P. H. HAWKER & I. J. REUTER.

IGNITION APPARATUS.

APPLICATION FILED DEC. 2, 1912.

1,109,064.

Patented Sept. 1, 1914.

2 SHEETS—SHEET 1.

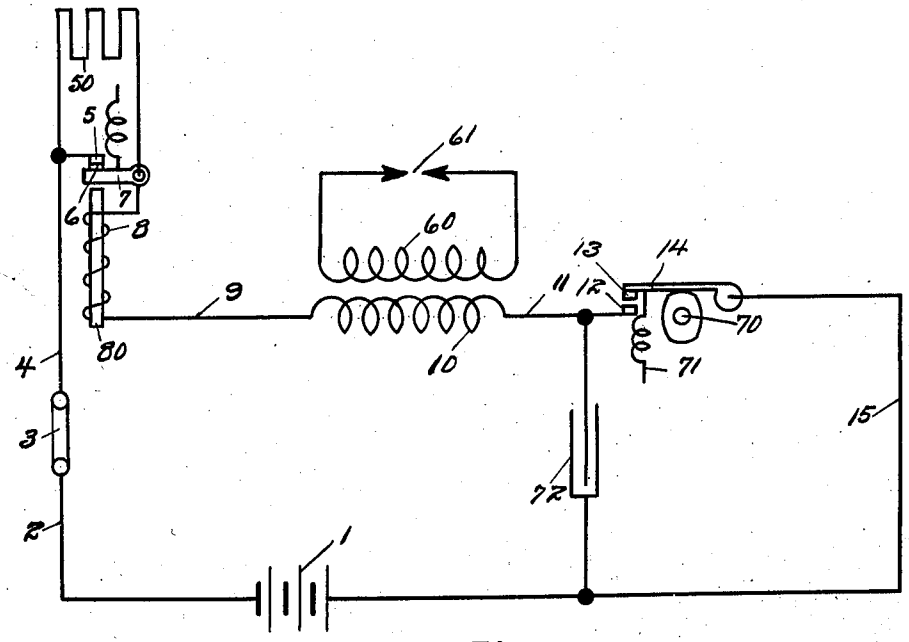


Fig. 1.

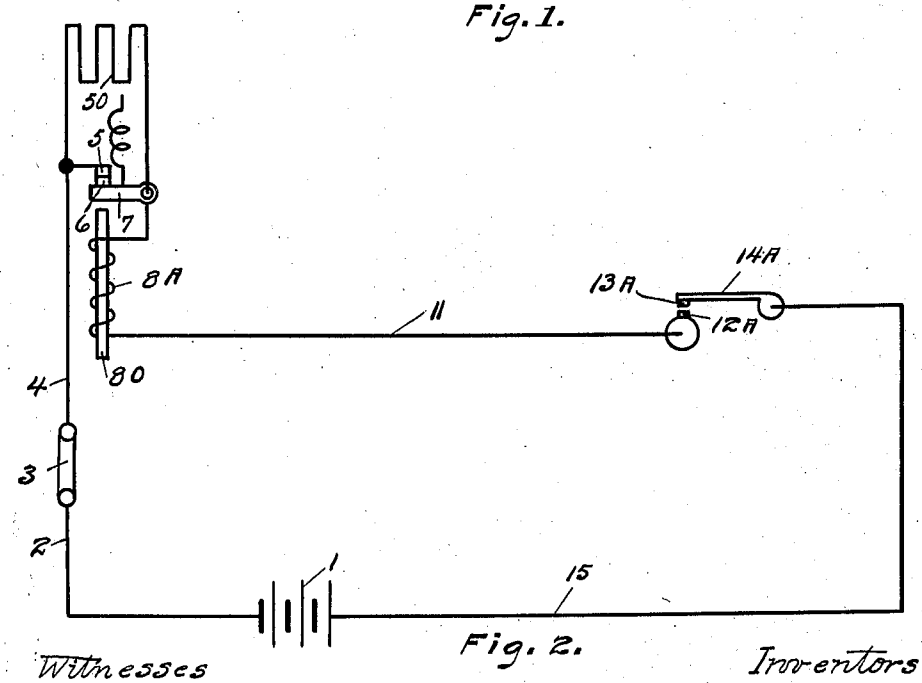


Fig. 2.

