

D. B. HUGHES.
IGNITION SYSTEM.

APPLICATION FILED APR. 27, 1910. RENEWED SEPT. 25, 1914.

1,138,569.

Patented May 4, 1915.

Fig. 1.

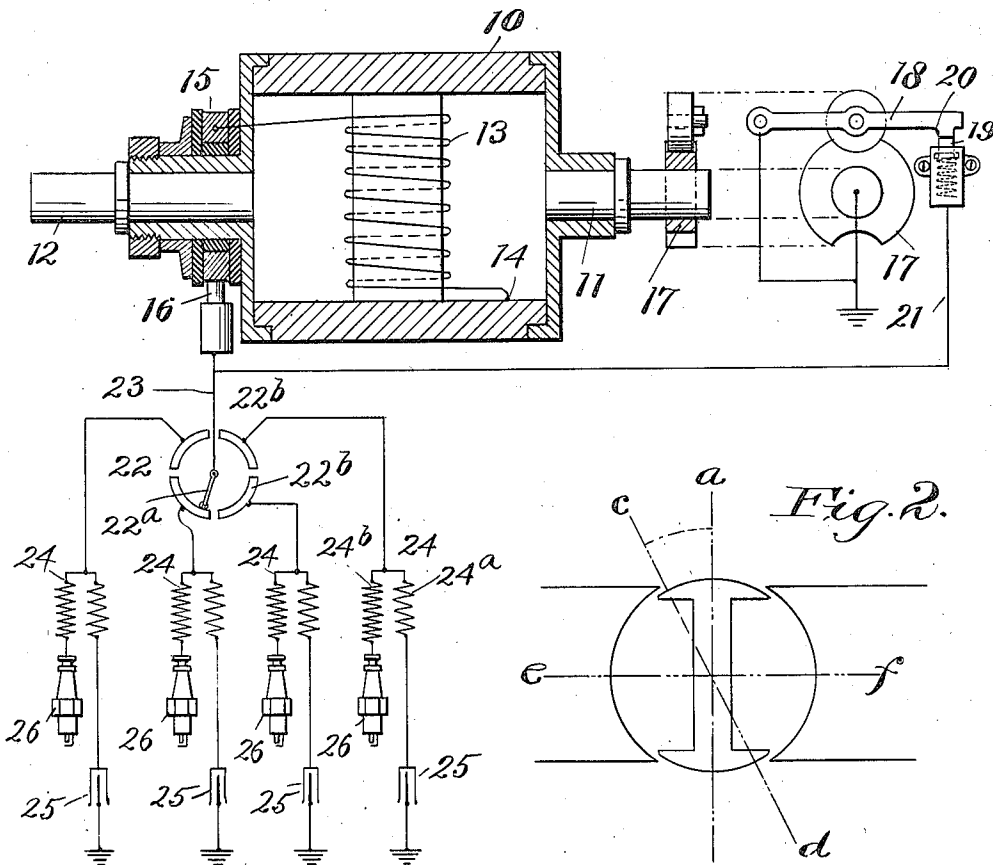


Fig. 2.

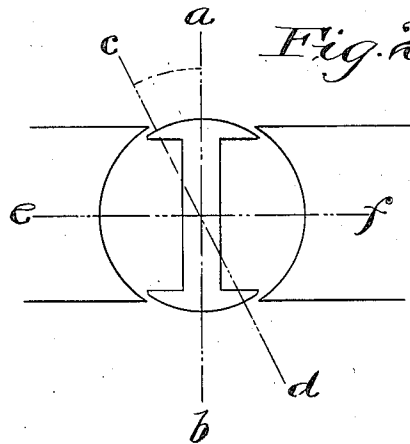
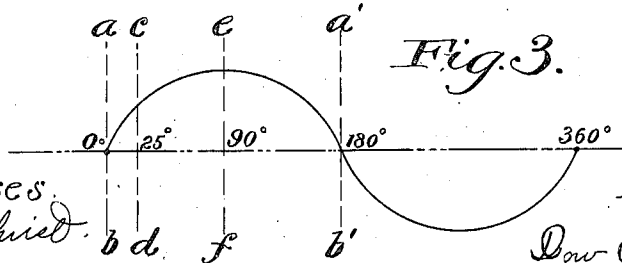


Fig. 3.



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UNITED STATES PATENT OFFICE.

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IGNITION SYSTEM.

1,138,569.

Specification of Letters Patent.

