United States Patent

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[54] **CONTINUING HIGH FREQUENCY ENERGY IGNITION SYSTEM WITH IMPROVEMENTS**
4 Claims, 1 Drawing Fig.

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[51] Int. Cl. **F02p 3/02**
[50] Field of Search ..... 123/148 E; 315/209, 206

[56] **References Cited**
UNITED STATES PATENTS

2,981,865	4/1961	Fernbach	315/209 X
3,018,413	1/1962	Neapolitakis	315/206

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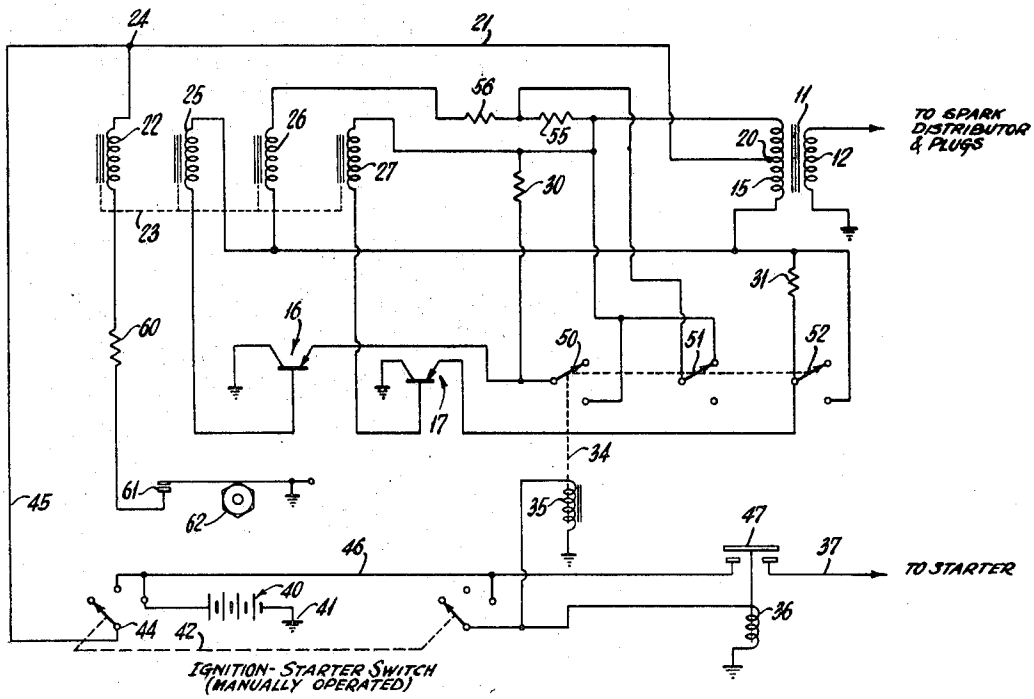
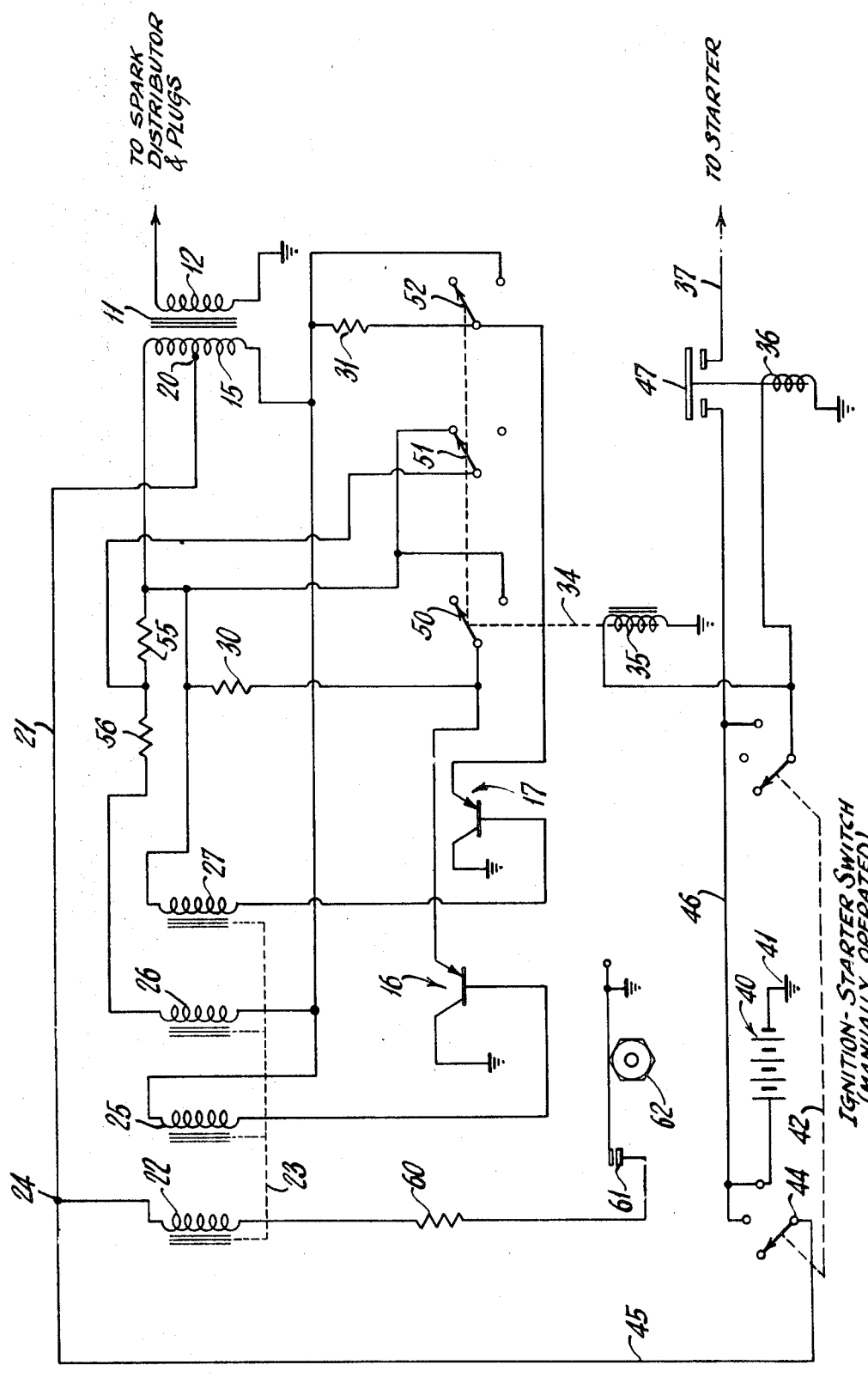
ABSTRACT: In connection with an ignition system that employs continuing high frequency energy for supplying a spark having a predetermined duration, there are relay controlled circuits for adding and removing resistances that will shift the circuit gain and compensate against a change in frequency.