Witnesses

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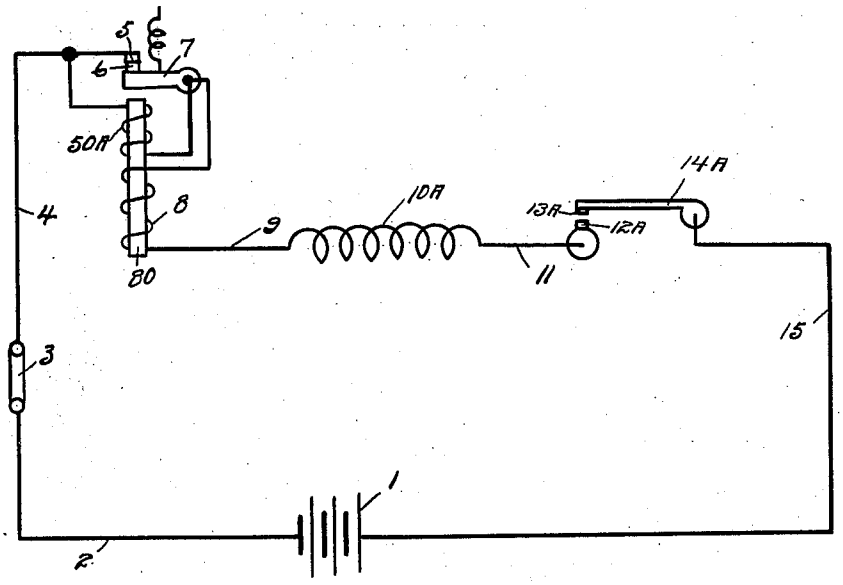


Fig 3.

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UNITED STATES PATENT OFFICE.

PAUL H. HAWKER AND IRVING J. REUTER, OF ANDERSON, INDIANA, ASSIGNORS TO REMY ELECTRIC COMPANY, OF ANDERSON, INDIANA.

IGNITION APPARATUS.

1,109,064. Specification of Letters Patent. **Patented Sept. 1, 1914.**

Application filed December 2, 1912. Serial No. 734,502.

To all whom it may concern:

Be it known that we, PAUL H. HAWKER and IRVING J. REUTER, citizens of the United States, and residents of Anderson, county of Madison, and State of Indiana, have invented a certain new and useful Ignition Apparatus, of which the following is a specification.

The object of this invention is to produce an ignition system for internal combustion engines, capable of giving satisfactory results throughout a wide range of speeds of operation.

It is particularly adapted to utilize energy from a battery or other source of current whose electromotive force does not materially increase with increasing speed of operation of the engine.

The invention is adapted to either jump-spark or make and break ignition.

The feature of the invention consists in the employment of a regulating resistance and electrically operated means for automatically introducing it into the circuit when desirable for the purpose of limiting the flow of current.

Referring to the drawings:

Figure 1 represents the invention employed for jump-spark ignition, and with a separate coil for actuating the controller. Fig. 2 shows the invention used for producing make and break ignition, and with the ignition coil also serving as the controller actuating coil. Fig. 3 shows another form of the invention for make and break ignition having the regulating resistance wound on the core of the controller actuating magnet, and with an ignition winding separate from the winding on said controller actuating magnet.

Referring to Fig. 1, 1 is a battery which is connected by wire 2 to one terminal of the switch 3, the remaining terminal of said switch being connected to the wire 4. 5 is the fixed contact of the controller. It is connected to wire 4. There is movable contact 6, carried by a spring actuated armature 7. Said contacts 5 and 6 and armature 7 constitute the controller. The contacts 5 and 6 are normally closed, that is, the spring tends to hold them in engagement. There is an electromagnet having a winding 8, on a core 80, adapted to actuate said armature 7, and separate the contacts 5 and 6. One terminal of the winding 8 is connected to the armature 7 and the other terminal of said winding 8 is joined by wire 9 to one end of the ignition winding 10. By the term ignition winding is meant a winding in the battery circuit, which assists in or causes the production of the spark when the current through said winding is interrupted. The ignition winding 10 here forms the primary winding of an induction coil whose secondary winding 60 is connected to a spark plug 61. The remaining end of the ignition winding 10 is joined by wire 11 to the fixed contact 12 of the timer. The movable contact 13 of said timer is shown attached to a lever 14. The particular form of the timer is immaterial, but in the form shown the lever 14 is controlled by the cam 70 and spring 71. The lever 14 of said timer is joined by wire 15 to the remaining terminal of the battery 1. There is a condenser 72 in parallel with the timer contacts 12 and 13, having its terminals connected to wires 11 and 15, respectively.

Referring now to Fig. 2, there is shown as heretofore the battery 1, wire 2, switch 3, wire 4, controller contacts 5 and 6, armature lever 7, and resistance 50, the relation between said parts being the same as shown in Fig. 1. The winding 8^A is the winding of the electromagnet for actuating the controller, but it also serves as the ignition winding. In this form, however, there is no secondary winding associated therewith. One terminal of said winding 8^A is connected to the armature 7 and the other terminal of said winding is joined by wire 11 to the fixed contact 12^A of the timer whose movable contact 13^A is attached to a lever 14^A. The lever 14^A is connected by the wire 15 to the remaining terminal of the battery 1.

