March 4, 1969 J. L. ELBERSON 3,430,617

APPARATUS FOR SCAVENGING EXHAUST GASES

Filed April 18, 1967 Sheet 1 of 2

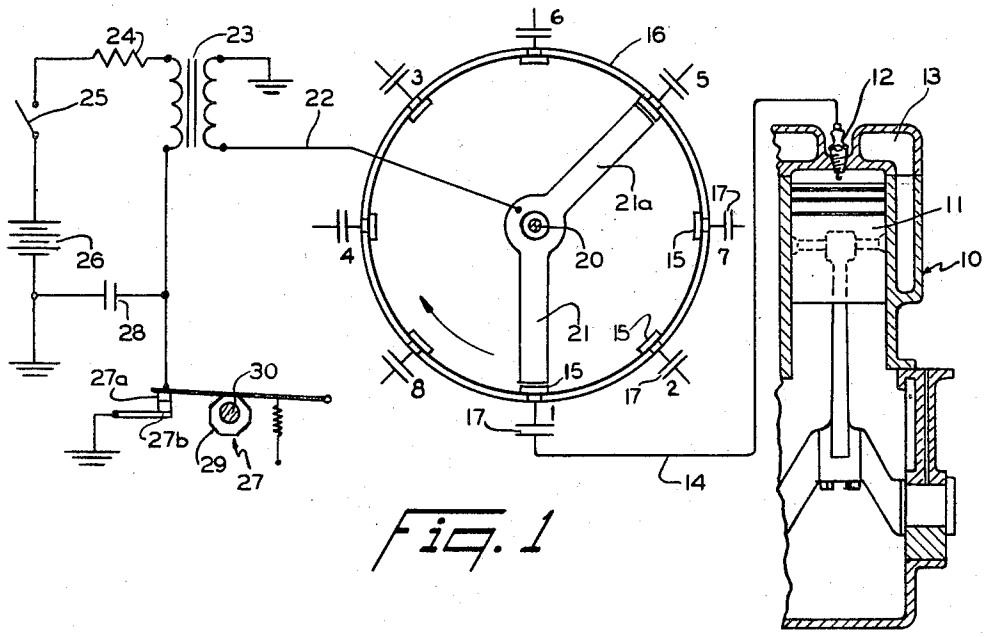

Fig. 1

IGNITION	1	8	4	3	6	5	7	2
	+	+	+	+	+	+	+	+
SCAVENGE	5	7	2	1	8	4	3	6

Fig. 2

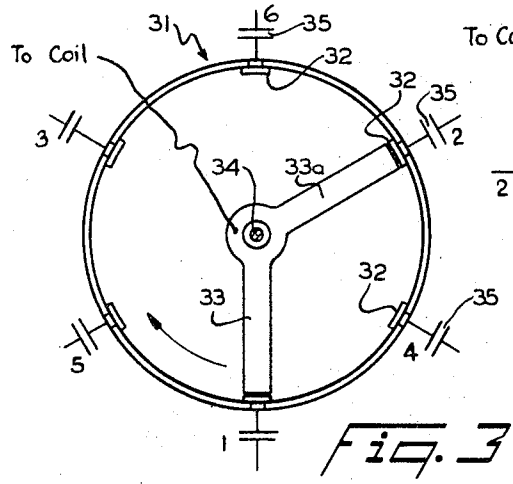

Fig. 3

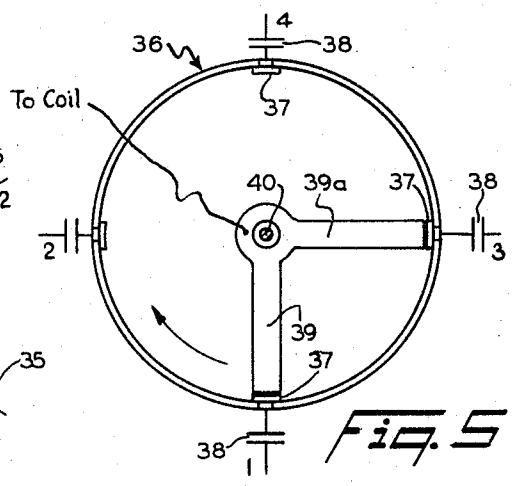

Fig. 5

IGNITION	1	5	3	6	2	4
	+	+	+	+	+	+
SCAVENGE	2	4	1	5	3	6

Fig. 4

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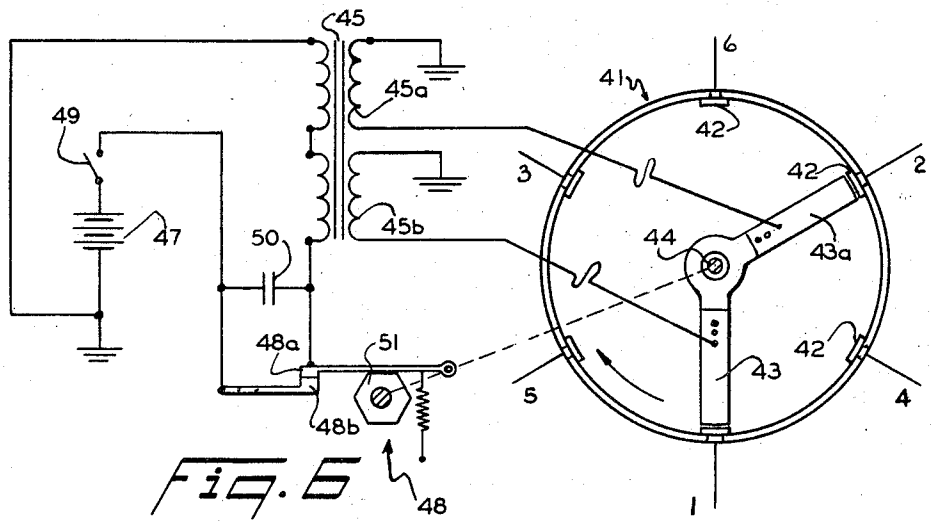

Fig. 6

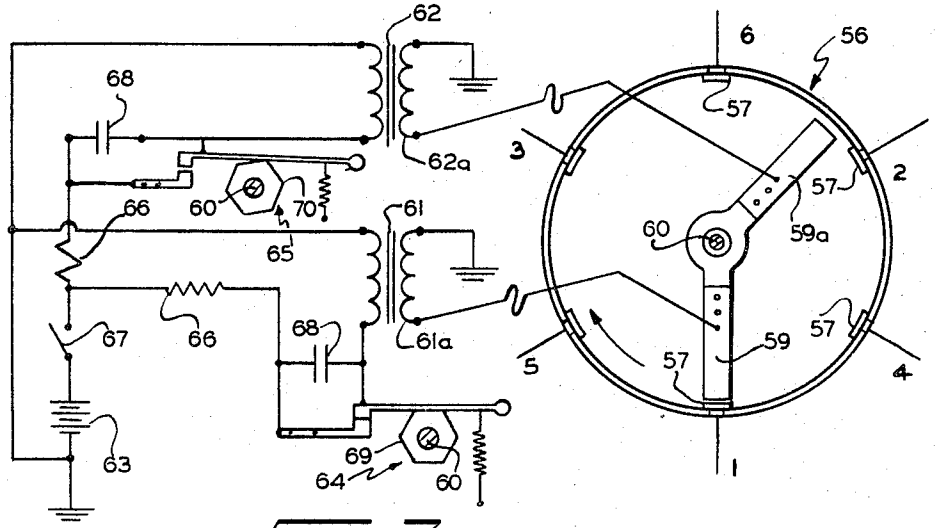

Fig. 7

IGNITION	1	5	3	6	2	4	
SCAVENGE	2	4	1	5	3	6	

Fig. 8

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United States Patent Office 3,430,617
Patented Mar. 4, 1969

3,430,617

APPARATUS FOR SCAVENGING EXHAUST GASES

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Filed Apr. 18, 1967, Ser. No. 631,664
U.S. Cl. 123—148 4 Claims
Int. Cl. F02p 9/00

ABSTRACT OF THE DISCLOSURE

An ignition system for clearing the exhaust of internal combustion engines of unburned gases has means for providing a spark at each cylinder conventionally at the commencement of its power stroke and also for providing an additional spark at each cylinder momentarily during the first half of its exhaust stroke. Such ignition means include dual ignition systems separately timed, dual ignition systems using a common distributor, and a single ignition system having a double contact arm in the distributor, one arm furnishing the power spark and the other the scavenging spark.