TO SPARK DISTRIBUTOR & PLUGS
TO STARTER
IGNITION-STARTER SWITCH (MANUALLY OPERATED)
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CONTINUING HIGH FREQUENCY ENERGY IGNITION SYSTEM WITH IMPROVEMENTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention concerns ignition systems generally and particularly an ignition system of the type that supplies continuing high frequency energy to the spark gaps. More specifically, it concerns an improvement for such type of ignition system.

2. Description of the Prior Art

Ignition systems that employ continuing duration high frequency energy for the spark supply, have not found very wide spread acceptance for various reasons. One problem that has been encountered is especially evident in such a system when a 24-volt battery is used. The battery is charged when the engine is running, and, on the other hand it supplies current to the starter motor during starting conditions. Consequently, there is a large swing in battery terminal voltage.

SUMMARY OF THE INVENTION

Briefly, this invention pertains to an ignition system for use with an internal combustion engine which has breaker points associated therewith for mechanically determining the timing of initiation of an ignition spark for a cylinder of said engine. The system also has an oscillator employing transistors and electromagnetic feedback coupling and provides relatively high frequency electrical energy having continuous duration during oscillation thereof. In addition, the system has means for saturating said feedback coupling with steady state magnetic flux to stop said oscillation, and has means under control of said breaker points for cutting off said steady state magnetic flux in order to cause rapid starting of said high frequency energy. Finally, the system also includes a DC power supply voltage subject to relatively large variation. In connection with the foregoing system, the invention relates to the improvement which comprises first resistor means for limiting the power dissipated in said transistors, and second resistor means in said feedback coupling for determining the frequency of said oscillator when said voltage is low. The improvement also comprises means for switching out said first resistor means and switching in said second resistor means when said voltage is low, in order to increase the circuit gain without increasing the frequency of the oscillation.