Fig. 3 shows the same arrangement as Fig. 2 except that there is an ignition winding 10^B separate from the controller actuating winding, connected to controller actuating winding 8 and timer contact 12^A by wires 9 and 11 respectively, and except that the regulating resistance 50^A is wound on the core 80 of the controller actuating magnet instead of being located away from said core.

The operation of the system is as follows: The switch 3, shown in all of the figures, is closed or opened manually according to whether it is desired to use the ignition or

not, and will be assumed to be closed in the following explanation: Referring now to Fig. 1, the spring 71 causes the engagement of the contacts 12 and 13, except when prevented from doing so by the action of the cam 70. This cam 70 is caused to rotate by any suitable means so as to cause repeated separation and engagement of the contacts 12 and 13, the separations occurring at the instants that the sparks are desired. Immediately after the engagement of the contacts 12 and 13, current flows through the following circuit: From battery 1, through wire 2, switch 3, wire 4, contacts 5 and 6, armature 7, winding 8, wire 9, ignition winding 10, wire 11, contacts 12 and 13, lever 14 and wire 15 to the battery 1. The flow of current in the winding 8 magnetizes the core 80 and tends to pull the armature 7 downward against the action of its spring, thereby separating the contacts 5 and 6. The separation of the contacts 5 and 6 does not occur immediately upon the closing of the circuit by the timer, but is delayed an appreciable time thereafter. The cause of the delay in the action of the controller is as follows: The contacts 5 and 6 will not be separated by the action of the electromagnet, until the current in the winding 8 reaches a certain value. This value of current is herein designated the operating value. Said operating value, as will be apparent, is dependent on the general proportions and adjustment of the spring, lever and electromagnet. On account of the inductance of the circuit, contained principally or entirely in the windings 8 and 10, the operating value of the current is not reached until a certain time after the closing of the circuit by the timer. Furthermore, the controller may not act the instant that the current in the winding 8 attains the operating value. Such a delay may result from the particular mechanical construction adopted, eddy currents in the magnet core, etc. When the contacts of the controller are separated, the current, in passing from the wire 4 to the winding 8 is obliged to pass through the resistance 50. The function of the controller is to introduce the resistance 50 into the circuit after the timer has been closed a suitable time. At high speeds the controller contacts may fail to open at all, as will be explained hereinafter. The introduction of the resistance 50 into the circuit may cause the current flowing in the circuit to decrease, or it may merely limit its increase. The current, after the introduction of the resistance, tends to assume the value determined by dividing the e.m.f. of the battery by the resistance of the circuit, including regulating resistance 50. If the current be greater than this when the resistance 50 is introduced a decrease will occur. If such decrease of current occurs, however, it should not be sudden enough to cause the induction coil to deliver a spark to the spark plug 61. The construction and adjustment of the controller and the magnet operating it is preferably such that the current flowing after the introduction of the resistance into the circuit is sufficient to hold the armature 7 against the action of its spring, causing the contacts 5 and 6 to remain separated until after the circuit is interrupted by the timer. When the contacts 12 and 13 of the timer separate the current is interrupted suddenly and produces in the secondary winding 60 a high tension impulse which causes a spark to occur in the spark plug 61. The action of the timer in thus producing a spark by interrupting the circuit is like the action in ignition systems in general use, and is well understood. When the engine is being operated at high speed the timer closes the circuit for such a short time that the controller does not introduce the resistance 50 into the circuit. When running slowly, however, the timer closes the circuit for a sufficient time to allow the controller to introduce the regulating resistance into the circuit, but whether this occurs or not, the spark is produced by the action of the timer and not by the controller. The manner in which this introduction of resistance produces a desirable regulation or control of the current will be apparent from the following explanation. When the system is operated at high speed, the interval between the closing and the opening of the timer contacts, hereinafter called time of contact, is short and the inductance of the circuit sufficiently limits the value which the current attains. It is then desirable to keep the resistance of the circuit relatively low, as resistance in the battery circuit further hinders the use of current and prevents the production of satisfactory sparks. At low speed operation, however, the time of contact is so great that the inductance alone is not a sufficient limit to the current rise and it is necessary to introduce additional resistance into the circuit to prevent the current from becoming excessive. Such excessive current if permitted would necessarily exhaust the battery and possibly injure the ignition apparatus. The action of the controller in introducing resistance into the circuit at low speed operation, and failing to do so at high speed is thus seen to give the regulation desired.

Referring now to Fig. 2, when the timer contacts are engaged, current flows from the battery 1, through wire 2, switch 3, wire 4, controller contacts 5 and 6, armature lever 7, winding 8^A, wire 11, contacts 12^A and 13^A, lever 14^A and wire 15 to the battery 1. If the timer contacts remain closed a sufficiently long time the action of the core 80 on the armature lever 7 causes the resistance 50 to be introduced into the circuit as in the

previously described arrangement. Whether this occur or not, when the contacts 12^A and 13^A separate, a spark occurs between them as in the well known make and break ignition. The winding 8^A in addition to actuating the controller serves as the ignition winding. In virtue of its inductance it has the well known effect of intensifying the spark occurring when the contacts 12^A and 13^A separate.

