G. HONOLD & M. RALL.

STARTING IGNITION FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED OCT. 20, 1910.

1,048,162.

Patented Dec. 24, 1912.

2 SHEETS—SHEET 1.

Fig. 1.

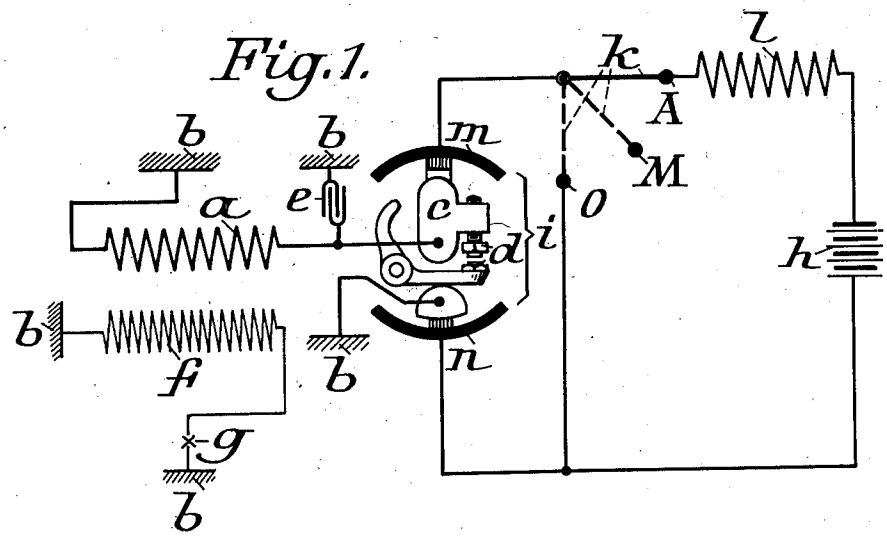
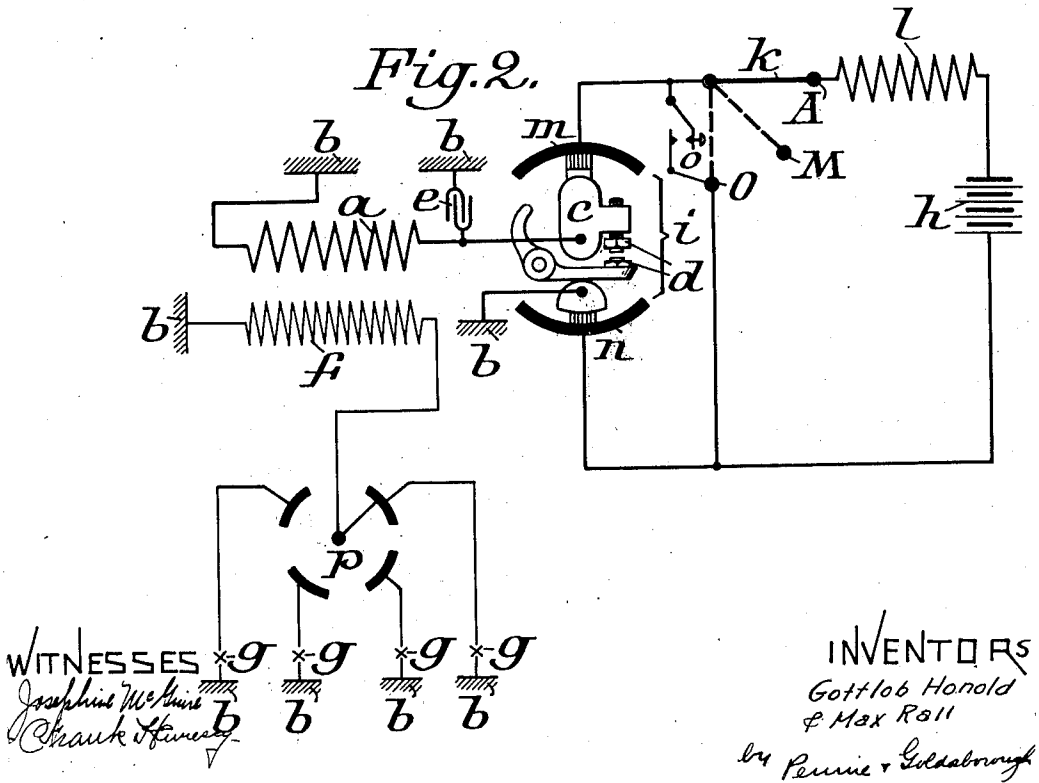


Fig. 2.