BRIEF DESCRIPTION OF THE DRAWING

The foregoing and other objects and benefits of the invention will be more fully set forth in connection with the best mode contemplated by the inventor of carrying out the invention, and in connection with which there are illustrations provided in the drawings, wherein:

The FIGURE of drawings shows a circuit diagram illustrating an ignition system according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

It will be appreciated that this invention concerns an improvement for the type of ignition system that supplies a continuing high frequency energy source during the entire period of a spark discharge. Such system is, of course, particularly applicable to internal combustion engines.

An illustration of a continuing frequency energy system of the type under consideration is to be found in U.S Pat. No. 3,407,795 to R. W. Aiken et al. issued Oct. 29, 1968. And, this invention is illustrated as applied to an ignition system like that disclosed in the Aiken et al. patent. The invention pertains particularly to an improvement which is beneficial under hard starting conditions, such as those encountered in very low temperatures where the power drain on the battery becomes so great that the output voltage of the battery may fall to a low level. For example, in a 24-volt battery system the starting voltage at the battery terminals may fall to as low as about 18 volts.

Another facet of the problem relates to the concomitant fact that under running conditions, i.e. while the battery is being charged, its terminal voltage may rise above normal to as high as 28 or 29 volts. Therefore, the problem is one of having the system able to accept the wide limit of voltage spread without damage to the various elements, such as the transistors of the oscillator that is employed.

Referring now to the FIGURE of drawings, it is pointed out that the system is basically like that disclosed in the Aiken et al. patent. There is an output transformer **11** that has an output winding **12** which is connected to the spark distributor and thereafter the spark plugs, as indicated by the caption. Transformer **11** also has a center-tapped input winding **15**. This winding is connected at the ends thereof to the emitter terminals respectively of a pair of transistors **16** and **17**. These connections will be traced in more detail hereafter. A center tap connection **20** on the winding **15** is connected via a circuit connection **21** to a common point **24** to which a source of DC potential is connected when the system is energized, as will appear in more detail hereafter.

There is a feedback transformer **23** that has an oscillation control or saturation winding **22**, in addition to three other windings **25**, **26** and **27**. These windings along with the transistors **16** and **17** and the two halves of the center tapped winding **15** of the output transformer **11**, are parts of the oscillator which supplies the continuing high frequency electrical energy for the duration of the spark intervals in the manner described in the aforementioned Aiken et al. patent.

It is pointed out that in accordance with this invention there are included in the basic oscillating circuit some added elements. These are in general for determining the conditions in the oscillator under alternative states of operation. Thus, there are included in the emitter connections of the transistors **16** and **17**, resistors **30** and **31**, respectively. These are connected between the emitter terminal and the corresponding end of winding **15** on transformer **11**, in each case. They are chosen so that with the parameters of the transformers **11** and **23** there will be an adequate spark as to breakdown of the gap and supplying enough current to ignite the fuel, while limiting the amount of power dissipated in the transistors **16** and **17** to a safe value which will not exceed their power ratings with the maximum voltage input.

However, when the engine is started there is a relay **34** that is operated by a solenoid **35**, which is connected for energization in parallel with a starting solenoid **36** that controls the contacts in a starter circuit **37**, as indicated by the caption. As will appear in more detail below, the relay **34** acts during starting to remove the resistors **30** and **31** so as to prevent the output voltage from transformer **11** from falling too low during the time when the terminal voltage of the battery is pulled down under heavy drain due to starting conditions of the engine.

It will be observed that there is a battery **40** which has one side grounded, i.e., at a ground connection **41**. The other side of the battery is connected to one contact terminal of a combination ignition and starter switch **42**. This switch **42** is indicated by the caption "Ignition-Starter Switch (Manually Operated)" and it is a double-pole, three-position switch.

It will be appreciated that the starter switch **42** will act in the conventional manner, with a spring bias (not shown) to the middle position away from the right hand (as viewed in the drawing) position. Furthermore, when the switch is thrown to either the start (right-hand) or run (middle) positions, the battery **40** will be connected into the system to supply electrical energy to the oscillator. This is done via a circuit connection **45** which goes from a switch arm terminal **44** to the common point **24** in the oscillator circuit.

Of course, there is also a circuit from the battery **40** for supplying power to the starter (circuit connection **37**). Such circuit goes via a connection **46** that leads to one side of a switch **47** that is actuated by the solenoid **36**. Thus, when the switch **42** is thrown to the start (right-hand) position, the solenoid **36** will be energized and the switch **47** closed. At the same time, the solenoid **35** of the relay **34** will be energized.