Background of the invention

This invention relates to ignition systems for internal combustion engines and more particularly to such a system which supplies a momentary sparking at each cylinder during the exhaust stroke as well as at the beginning of the power stroke.

Conventional ignition systems supply only the one momentary sparking at the commencement of the power cycle. Some, such as diesels, supply the equivalent by means of compression. None provide means for burning unburnt gases after the power stroke in the cylinder itself. As a result, the engine emits unconsumed gases which are discharged into the atmosphere or must be further consumed in an after burner.

Summary of the invention

This invention contemplates consuming gases left unburnt after the power stroke by causing a spark in the cylinder after the commencement of the exhaust stroke, after the exhaust valve has opened but before the gases have been expelled from the cylinder. Obviously this can be done by dual ignition systems, including a pair of spark plugs for each cylinder. Since the duplication of spark plugs is unnecessary, it is proposed to utilize existing plugs, distributor means and other ignition components as far as practicable.

The principal object of the invention, accordingly, is to provide ignition means for completing the combustion of unburnt but flammable exhaust gases in the engine cylinder before expelling them from the exhaust manifold.

Another important object is to provide ignition systems for the accomplishment of the above stated object utilizing conventional ignition means with as little change as possible.

Other objects and advantages will become apparent from the following description in conjunction with the accompanying drawings.

Brief description of the drawing

FIGURE 1 is a diagrammatic and fragmentary view of one cylinder of a multiple cylinder engine and associated ignition system for eight cylinders showing a two armed distributor rotor;

FIGURE 2 is a schematic chart of the firing order of the distributor of FIGURE 1;

FIGURE 3 is a diagrammatic view of a distributor similar to that of FIGURE 1 but for six cylinders;

FIGURE 4 is a schematic chart of the firing order of the distributor of FIGURE 3;

FIGURE 5 is a diagrammatic view of a distributor similar to that of FIGURE 1 but for four cylinders;

FIGURE 6 is a diagrammatic view of a portion of another ignition system for six cylinders;

FIGURE 7 is a diagrammatic view similar to FIGURE 6 of still another ignition system for six cylinders; and

FIGURE 8 is a schematic chart of the firing order of the system of FIGURE 7.

Description of the preferred embodiment

In one cylinder engines it will be obvious to those skilled in the art that the magneto providing ignition for the single cylinder may be provided with two sets of breaker points to provide the desired additional sparking at the single plug for the exhaust stroke. In multicylinder engines the problem is more involved and the following embodiments of ignition systems according to the invention are described.

In FIGURE 1, one cylinder of an eight cylinder internal combustion engine is shown at **10**, with its piston **11** at, or near the top of its stroke. A single spark plug **12** is located conventionally at the top of the cylinder, recessed in water jacket **13**.

Each spark plug of engine **10** is separately connected by an insulated wire **14** to a respective stationary contact **15**, in distributor **16**, only the wire to the first cylinder being shown. This connection of plugs to distributor is entirely conventional except that a capacitor **17** is interposed between contact **15** and plug **12** for each wire **14**, this interposition not being novel in ignition systems. Capacitor **17** may be carried by the wire, as shown, or by distributor **16** or plug **12**.

Centrally of the distributor **16**, the distributor shaft **20** carries the usual arm **21**, which is insulated from contacts **15**, the shaft **20** being synchronized with the cyclical movements of pistons **11** in the usual manner. In addition to arm **21**, shaft **20** carries an additional arm **21***a*, angularly spaced from arm **21** as shown. The ends of arms **21** and **21***a* are rotating or moving contacts cooperating with the fixed contacts **15** in the usual manner.

Arms **21** and **21***a* are electrically connected together and connected, through a slip ring arrangement not shown, by wire **22** to one terminal of the secondary winding of a coil or transformer **23** whose other terminal is grounded, one terminal of each plug **12** being grounded in the usual manner.