WITNESSES

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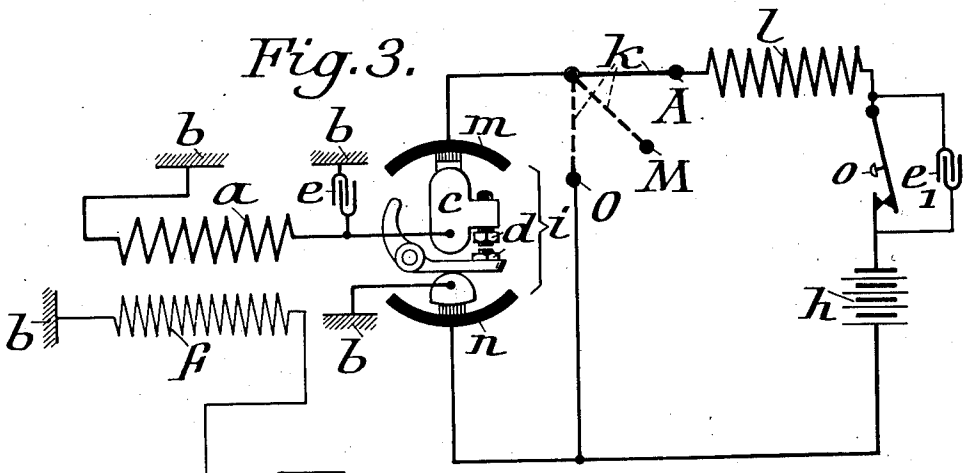
2 SHEETS—SHEET 2.

Fig. 3.



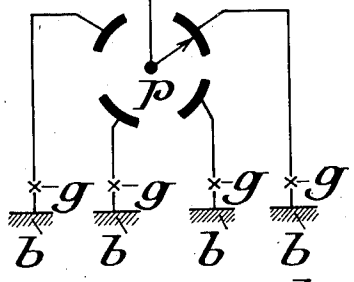
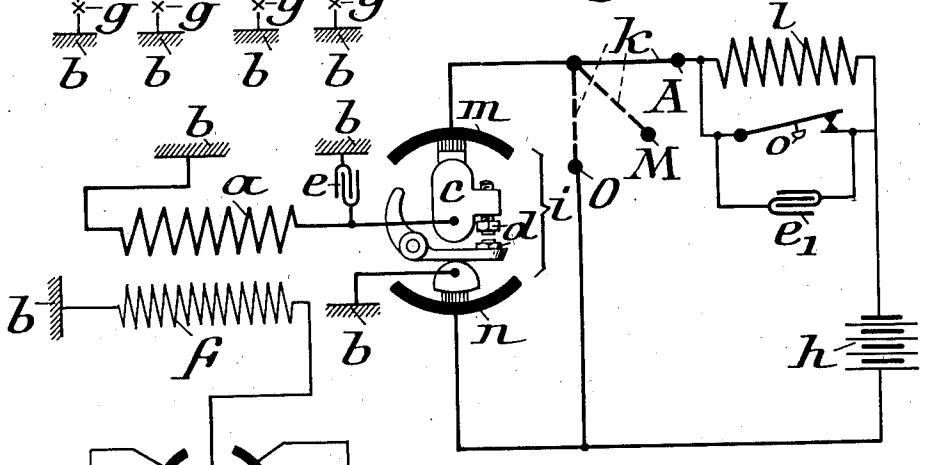
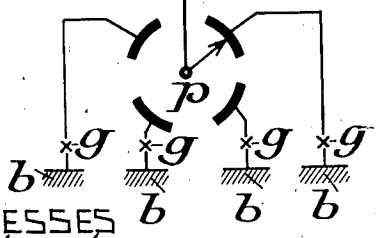


Fig. 4.





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UNITED STATES PATENT OFFICE.

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STARTING IGNITION FOR INTERNAL-COMBUSTION ENGINES.

1,048,162. Specification of Letters Patent. Patented Dec. 24, 1912.

Application filed October 20, 1910. Serial No. 588,137.

To all whom it may concern.