Referring to Fig. 3, the operation is similar to Fig. 2. When the timer contacts engage, current flows from battery 1, through wire 2, switch 3, wire 4, contacts 5 and 6, armature 7, winding 8, wire 9, ignition winding 10^B, wire 11, timer contacts 12^A and 13^A, lever 14^A, and wire 15 to the battery. When the controller contacts are separated the current is obliged to traverse the resistance winding 50^A, and this winding assists in magnetizing the core 80. The inductance of the winding 10^B assists in producing the spark in the well known manner. This arrangement of the regulating resistance is particularly suited to cases where it is desirable to so adjust the controller that the operating current is in excess of the current which tends to flow when the resistance is in the circuit. The insertion of the additional turns 50^A into the circuit assists in holding the armature 7 when the current is reduced by the introduction of said turns.

Our invention is adapted to use with a timer in which the time of contact changes with change of speed. Such timers are readily constructed in durable form and permit of very accurate timing of the instant of break. Since we employ the interruption of the circuit by this timer to produce the spark the sparks are accurately timed. Thus irregular action or lag in the controller cannot affect the timing of the sparks, eliminating an objectionable feature present when an electrically operated controller or relay influences the instant of sparking. Should the controller 28 become deranged and the contacts remain separated, the system would still give good sparks at low speed. Should the contacts on the other hand, remain permanently in engagement, an excessive current would flow during low speed operation. Although this would soon exhaust the battery, yet it would not render the system immediately inoperative. Thus a derangement of the controller will not entirely disable the system immediately. This is of especial advantage on automobiles as in case of trouble of this character, the automobile may still be driven to a suitable place for repairing the system. A further advantage of the invention is the ability of the controller to adapt itself to various battery conditions. Should the battery be weak, giving a current below the operating value, the controller will fail to operate. Thus resistance will not be introduced when the current is sufficiently weak without said resistance being in the circuit. If the battery be exceptionally strong, causing the current to reach the operating value more quickly than usual, the resistance will be introduced into the circuit earlier. In illustrating different forms of the invention, there have been shown two varieties of ignition and two locations of the regulating resistance. The ignition winding has been shown both combined with the controller actuating magnet winding and separate therefrom. There are other combinations of these variations than those illustrated which will be evident to one skilled in the art. Such variations do not depart from the spirit of the invention and we therefore do not limit ourselves to the specific combinations shown here, nor to the particular methods of arranging the circuits.

We claim as our invention:

1. An igniting apparatus including in combination an ignition winding, a regulating resistance in series with said winding, and electrically controlled contact points in parallel with said regulating resistance.

2. An ignition apparatus including in combination an ignition winding, a regulating resistance, a timer, and a source of current, the aforesaid parts being connected in series, and electrically actuated controller contacts in parallel with said regulating resistance.

3. An ignition apparatus including in combination a source of current, an ignition winding, a regulating resistance in series with said ignition winding, normally closed contact points in parallel with said regulating resistance, electrical means for opening said contact points, a source of current adapted to supply current to said ignition winding and to said means for opening said contact points, and a timer adapted to control the supply of current to said winding and to said means for opening said contact points.

4. An ignition apparatus including in combination an ignition winding, a regulating resistance in series with said ignition winding, a controller responsive to the current in said ignition winding and having normally closed contacts in parallel with said regulating resistance.

5. In ignition apparatus, the combination of an ignition winding, a regulating resistance adapted to be introduced into the circuit of said ignition winding, and electromagnetic means for introducing said resistance into the circuit of said ignition winding.

6. In ignition apparatus, the combination

with a circuit including an ignition winding, a source of electric energy, and a timer adapted to produce ignition by interrupting the circuit, of means responsive to the current of said circuit and adapted to introduce resistance into said circuit when the current exceeds a predetermined value.

7. In ignition apparatus, the combination with a circuit including an ignition winding, a source of electric energy and a timer adapted to produce ignition by interrupting the circuit, of an electrically operated means adapted to introduce a resistance into said circuit when said timer is operated at relatively low speeds.

8. In ignition apparatus, the combination with a circuit including an ignition winding, a source of electric energy and a timer adapted to produce ignition by interrupting the circuit, of an electromagnetic means for varying the resistance of said circuit.

9. In ignition apparatus, the combination with a circuit including an ignition winding, a source of electric energy and a timer adapted to produce ignition by interrupting the circuit, of an electromagnetic means adapted to limit the flow of current when said timer is operated at relatively low speeds.

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