The primary of coil **23** has one terminal conventionally connected through a resistor **24** and ignition switch **25** to the positive terminal of battery **26**, or other power source. The negative battery terminal is connected to ground and the other coil primary is connected in the usual manner to one contact of a timer arrangement **27**, the other timer contact being connected through ground to the negative battery terminal. A capacitor **28** is connected between the first timer contact and the negative battery terminal, that is, across the timer contacts **27***a* and **27***b*.

The timer **27** has the usual movable contact **27***a* and fixed contact **27***b*. The timer is arranged to break the coil circuit by opening contacts **27***a* and **27***b* by means of a rotating, eight-sided cam **29** mounted on a shaft **30** synchronized with engine **10**.

The arrangement of fixed contacts **15** about the distributor **16** and their respective connections to the eight cylinders of engine **10** determine that the firing order of engine **10** is cylinders 1, 8, 4, 3, 6, 5, 7, 2 in the particular engine selected for FIGURE 2. Arm **21***a* is angularly spaced behind arm **21** 135 degrees, as shown. Each time the timer contacts **27***a* and **27***b* are separated a high voltage pulse is induced in the secondary of coil **23** in the

usual manner and a spark, or momentary sparking, occurs at whichever plug is connected to the contact **15** in connection with arm **21** at that moment. The connection of shaft **20** with motor **10** ensures that the piston **11** of that cylinder is then at the start of its power cycle or stroke.

Arm **21***a*, however, is electrically connected to arm **21** and in contact with a different cylinder at that same time, with cylinder **5** when No. 1 is firing, with cylinder **7** when No. 8 is firing, and so on. Each contact **15** is connected through a respective capacitor **17** to its respective plug **12** and this ensures that both plugs are fired alternately. Oscilloscope analysis of the coil primary circuit indicates at least two sparks at each plug, the time interval of the oscillations, measured in microseconds, being so short as to be only momentary and producing practically simultaneous firing at each plug. FIGURE 2 indicates this in that, when No. 1 is fired for its power stroke, No. 5 fires simultaneously for scavenging at 90 degrees of crankshaft rotation after its exhaust stroke has commenced, and when No. 8 fires for power, No. 7 fires simultaneously for scavenging, etc., as indicated in FIGURE 2.

FIGURE 3 shows another distributor **31** which, it will be understood, is connected in the ignition system of a six cylinder engine in the same manner as distributor **16** in FIGURE 1. Distributor **31** has six equiangularly spaced fixed contacts **32** and two rotating contact arms **33** and **33***a*, angularly spaced at 120 degrees, carried on a shaft **34** synchronized with the six cylinder engine. Each fixed contact **32** is connected through a capacitor **35**, to a plug, not shown, in the respective cylinder of the engine.

It will be apparent that the operation of distributor **31** for a six cylinder engine is substantially the same as that described for distributor **16** except for the firing order being that shown in FIGURE 4. When No. 1 cylinder fires for power, No. 2 fires substantially simultaneously for scavenging, and so forth. Due to spacing of contacts **32** around the distributor arm **33***a* is spaced from arm **33** 120 degrees and when No. 2 fires for scavenging its piston is about ⅓ through its exhaust stroke.

In FIGURE 5 the distributor **36** is adapted for use with a four cylinder engine. There are four equiangularly spaced stationary contacts **37** and the lead wires to the respective spark plugs are each provided with a capacitor **38**. Two arms **39** and **39***a* are carried on the distributor shaft **40**, angularly spaced at 90 degrees.

The operation of distributor **36** is likewise the same as distributor **16** except the firing order is 1, 2, 4, 3 in this instance and the order of simultaneous scavenger sparking is 3, 1, 2, 4. Due to the spacing of contacts **37**, when No. 3 is fired for scavenging it is at the beginning of its exhaust stroke.

In FIGURE 6, a distributor **41** is shown having six equiangularly spaced contacts **42** with lead wires to the respective cylinders. Two angularly spaced arms **43** and **43***a* are carried on shaft **44** but the contact portions of arms **43** and **43***a* are electrically insulated from one another and from shaft **44**.

Arms **43** and **43***a* are each electrically connected to a terminal of a respective secondary winding **45***a* and **45***b* of a coil **45**. The other terminal of each secondary winding is grounded.