Be it known that we, GOTTLOB HONOLD, a subject of the Emperor of Germany, residing at Nos. 11–13 Hoppenlaustrasse, Stuttgart, Germany, and MAX RALL, a subject of the Emperor of Germany, residing at No. 17 Rue Theophile Gautier, Paris, France, respectively, have invented certain new and useful Improvements in Starting Ignition for Internal-Combustion Engines; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The invention relates to the electric ignition in combustion engines in which an electric current derived from a direct current source, such as a battery or a generator, is employed for starting, whereas an alternating current machine is employed for ignition during the subsequent period of normal running. With both kinds of ignition, the arrangement is such that the high tension current is generated in the armature winding of the alternating current machine without a special transformer coil.

It has been ascertained that when a high tension current is employed for the ignition in combustion engines, the best operation is realized where the mechanically controlled interrupter and the condenser upon the armature of the alternating current machine are arranged in direct connection with the primary winding; that is, where the primary current has no contact resistances to overcome. Therefore, electrical circuits including both rotating and stationary parts, and the sliding contacts necessitated thereby, should be avoided and only soldered, screw or similarly short and permanent connections should be employed. Furthermore, for facilitating the starting of combustion engines, it has been shown to be advantageous to employ a direct current source in addition to the alternating current machine, which at slow speed has too low an operating efficiency, so that both at starting and during running reliable ignition is assured.

The most usual ignition systems of this sort employ transformer coils for battery ignition, changing the battery current into high tension current. An arrangement of this sort is, however, rather troublesome and furthermore, is not well adapted for use where it is desirable to economize in weight as much as possible.

Methods are already known for the ignition of combustion engines which recognize the above mentioned difficulties and seek to avoid them by employing the armature winding of the alternating current machine instead of an ignition coil, so that a special ignition coil is dispensed with. In installations of this kind, however, the source of direct current supply and the commutator which serves to rectify the currents, are put in series with the primary winding on the armature of the alternating current machine and the mechanically controlled interrupter. In such arrangements there is the accompanying disadvantage that sliding contacts are present in the primary circuit of the alternating current machine, which introduce a great resistance to the flow of current and reduce the efficacy of the ignition. In contrast to these prior methods of ignition, the source of direct current supply employed for starting the combustion engine in accordance with the present invention, together with the commutator, are put in parallel with the primary circuit of the alternating current machine, whereby the two sources are opposed to one another. When a battery is employed as a source of direct current supply in this arrangement, short circuiting of the battery is prevented when the mechanically actuated interrupter is closed, and the efficiency of the battery thereby raised, by interposing a self-induction coil in the battery circuit. By this expedient, no sliding contacts are included in the primary circuit of the alternating current machine in normal operation. The commutator brushes are used only at starting, to conduct the direct current as long as the source of direct current is in circuit.

The accompanying drawings, forming a part of this specification, show, in several modifications, the necessary circuits for carrying out the new method of ignition.

Figure 1 is a diagrammatic illustration of the arrangement employed for a one-cylinder combustion engine. Fig. 2 is a diagrammatic illustration of the arrangement employed for a four-cylinder combustion engine, with a starting push-button arranged in parallel with the direct current source,

Figs. 3 and 4 illustrate modified arrangements for a four-cylinder combustion engine wherein the starting push-button is in series with the direct current source.

On the armature of the ignition machine is arranged the winding *a* having one end connected to the engine body *b* and the other end connected to the insulated interrupter contact *c* of the mechanically controlled interrupter *d*, the other contact of *d* being permanently connected to the engine body *b*. A condenser *e* is arranged in parallel with the interrupter contacts, so as to render the interruption as nearly sparkless and as quick as possible. The armature carries the primary winding *a* and also a secondary winding *f* in which is produced the high tension current for creating the sparks at the points *g*. The mechanical interrupter is mounted on the armature shaft which is rotated by the engine.

In parallel with the primary circuit of the ignition machine is arranged a branch circuit containing a direct current source such as a battery or generator *h*. In this circuit there is a commutator *i* with the segments *m* and *n* which serve to rectify the alternating current so that the coöperation of the direct current and the alternating current becomes possible. A switch *k* serves for closing the battery circuit. In order that a short circuit of the battery *h* may be prevented upon closure of the mechanically controlled interrupter *d* and closure of the switch *k*, a self-induction coil *l* is interposed in series with the battery. The push-button *o* is employed for starting the combustion engine. In the modifications shown in Figs. 3 and 4, a condenser e^1 is interposed in parallel with the push-button *o*. In Figs. 2, 3 and 4, *p* is a current distributer which, in the case of multi-cylinder combustion engines, distributes the secondary current to the individual spark plugs.

