April 17, 1962 W. J. JOHNSTON 3,030,549

IGNITION SYSTEM

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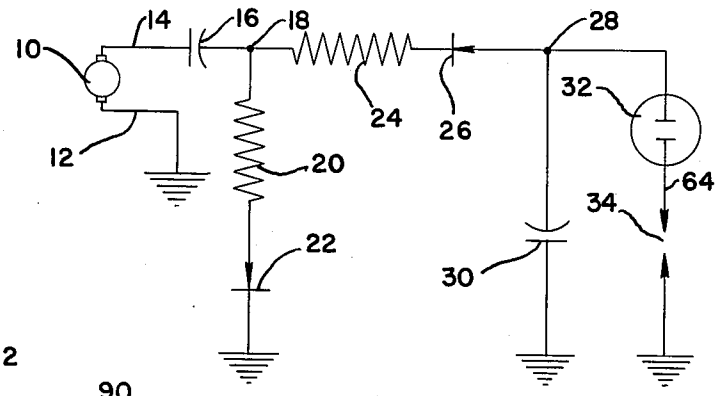


Fig. 1

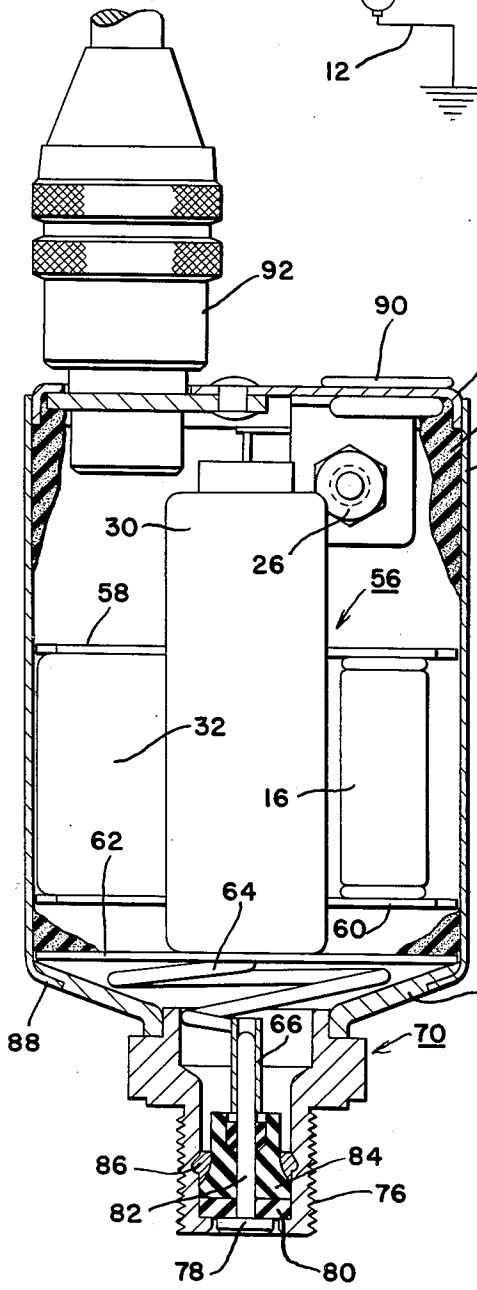


Fig. 3

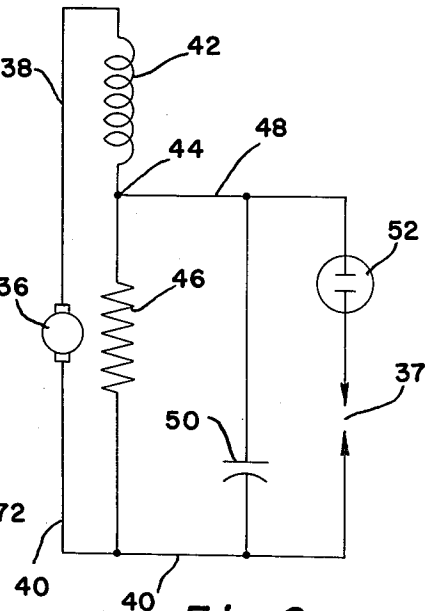


Fig. 2

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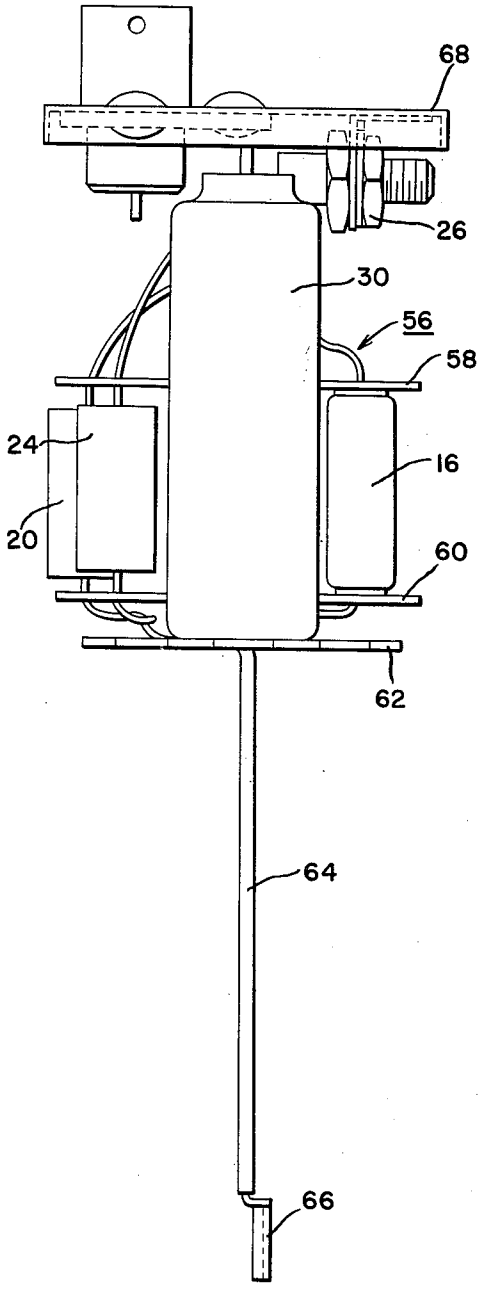


Fig. 4

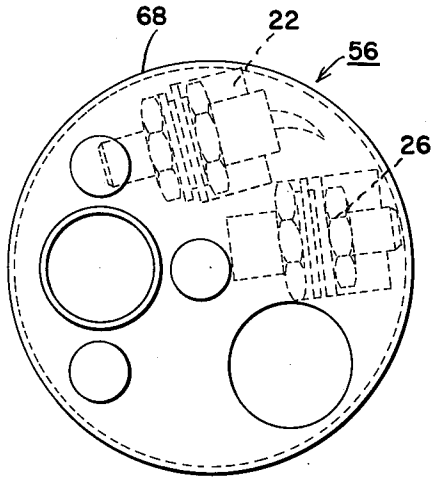


Fig. 5

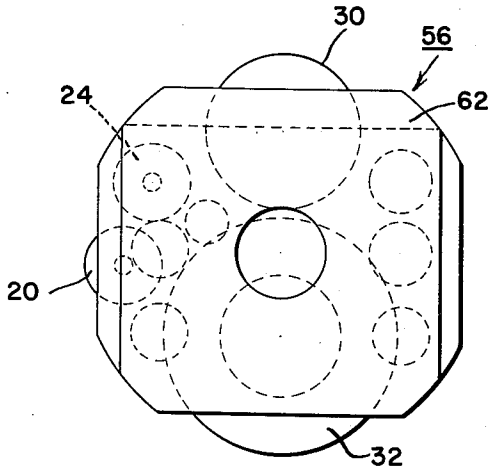


Fig. 6

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IGNITION SYSTEM

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4 Claims. (Cl. 315—188)

This invention relates to ignition systems and apparatus for igniting the combustible fuels of gas turbines, rockets and the like.

One of the objects of this invention is to provide an ignition system that is comprised of relatively few parts but which is capable of boosting the input voltage to provide maximum efficiency in the firing of a spark discharge device.

Another object of this invention is to provide an ignition system that is powered by a source of A.C. voltage, the system including a resonant circuit that is resonant at the frequency of the source and further wherein the voltage developed across one of the circuit elements of the resonant circuit is used to fire a spark discharge device.

Still another object of this invention is to provide an ignition system that is powered by a source of A.C. voltage that includes a pair of condensers and a pair of rectifiers, the condensers and rectifiers being so connected that one condenser is charged on a first half cycle of applied voltage and the other condenser is charged on the other half cycle through the first condenser, the other condenser thus charging to approximately twice the peak voltage of the input voltage and this voltage being used to fire a spark discharge device.