The primary of coil **45**, which may be a single coil or two coils in series, as shown, is connected at one end to the negative grounded terminal of battery **47** and at the other end to one of a pair of contacts **48***a* and **48***b* of a timer **48**. The other timer contact is connected through an ignition switch **49** to the positive terminal of battery **47**. The usual capacitor **50** is connected across the timer contacts **48***a* and **48***b*.

The movable contact **48***a* is operated to break the circuit through the primary of coil **45** for each cylinder power stroke by the six-sided timer cam **51** carried on shaft **44** or another shaft rotating synchronously therewith.

The operation of this modified ignition system is much the same as that shown in FIGURE 1. For each power stroke the circuit through the primary of coil **45** is broken, inducing a high tension current surge in each of the secondary windings **45***a* and **45***b* which is communicated through the respective arms **43** and **43***a* of the distributor. When contact arm **43** is in contact with contact **42** connected to the plug at cylinder No. 1, arm **43***a* is in contact with fixed contact **42** connected to the plug at No. 2, so that sparks at both plugs are induced. Since each of the arms **43** and **43***a* are connected to a separate coil secondary there is no need for any capacitor in the lines between the fixed contacts **42** and the plugs at the cylinders.

In FIGURE 7, another modification of an ignition system adapted for the practice of the invention is shown. The distributor **56** has six equiangularly spaced fixed contacts **57**, each connected to a respective cylinder plug, not shown. Two angularly spaced rotating contact arms **59** and **59***a* are carried on the distributor shaft **60**, each arm insulated from the other and from the shaft.

Arm **59** is electrically connected to one terminal of the secondary winding **61***a* of a coil **61**, the other terminal being grounded. Arm **59***a* is connected to one terminal **62***a* of the secondary winding of a coil **62**, the other terminal being grounded. The respective primary windings of coils **61** and **62** each have one end connected to the negative grounded terminal of a battery **63** and the other end connected respectively to one contact of a pair in timers **64** and **65**. Each pair of timer contacts has the other contact of the pair connected through a respective resistor **66** and through an ignition switch **67** to the positive terminal of battery **63**. The usual capacitors **68** are connected across each pair of contacts.

Six sided timer cams **69** and **70** may both be mounted on distributor shaft **60**, as shown, or on separate shafts synchronized with shaft **60** and the engine.

Preferably the timer cams are adjustably mounted but, in any event, they are mounted to break the circuit through their respective coil primaries at different angular positions of the timer arms **59** and **59***a*. For example, when arm **59** is in contact with the fixed contact **57** for No. 1 cylinder, the cam **69** breaks the circuit through the primary of coil **61**, but the contact through coil **62** is not broken until arm **59***a* reaches the point of contact with its fixed contact **57** connected to No. 2 cylinder.

In operation, arms **59** and **59***a* have independent timers and independent coils so that it is possible, by adjusting cams **69** and **70**, to obtain, for each power stroke, first a power sparking at that cylinder, No. 1 as shown, and, an instant later, a sparking at another cylinder, No. 2, as shown, for the scavenging sparking at that other cylinder.

FIGURE 8 illustrates this non-simultaneous timing of power and scavenge sparking. First No. 1 fires at its power stroke commencement. After an instant's delay, No. 2 fires in its exhaust stroke, as shown, 15 degrees movement of the timer arms after the firing of No. 1. In the same manner, No. 4 fires in its exhaust stroke after No. 5 fires in its power stroke, and No. 1 fires in its exhaust stroke an instant after No. 3 fires for ignition in its power stroke.

It will be apparent to those expert in the art that other ignition systems, including transistorized systems, may be adapted for use in carrying out the invention. By providing spark plugs at each cylinder in diesel engines, a spark to ignite the unconsumed gases during the exhaust stroke may be obtained by timing the sparking at the plug with the movement of the piston in the cylinder.

In constructed embodiments of ignition systems according to the invention for both six and eight cylinder engines not only cleaner exhausts were obtained but also gas savings, in miles per gallon, were obtained amounting to as much as 15 to 25 percent increased mileage.

As will be apparent to those familiar with the art, the invention may be embodied in other specific forms with-

out departing from the spirit or essential characteristics thereof. The embodiments disclosed therefore are to be considered in all respects as illustrative, rather than restrictive, the scope of the invention being indicated by the appended claims.

