of said control transformer, a magnetic pick-up device including a coil winding which has pulses of voltage induced therein in synchronism with operation of said engine, and means connecting said coil winding across the emitter and base electrodes of said transistor.

9. An electronic ignition system for igniting the combustible mixture of an engine comprising, a battery, power transforming means energized from said battery, said power transforming means including a transistor oscillator and a diode means for rectifying the A.C. output of said transistor oscillator to direct current, a pair of lead wires energized with direct current from said power transforming means, a condenser, a spark discharge device, a charging circuit for said condenser connected

across said lead wires, a discharging circuit for said condenser adapted to energize said spark discharge device and including electronic switch means, said electronic switch means having a control electrode, a semiconductor switch means having a pair of current carrying terminals and a control terminal, a control transformer having a primary winding and a secondary winding, means connecting the control electrode of said electronic switch means with the secondary winding of said control transformer, means connecting the current carrying terminals of said semiconductor switch means in series with said battery and with the primary winding of said control transformer, a magnetic pick-up device including a coil winding which has pulses of voltage induced therein in synchronism with operation of said engine, and means connecting said coil winding across the control terminal and one of the current carrying terminals of said semiconductor switch means.

10. The system according to claim 9 wherein the semiconductor switch means is a transistor.

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