Patented May 4, 1915.

Application filed April 27, 1910, Serial No. 557,889. Renewed September 25, 1914. Serial No. 863,550.

To all whom it may concern:

Be it known that I, Dow B. HUGHES, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Ignition Systems, of which the following is a full, clear, and exact description.

This invention relates to ignition systems for internal combustion engines and is designed as an improvement over an ignition system disclosed in my pending application, filed April 2nd, 1910, Serial No. 553,111.

The specific objects of the present invention are to provide a system which is more satisfactory in operation than the one disclosed in my pending application referred to, and to simplify the construction of parts and the number and arrangement of electric conductors and connections, and to reduce the cost of construction and installation.

In accordance with the present invention, I employ in connection with a suitable source of current, such as a magneto having a low voltage winding, suitable means for making and then breaking a short circuit about the winding and connect the winding to a distributor, the stationary segments or contacts of which are each connected to one of the spark plugs to a disruptive discharge coil and to a condenser. Each condenser which is connected to one of the distributor segments is connected to ground in series with the primary of the corresponding disruptive discharge coil and in shunt to the corresponding spark plug and the secondary of the coil, the secondary and spark plug being in series.

The voltage of the generator is ordinarily insufficient to establish arcs across the terminals of the spark plugs, but with the arrangement above described, by temporarily short-circuiting the armature winding, and then opening the same, the condenser which is in circuit with the segment which happens to be connected to the armature winding through the movable member of the distributor is charged and discharged with great rapidity, setting up in the primary which is in series with that condenser, a high frequency current of high voltage but of extremely low amperage. The high frequency current induces a high frequency

current in the corresponding secondary, and this induced high frequency current establishes an arc of low heat value across the terminals of the spark plug connected to that secondary and thereby reduces the resistance of the air gap to an extent such that this arc of low heat value is followed up by an arc of high heat value produced by magneto current, the voltage of the magneto being sufficient to establish the arc of high heat value when the resistance of the air gap is reduced. The make and break device and distributor are so timed that by the movement of the distributor arm, high frequency currents are induced in the different spark plug circuits successively, causing arcs of low heat value which are followed up by the arcs of high heat value in the manner above described.

Preferably, the short circuiting of the magneto winding takes place when the magneto armature is at or substantially at its vertical position between the field poles, and the short circuit continues while the armature turns through a suitable arc or fraction of a revolution and is sweeping into the magnetic field and building up the voltage so that when the short circuit is broken and the high frequency current is induced in one of the spark plug circuits, the magneto voltage will be sufficient to establish the arc of high heat value. This arc of high heat value having been established between the electrodes, it continues for a considerable period and, in fact, it continues until after the armature has been moved through a considerable arc and has passed beyond the position of highest voltage.

The invention may be further briefly summarized as consisting in certain novel combinations and arrangements of parts which will be described in the specification and set forth in the appended claims.

Reference is had to the accompanying sheet of drawings wherein—

Figure 1 is a diagrammatic view of my improved ignition system for a four cylinder engine, parts on the magneto armature shaft being projected at right angles so as to show more clearly the operation and electric connections; Fig. 2 is a diagrammatic view of a portion of the fields and armature of the magneto and showing by dotted lines the approximate positions of the armature when the armature winding is short circuited, and

when the short circuit is broken; Fig. 3 is a sine voltage curve showing graphically the approximate comparative voltages when the winding is short circuited and opened.

Referring now to the figures of the drawing, and first to Fig. 1, 10 represents the magneto armature which is supported on shaft sections 11 and 12 and is provided with a single low voltage winding 13, one end of which is grounded at 14, and the other end of which is connected to a collector ring 15 which is supported on shaft section 12, and is engaged by a brush 16. At the opposite side of the generator from the ring 15 is a make and break device for short-circuiting and opening the short circuit of the armature winding, this make and break device including a cam 17, a lever 18 adapted to be shifted by the cam, and a contact member 19 adapted to be engaged by a corresponding contact member 20 on the lever, this contact member 19 being insulated from the frame work of the machine and being connected by a conductor 21 to the brush 16. The cam is constructed in a manner such that at each half revolution thereof, the contact members 19 and 20 are brought into engagement, and therefore, as the cam and lever 18 are both grounded, the armature winding will be temporarily short-circuited upon itself at each half revolution. The cam and lever are shown in Fig. 1, for the sake of clearness, as grounded by conductors, but in reality, the cam is grounded by being mounted on the grounded shaft section 11, and the lever 18 will be grounded by being pivoted upon a portion of the magneto frame.