In accordance with our invention, the mode of operation of the arrangement shown in Fig. 1 is as follows: If the engine is to be started, the controlling lever *k* is brought to the point A as shown, whereby the direct current source is connected in circuit. The armature of the alternating current machine is operatively coupled with the engine so that when the engine is rotated a current is generated in the primary winding *a* of the armature of the alternating current machine, which current, when the interrupter is closed, flows by way of the insulated armature winding, and through the interrupter *d* and the engine body *b* back to the armature winding. Since the battery circuit is likewise connected at the same time to the interrupter *d*, this circuit is also short-circuited when the interrupter is closed. Then at the instant the interrupter is opened, the current from the direct current source *h*, reinforced by the current produced by the action of the self-induction coil *l*, flows through the closed contact arm *k*, commutator segment *m*, and the primary winding *a* of the armature, connected so as to be in opposite direction to the current produced by the rotation of the armature in the magnetic field. Thus if it be assumed that the two current sources are equal, the two currents are completely annulled and the current in the armature winding therefore falls to zero very quickly. By this arrangement not only does the opening of the interrupter contacts reduce the tension in the armature winding, but the oppositely directed current from the direct current source assists the operation of the interrupter in such degree that the resulting fall in tension of the current in the armature winding becomes extraordinarily sudden. Thus there is produced a considerably more powerful induction current in the secondary winding *f* of the armature than would be created by the interruption of the previously short-circuited primary winding alone. After the engine has been started in this manner, the contact arm *k* is shifted to the position M, so that only the alternating current machine is in circuit. Then the sparking proceeds in the usual manner. If the engine is to be brought to rest by interrupting the ignition, the lever *k* is shifted to the position O, whereby both current circuits are short-circuited through the arm *k* and the interrupter *d* is without effect.

In order to use the direct current source for starting those engines which automatically start from rest by ignition alone (see Figs. 2 and 3) the interrupter *d* must be in its open position. The direct current circuit is then closed by bringing the lever *k* to A and depressing the push-button *o*. In the case of Fig. 2 the following operation then results: Upon closing the push-button *o*, the direct current source is short-circuited, so that no current flows in the armature winding *a*. This short-circuit path is then quickly interrupted by releasing the push-button *o* whereupon the current from the direct current source flows through the armature winding *a*. The sudden interruption of the short-circuit of the direct current source has the further consequence that a more powerful current is produced by the induction coil *l* which then flows through the armature winding. However, since the induction current from the coil *l* has only a short duration, *i. e.*, has the character of an electrical surge, the current falls to the strength of the current from the direct current source about as suddenly as it rose. This abrupt rise and fall of the current produces in the secondary winding *f* of the armature a powerful induction current, thereby causing the ignition spark.

In the arrangement shown in Fig. 3 a uniform current flows through the armature winding *a* when the contact lever *k* is introduced into circuit and the push-button *o* is closed (normal position). Then upon opening the push-button contact, the circuit is broken and the current in the armature circuit falls abruptly to zero, whereby there is produced in the secondary coil *f* of the armature, the induction current necessary for ignition of the gas mixture as before. When the combustion engine has attained a sufficient speed of rotation, the switch-arm *k*, just as has been described with reference to the arrangement of Fig. 1, is brought into position M; and for subsequently cutting off of the ignition, it is brought to point O. The arrangement according to Fig. 3, can also be altered with advantage in the manner disclosed in Fig. 4, in which the push-button *o* is placed in parallel with the induction coil *l*. In this way the current from the battery does not flow through the induction coil when *o* is depressed.

The constructive features for our invention can be embodied, for instance, in two commutator brushes attached to the mechanically controlled interrupter of a high tension ignition machine. One of these brushes is mechanically secured to the insulated part *c* of the interrupter and the other is supported from that member of the interrupter which is connected to the frame of the alternating current machine. The current from the direct current source is conducted to both of these brushes through two stationary segments, which are separated from one another by insulating material. The arrangement may also be so chosen that both segments of the commutator rotate with the interrupter while the current of the direct current source is conducted to these segments through two carbon brushes.