The latter action, i.e. energization of relay solenoids **35** and **36** that are connected in parallel, takes place during a starting period that will be determined by the holding of the switch **42** in its right-hand (start) position against the spring bias. Thereafter, when released the switch **42** will return to its middle position for "run" conditions.

It will be observed that the relay **34** has a two position switch arm **50** that is actuated simultaneously with two other similar two position switch arms **51** and **52**. These are all shown in the deenergized position which is that occupied under "run" conditions for the system. It will be noted that under such run conditions, switch arms **50** and **52** occupy an open circuit position. This results in the resistors **30** and **31**, respectively, being left effectively connected into the emitter circuits of transistors **16** and **17**, and the result is to set the oscillator to operate within safe limits (as indicated above) even when the battery terminal voltage is above normal such as when the battery is being charged.

On the other hand when the relay **34** is actuated, i.e., under starting conditions, the switch arms **50** and **52** will occupy the other position. In that case a shunt circuit which bypasses or short circuits the resistors **30** and **31** respectively will be connected. The effect of this arrangement is to remove the emitter lead resistors **30** and **31** under starting conditions so that the gain at the oscillator output from transformer **11** will be increased to compensate for the low battery terminal voltage that is encountered during starting conditions.

In order to avoid an increase in the frequency of the oscillator beyond acceptable limits when the emitter lead resistors **30** and **31** are not connected into the circuit, there is a resistor **55** that is added into the oscillator feedback circuit which involves the winding **26** on the saturation transformer **23**. Thus, the amount of resistance in that feedback circuit will be increased during the starting conditions by adding the resistance of the resistor **55** to a feedback circuit resistor **56**. The circuit for accomplishing this includes the switch arm **51** which will occupy the other position from that illustrated. Thus the short circuit path around resistor **55** is removed. The value of the resistor **56** will have been selected to give a proper frequency so that correct restart characteristics exist at the spark plug gaps.

It may be observed that the basic ignition system employs the saturation winding **22** (on transformer **23**) for starting and stopping the oscillator in the manner described in the Aiken et al. U.S. Pat. No. 3,407,795. Energization of this saturation winding is under control of a circuit including a resistor **60** and "timing" contacts, or points **61**. The latter are controlled from a cam **62** that is located at the distributor (not shown) of the engine, in a conventional manner.

It is to be particularly noted that this invention provides a system which is applicable to and is an improvement for a continuous high frequency ignition system. It does provide adequate spark energy power output under high battery voltage conditions, while also including means to switch over and avoid increasing the frequency of the oscillator under low battery voltage conditions. During the latter situation the gain of the system is increased to maintain adequate spark energy under hard starting conditions. At the same time the invention permits close control so that a cost saving may be possible by permitting use of germanium instead of silicon transistors.

While a particular embodiment of the invention has been described above in considerable detail, it is not to be taken as in any way limiting the invention, but as merely being descriptive thereof.

I claim:

1. In an ignition system for use with an internal combustion engine having breaker points associated therewith for mechanically determining the timing of initiation of an ignition spark for a cylinder of said engine, and having:

1. an oscillator employing transistors and electromagnetic feedback coupling and providing relatively high frequency electrical energy having continuing duration during oscillation thereof.
2. means for saturating said feedback coupling with steady state magnetic flux to stop said oscillator.
3. means under control of said breaker points for cutting off said steady state magnetic flux in order to cause rapid starting of said high frequency energy, and
4. a DC power supply voltage subject to relatively large variation,

the improvement comprising first resistor means for limiting the power dissipated in said transistors of (1),

second resistor means in said feedback coupling of (1) for determining the frequency of said oscillation when said voltage (4) is low, and

means for switching out said first resistor means and switching in said second resistor means when said voltage (4) is low in order to increase the circuit gain without increasing the frequency of the oscillation.

2. The invention according to claim **1** wherein said means for switching comprises

a relay, and

circuit means connected to said first and second resistor means and including contacts of said relay.

3. The invention according to claim **2** further including means for actuating said relay during starting of said engine.

4. In an ignition system according to claim **1**,

the improvement comprising a resistor in series with the emitter of each of said transistors for limiting the power dissipated in the transistors,

another resistor connected in series with the circuit for said electromagnetic feedback coupling,

a relay having switch contacts, and

circuit connections including said switch contacts for short circuiting said first named emitter resistors and for adding more resistance to said feedback coupling resistor,

said relay being connected for actuation simultaneously with the starter for said internal combustion engine.