At 22 is shown a distributor or timing device which, for a four-cycle four cylinder engine will be driven at one half magneto speed, and which is provided with a movable distributor arm 22^a, and stationary contacts or segments 22^b, the former being permanently connected by a conductor 23 to the brush 16 which engages the collector ring 16, to which one end of the armature winding is connected. The distributor arm is therefore at all times electrically connected to the armature winding. Each of these segments 22^b is connected through the primary 24^a of a disruptive discharge coil 24 and through a condenser 25 to ground, and is also connected through the secondary 24^b of the disruptive discharge coil to one of the spark plugs 26, one terminal of which is, of course, grounded. The primary of the coil and condenser are therefore in shunt to the secondary of the coil and the spark plug. The condensers 25 have small capacity, as compared with the condensers ordinarily employed in ignition systems, and in fact, I find that a condenser formed of substantially twenty square inches of tin-foil arranged in strips and separated by mica, pro-

duces very good results, whereas the condenser ordinarily employed in an ignition system contains hundreds of square inches of tin-foil. Also the disruptive discharge coils have very low reactance, this condition being secured by providing coils without cores and having small numbers of turns in the primaries and secondaries. In fact, the coils and condensers being very small, I prefer to place the condenser and also the corresponding disruptive discharge coil in a small case, each of which may be mounted on one of the cylinders of the engine.

It will be seen that, as the magneto and distributor arms are rotated, the different segments of the distributor and consequently the different spark plugs are successively connected to the armature winding, and by driving the distributor at one half the speed of the magneto and by providing a make and break device which short circuits the armature winding and then opens the same twice at each revolution of the magneto, as the distributor arm passes onto one of the segments, the armature is short circuited and remains short-circuited for a fraction of a revolution of the armature, and is then opened. By opening the short-circuit, the condenser 25, which is connected to that segment, is charged and discharged, causing a high frequency current to be set up in the primary 24^a to which the condenser is connected, and this high frequency current which is of high voltage but almost negligible amperage, induces a high frequency current in the corresponding secondary 24^b. This induced high frequency current being of very high voltage, although of low amperage, causes an arc of low heat value to be established across the corresponding spark plug. This arc is of insufficient heat value to ignite the explosive mixture in the cylinder of an engine, but it reduces the resistance of the air gap of the spark plug to an extent such that the magneto current at the generated voltage will establish a flaming arc of high heat value at the spark plug, the current passing directly from the distributor arm to the segment previously referred to, and into the plug through the secondary of the induction coil. The condenser or high frequency circuit does not include the armature winding because of the make and break device which, as before stated, is in shunt to or short circuits the armature winding. On the opening of the make and break device the latter serves as a spark gap device across which the condenser is disruptively discharged. As the distributor arm passes to the next segment, the armature winding is again short circuited and then opened, causing the condenser connected to the second segment to set up a high frequency current which induces in the

secondary of the disruptive discharge coil connected to the second segment, a high frequency current, which in turn creates an arc of low heat value at the second spark plug, this arc being followed up while the distributor arm is still on the second segment by an arc of high value produced by the magneto current at the generated voltage. This action continues at the different spark plugs as the distributor arm passes from segment to segment.

Preferably, as before stated, the armature winding is short circuited by the make and break device when the armature is substantially vertical or in the position shown in Fig. 2, and indicated by the line *a-b*, and the armature winding remains short-circuited while the armature sweeps through a small arc, preferably of substantially 25 degrees, or until the armature reaches substantially the position indicated by the line *c-d*. At this time, the voltage is being built up as indicated by the sine curve shown in Fig. 3, and when the position *c-d* is reached and the short circuit is broken, the voltage is sufficient to establish the arc of high heat value after the arc of low heat value is formed. After the short circuit is broken, the voltage builds up until the armature reaches the position indicated by the line *e-f* in Figs. 2 and 3, which is the position for maximum voltage, and when the armature reaches the position 180 degrees from the line *a-b*, indicated by the line *a'-b'*, Fig. 3, the voltage has again dropped to zero, at which time the distributor arm passes to the next segment and the armature winding is again short circuited by the make and break device.