What is claimed is:

1. In an internal combustion engine having a plurality of cylinders and reciprocating pistons therein arranged to sequentially have successive intake, compression, power, and exhaust strokes; ignition means including a high tension current source, timing means for momentarily interrupting current in the high tension source, and distributor means having a first distributor arm rotating synchronously with the reciprocation of the pistons and adapted to momentarily communicate a spark to each cylinder substantially at the commencement of its power stroke; the improvement comprising the distributor means having a second arm rotating electrically connected to the first arm and secured in a fixed angular relation to the first arm for successively momentarily communicating a spark to each cylinder during the first half of its exhaust stroke; whereby unburnt gases in each cylinder are ignited to be burnt in the cylinder during its exhaust stroke.

2. An internal combustion engine having a plurality of cylinders and reciprocating pistons therein arranged to sequentially have successive intake, compression, power, and exhaust strokes; and ignition means, comprising: a source of electricity, a coil having its primary winding connected across the source, circuit breaker means synchronized with the reciprocation of the pistons for momentarily breaking the circuit through the coil primary, a single spark plug having spaced electrodes at each cylinder, a distributor having a first rotating contact electrically connected to one end of the coil secondary winding and a plurality of equi-angularly spaced fixed contacts each connected through a capacitor to one electrode of a respective plug for successively causing a momentary sparking at the plugs, the other end of the coil secondary winding and the other plug electrodes being grounded, the distributor having a second rotating contact electrically connected to the first rotating contact and angularly spaced from the first rotating contact at an angle which is a multiple of the angular spacing of the fixed contacts, whereby breaking of the circuit through the coil primary causes momentary sparking at one plug when its associated piston is substantially at the commencement of its power stroke and substantially simultaneously causes momentary sparking at another plug while its associated piston is in the first half of its exhaust stroke.

3. An internal combustion engine having a plurality of cylinders and reciprocating pistons therein arranged to sequentially have successive intake, compression, power, and exhaust strokes; and ignition means, comprising: a source of electricity, a coil having its primary winding connection across the source, circuit breaker means synchronized with the reciprocation of the pistons for momentarily breaking the circuit through the coil primary, a single spark plug having spaced electrodes at each cylinder, a distributor having a first rotating contact electrically connected to one end of one of a pair of coil secondary windings and a plurality of equi-angularly spaced fixed contacts each connected to one electrode of a respective plug for successively causing a momentary sparking at the plugs, the other end of said one coil secondary winding and the other plug electrodes being grounded, the distributor having a second rotating contact insulated from and angularly spaced from the first rotating contact at an angle which is a multiple of the angular spacing of the fixed contacts, the second rotating contact being electrically connected to one end of the other coil secondary winding, the other end of said other coil secondary winding being grounded, whereby breaking of the circuit through the coil primary causes momentary sparking at one plug when its associated piston is substantially at the commencement of its power stroke and substantially simultaneously causes momentary sparking at another plug while its associated piston is in the first half of its exhaust stroke.

4. An internal combustion engine having a plurality of cylinders and reciprocating pistons therein arranged to sequentially have intake, compression, power, and exhaust strokes; and ignition means, comprising: a source of electricity, a pair of coils each having its primary winding connected across the source, circuit breaker means associated with each coil and synchronized with the reciprocation of the pistons for momentarily breaking the circuit through the coil primary, a spark plug having spaced electrodes at each cylinder, a distributor having a first rotating contact electrically connected through one of the coil secondary windings to ground and a plurality of angularly spaced fixed contacts each connected to one electrode of a respective plug for successively causing a momentary sparking at the plugs, the other plug electrode being grounded, the distributor having a second rotating contact insulated from and angularly spaced from the first rotating contact, the second rotating contact being electrically connected through the other coil secondary winding to ground, the circuit breaker means being adjusted to break the current through one coil an instant after the circuit is broken through the other coil, whereby a momentary sparking in one cylinder occurs at the commencement of its power stroke and momentary sparking at another cylinder occurs an instant later during its exhaust stroke.

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LAURENCE M. GOODRIDGE, *Primary Examiner.*

U.S. Cl. X.R.

60—30; 123—149