A further object of this invention is to provide an igniter that includes an ignition system and a spark discharge device in one integral unit. In carrying forward this object of the invention, the parts of the ignition system are fitted as a unit within a housing the lower end of which is enclosed by a spark discharge device. The housing is filled with a plastic material such as an epoxy resin which encapsulates the ignition system parts and provides a bond between them and the housing.

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:

FIGURE 1 is a circuit diagram of an ignition system made in accordance with this invention.

FIGURE 2 is a schematic circuit diagram of a modified ignition system made in accordance with this invention.

FIGURE 3 is a sectional view of an integral igniter made in accordance with this invention.

FIGURE 4 is a plan view of a sub-assembly forming a part of the igniter illustrated in FIGURE 3.

FIGURE 5 is an end view of the assembly illustrated in FIGURE 4.

FIGURE 6 is another end view of the assembly illustrated in FIGURE 4.

Referring now to the drawings and more particularly to FIGURE 1, the reference numeral **10** designates a source of A.C. voltage having one side thereof connected to ground via a lead wire **12**. The opposite side of the power source **10** is connected with lead wire **14** and it is seen that this lead wire is connected to one side of a condenser **16**. The condenser **16** is connected with a junction **18**, and a resistor **20** is connected between the junction **18** and a rectifier **22**. The rectifier **22** may be of the p-n junction, semi-conductor type and has its

opposite side thereof connected directly to ground as shown.

The junction **18** is connected with a resistor **24** which is in turn connected with a rectifier **26** that may be of the same type as the rectifier **22**. The opposite side of rectifier **26** is connected with junction **28** and it is seen that a condenser **30** is connected between junction **28** and ground. The junction **28** is connected to one side of a cold cathode discharge tube **32** the opposite side of the tube being connected with a creepage gap or shunted surface gap type of spark plug **34**. The opposite side of the spark plug **34** is connected directly to ground as shown in FIGURE 1.

In the operation of the circuit illustrated in FIGURE 1 and when the lead wires **12** and **14** are energized from the source of A.C. voltage, the condenser **16** will be charged on a half cycle of the A.C. voltage when, for example, the lead wire **14** is positive with respect to the lead wire **12**. This charging circuit is through the condenser **16** through the resistor **20** and through the rectifier **22** to ground. On a next half cycle of applied voltage the polarities of lead wires **12** and **14** is reversed so that the lead wire **12** will be positive with respect to the lead wire **14**. Under this condition of operation, the voltage across condenser **16** is adding to the input voltage and current will flow from the A.C. power source through the condenser **30**, through rectifier **26**, through resistor **24** and through the condenser **16**. The condenser **30** will now be charged to approximately twice the peak value of the input voltage.

The cold cathode discharge tube **32** is chosen to have a break-down voltage that is less than the maximum voltage which can be reached across condenser **30**. When this break-down voltage is reached, the condenser **30** will discharge through the cold-cathode discharge tube **32** and through the spark gap **34** to provide a spark. The tube **32** will then deionize and the process will be repeated.

It will be appreciated that the spark repetition rate is a function of the value of the resistors **20** and **24** and the value of condensers **16** and **30** and also will vary according to the input frequency of the voltage source **10**.

Referring now to FIGURE 2, another circuit for boosting the input voltage to fire a spark discharge device is illustrated. In this circuit the reference numeral **36** designates a source of A.C. voltage. The A.C. voltage source **36** is connected with lead wires **38** and **40**, the lead wire **38** being connected to one side of an inductor **42**. The opposite side of inductor **42** is connected with a junction **44** and it is seen that a resistor **46** is interposed between the junction **44** and the lead wire **40**. A condenser **50** is connected between lead wires **40** and **48**. The lead wire **48** is connected to one side of a cold cathode discharge tube **52** which may be of the same type as the tube **32** illustrated in FIGURE 1. The tube **52** is connected with a creepage gap or shunted surface gap type of spark plug **36**, the opposite side of the plug being connected with lead wire **40**.

In selecting the components for the circuit of FIGURE 2, the condenser **50** and inductance **42** are selected to provide resonance at the frequency of the voltage source **36**. Thus in a typical system the inductance of inductor **42** may be .156 henry, the resistance of resistor **46** one megohm and the capacitor 1 mfd. With this system the inductor **42** and capacitor **50** are resonant at the 400 cycle A.C. input. In addition, the spark rate achieved is approximately 300 to 400 sparks per second.