The arc of high heat value continues for a considerable period at the spark plug and it may continue from the armature position *c-d* nearly to the position *a'-b'*, or to a position such that the voltage has dropped from its maximum value at the position *e-f* to a value such that it is no longer able to maintain the arc. The arc of high heat value is established during the continuance of the arc of low heat value, the latter sustaining or carrying the arc, so to speak. Largely to this do I attribute the fact that the arc of high heat value may be maintained for a considerable period by voltage considerably lower than that heretofore thought possible in low tension ignition apparatus. By establishing and continuing the arc in this manner, total ignition of the gas in the engine cylinder takes place, and consequently all the available potential energy in the cylinder is made use of.

A further advantage of applicant's system is that very little electrical energy is expended in establishing the igniting arc, particularly as the first arc, or the resistance decreasing arc is not created by an ordinary

generated direct or alternating current, but by a current in the nature of a static current which has an almost negligible amperage. Furthermore, the electrical connections can be easily made and few conductors are required; the conductors that are exposed are low voltage conductors; and the magneto is inexpensive to manufacture, inasmuch as it has a single low voltage winding which does not require high voltage insulation.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In an ignition system, a plurality of spark plugs, a source of current, a distributor having its movable member connected to said source of current, a disruptive discharge coil and a condenser for each spark plug, each of the stationary members of the distributor being connected to a spark plug, to a disruptive discharge coil, and to a condenser, and a make and break device co-operating with said source of current, the condensers being connected to the distributor in series relation with the primaries of the different coils, and the spark plugs and secondaries being connected through the distributor to the source of current independently of the condensers and of the make and break devices.

2. In an ignition system, a source of current, means for making and breaking a short circuit about said source of current, a distributor having its movable member connected to said source of current, a plurality of spark plugs, a disruptive discharge coil and a condenser for each spark plug, each of the stationary members of the distributor being connected to a condenser and to a primary of a disruptive discharge coil in series relation, and being connected to a spark plug and to the secondary of the disruptive discharge coil, the secondary and spark plug being in series relation.

3. In an ignition system, a magneto having an armature winding, means for making and breaking a short circuit about the armature winding, a distributor having its movable member connected to the winding, and a disruptive discharge coil and condenser for each spark plug, each of the stationary members of the distributor being connected to a spark plug and to the secondary of a disruptive discharge coil in series relation and being also connected to the primary of the coil and to a condenser in series relation.

4. In an ignition system, a magneto having an armature winding, one end of which is grounded, a distributor having a movable member connected to the opposite end of the winding, a make and break device for making and breaking a short circuit about the armature winding, a plurality of spark plugs, a disruptive discharge coil and a con-

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 denser for each spark plug, each of the stationary members of the distributor being connected to ground through the primary of a disruptive discharge coil and condenser, and each being connected to a spark plug through the secondary of the disruptive discharge coil.

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 10 5. In an ignition system, a magneto having an armature winding, one end of which is grounded, a distributor having its movable member connected to the armature winding, a plurality of spark plugs, a disruptive discharge coil and a condenser for each spark plug, each of the stationary members
 15 of the distributor being connected to ground through a condenser and a primary of a disruptive discharge coil, and being connected to ground through the secondary of the coil and through a spark plug; the
 20 condenser and primary being in series relation and being in shunt to the secondary and the spark plug which are in series relation, and means for making and breaking a short circuit about the armature winding.

25 6. In an ignition system, a generator, having a winding with means for temporarily and periodically short-circuiting the same, a plurality of spark plugs, a distributor having its movable member connected to the
 30 winding and having stationary contacts connected to the different spark plugs, a condenser connected to each of the distributor contacts, a plurality of disruptive discharge

coils, each having a primary connected to the condenser and a secondary connected to a spark plug. 35

7. In an ignition system, a source of current, a plurality of spark plugs, a disruptive discharge coil and a condenser for each spark plug, each condenser and a primary of one coil being in series relationship, and a spark plug and the secondary of the same coil being in series relationship, and means including a distributor for establishing connection between the source of current and the different condensers, and also between the source of current and the different spark plugs. 40 45

8. In an ignition system, a source of current, a make and break device associated therewith, a plurality of spark plugs, a distributor having its movable member connected to the source of current and having stationary contacts connected to the different spark plugs, a condenser connected to each of the distributor contacts, a plurality of disruptive discharge coils, each having a primary connected to a condenser, and a secondary connected to a spark plug. 50 55

In testimony whereof, I hereunto affix my signature in the presence of two witnesses. 60

DOW B. HUGHES.

Witnesses:

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 A. F. KWIS.