In order that reliable ignition may be assured, and, so that, in the case of the employment of a battery as direct current source, the battery may not become short-circuited when the contacts of the interrupter touch each other, there is interposed between the battery and one segment the induction coil *l*, which serves primarily as resistance, but can, at the same time, be employed for producing a surge as described above. However, when a sufficiently strong battery is available, for example, a battery having a terminal voltage of 50 volts, a non-inductive ohmic resistance can be used in place of the self-induction coil *l*, which resistance is high enough to prevent the flow of too much current from the battery. If, however, a direct current dynamo is employed in place of the battery, the induction coil may be entirely omitted.

The described method of ignition may be employed to advantage with one-cylinder engines, as well as with multi-cylinder engines, with the result that starting by means of the external direct current source is materially assisted. With four- and six-cylinder engines it becomes possible with my invention to start by means of a push-button, a special transformer being unnecessary.

The essential character of the invention would not be altered if, for facilitating the starting by means of a push-button, an electro-magnetic self-interrupter were inserted in the push-button circuit. The push-button itself can be arranged either in parallel with the battery or in series with it. Likewise, condensers can be interposed in parallel with the push-button circuit.

Having thus described our invention, what we claim is:

1. In an ignition system for internal combustion engines, two electrical circuits, a mechanical interrupter common to both of said circuits, an alternating current machine having a primary winding and a secondary winding, said primary winding being connected in one of said circuits, and a source of direct current connected in the other of said circuits; substantially as described.

2. In an ignition system for internal combustion engines, two electrical circuits, a mechanical interrupter common to both of said circuits, an alternating current machine having a primary winding and a secondary winding, said primary winding being connected in one of said circuits, and a source of direct current and a commutator connected in electrical series in the other of said circuits; substantially as described.

3. In an ignition system for internal combustion engines, two electrical circuits, a mechanical interrupter common to both of said circuits, an alternating current machine having a primary winding and a secondary winding, said primary winding being connected in one of said circuits, and a source of direct current and a self induction coil connected in electrical series in the other of said circuits; substantially as described.

4. In an ignition system for internal combustion engines, two electrical circuits, a mechanical interrupter common to both of said circuits, an alternating current machine having a primary winding and a secondary winding, said primary winding being connected in one of said circuits, and a source of direct current, a commutator and an induction coil in electrical series in the other of said circuits; substantially as described.

5. In an ignition system for internal combustion engines, two electrical circuits, a mechanical interrupter common to both of said circuits, an alternating current machine having a primary winding and a secondary

winding, said primary winding being connected in one of said circuits, a source of direct current, a commutator and a self induction coil in electrical series in the other of said circuits, and a switch in said last named circuit adapted to suddenly interrupt the current from the direct current source; substantially as described.

6. In an ignition system for internal combustion engines, two electrical circuits, a mechanical interrupter common to both of said circuits, an alternating current machine having a primary winding and a secondary winding, and a source of direct current in electrical series with a commutator, the said primary winding being so connected in one of said electrical circuits that its current is opposed to the current from the direct current source in the other of said circuits; substantially as described.

7. Mechanism for initiating ignition in combustion engines comprising the combination with an alternating current ignition machine having a primary and a secondary circuit, a spark plug in the secondary circuit and a mechanical interrupter in the primary circuit, of a direct current source connected in parallel with the primary circuit of the ignition machine through the mechanical interrupter, and mechanism for suddenly varying the current flowing from the direct current source, whereby when the machine is at rest with the interrupter open the current from the direct current source may be directed through and suddenly varied in the primary circuit of the alternating current machine to generate a sparking potential in the secondary circuit thereof; substantially as described.

8. In an ignition system for internal combustion engines, two electrical circuits, a mechanical interrupter common to both of said circuits, an alternating current machine having a winding connected to one of said circuits, a source of direct current connected in the other of said circuits, and a commutator electrically connected to the alternating current machine and to the source of direct current in such manner that the rectified current from the machine is opposed to the current from the direct current source to thereby prevent demagnetization of the field of the machine by the direct current source when the electrical path through the mechanical interrupter is open; substantially as described.

In testimony whereof we affix our signatures, in presence of two witnesses.

GOTTLOB HONOLD.
MAX RALL.

Witnesses as to Gottlob Honold:
MAX ANSCHUTZ,
REINHOLD ELWORT.
Witnesses as to Max Rall:
EUGÉNE SERRE,
LÉON PETIT.