It will be appreciated that during the operation of this system, the voltage appearing across condenser **50** will be many times the value of the input voltage from source **36**. When the condenser **50** is charged to a voltage sufficient to break down the cold cathode discharge tube

52, the condenser discharges through the creepage plug 37. This system thus greatly increases the input voltage and uses this voltage in causing sparking across the spark plug 36. The function of the resistor 46 is to discharge the capacitor 50 when the circuit is inoperative and thus prevent an undesired spark.

Although the system of FIGURE 2 has principle utility for use with a creepage gap plug, the same principles of this invention could be applied to a high tension plug. With a high tension plug, no discharge tube 52 would be necessary to prevent the condenser from prematurely discharging through the spark gap 37.

Referring now more particularly to FIGURES 3 through 6, a physical embodiment of the circuit illustrated in FIGURE 1 is shown. In these figures the ignition circuit and spark plug are formed in one integral unit which may then be fitted to an engine for causing ignition of the combustible fuel of the engine. As shown in FIGURE 3, the integral igniter includes a metal can which is designated by reference numeral 54 containing the ignition system in FIGURE 1. The can 54 contains a sub-assembly generally designated by reference numeral 56 and shown in FIGURES 4 through 6 of the drawings. The sub-assembly 56 includes plates 58, 60 and 62. The plate 62 supports the condenser 30 whereas the plates 58 and 60 support the resistors 20 and 24 as well as the condenser 16. The cold cathode discharge tube 32 is not visible in FIGURE 4 but is visible in the end view of FIGURE 6. One side of the cold cathode discharge tube is connected with a conductor 64 that is secured to a terminal 66.

The sub-assembly 56 further includes an assembly including a metal cover member 68 that supports the rectifiers 22 and 26. These rectifiers are supported on brackets having portions that extend downwardly from the cover 68.

The integral igniter further includes a spark plug portion which is designated in its entirety by reference numeral 70. This spark plug portion includes the member 72 formed of metallic material and the portion 74 having threads 76. The electrode portion 74 is spaced from a center electrode 78 as is clearly apparent from FIGURE 3. A button 80 or any suitable semi-conductor material is fitted around the rod portion 82 of the center electrode 78 and is interposed between this center rod portion and the outer electrode 74. An insulator 84 insulates the rod portion 82 from the outer electrode portion 74 and is held in place by metal material 86 which is wedged in place.

In assembling the integral igniter of FIGURE 3, the lower electrode portion 70 is fitted to the can 54 and is silver soldered thereto along the area designated by reference numeral 88. The sub-assembly 56 is then fitted within the container 54, the terminal 66 being secured to the rod portion 82 at this time and the conductor 64 being formed to the shape illustrated in FIGURE 3. After the lower connections have been made for the integral igniter as described, the cover member 68 is soldered to the can 54 and the can is then filled with a plastic material such as an epoxy resin through an opening that is later closed by the plug 90. It is seen that a connector 92 is also provided which may form she power input connection for the integral igniter. The plastic substance which entirely fills the can 54 when it is completely assembled is designated by reference numeral 94 in FIGURE 3. Only portions of this material are shown so that the ignition system within the can may be illustrated. It will be apparent that the epoxy resin 94 completely seals the system so that the parts of the ignition system are encapsulated in the epoxy resin and this resin provides a shock absorbing mounting for all of the parts located within the can 54. The filling of the can with epoxy resin also prevents destruction of the integral igniter where the igniter is subjected to severe pressure changes in high altitude operation.

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

What is claimed is as follows:

1. An electrical ignition system comprising, a source of A.C. voltage, a circuit resonant at the frequency of said A.C. source connected across said A.C. voltage source including an inductor and a capacitor, a spark plug of the creepage gap type, and a discharging circuit for said condenser including said spark plug and a circuit element having a break down voltage which is less than the voltage attained by said capacitor.

2. An electrical ignition system comprising, a source of A.C. voltage, a circuit resonant at the frequency of said A.C. voltage source connected across said source of A.C. voltage, said circuit including an inductor and a condenser, and a discharging circuit for said condenser including a cold cathode discharge tube and a spark plug of the creepage gap type.

3. An electrical ignition system comprising, a spark discharge device, a condenser connected with said spark discharge device and adapted to discharge therethrough, a source of A.C. voltage, and a circuit resonant at the frequency of said A.C. voltage source connected across said source and including said capacitor and an inductor.

4. An electrical ignition system comprising, a source of A.C. voltage, a circuit resonant at the frequency of said A.C. voltage source connected across said source and including a series connected inductor and a capacitor, a resistor shunting said capacitor, a spark plug of the creepage gap type, and means connecting said spark plug across said capacitor including a cold cathode discharge tube.

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