No. 882,003. PATENTED MAR. 17, 1908.

E. S. HUFF.

ELECTRICAL IGNITING APPARATUS.

APPLICATION FILED JULY 1, 1905.

2 SHEETS—SHEET 1.

Fig. 5.

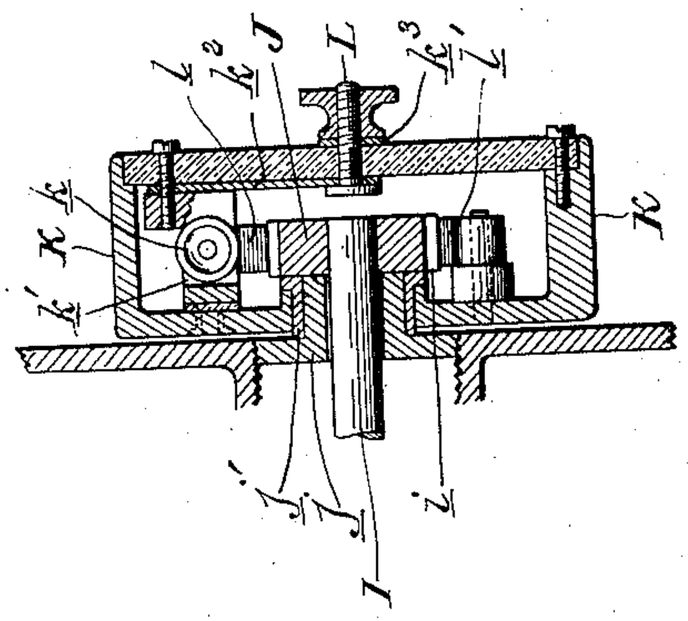
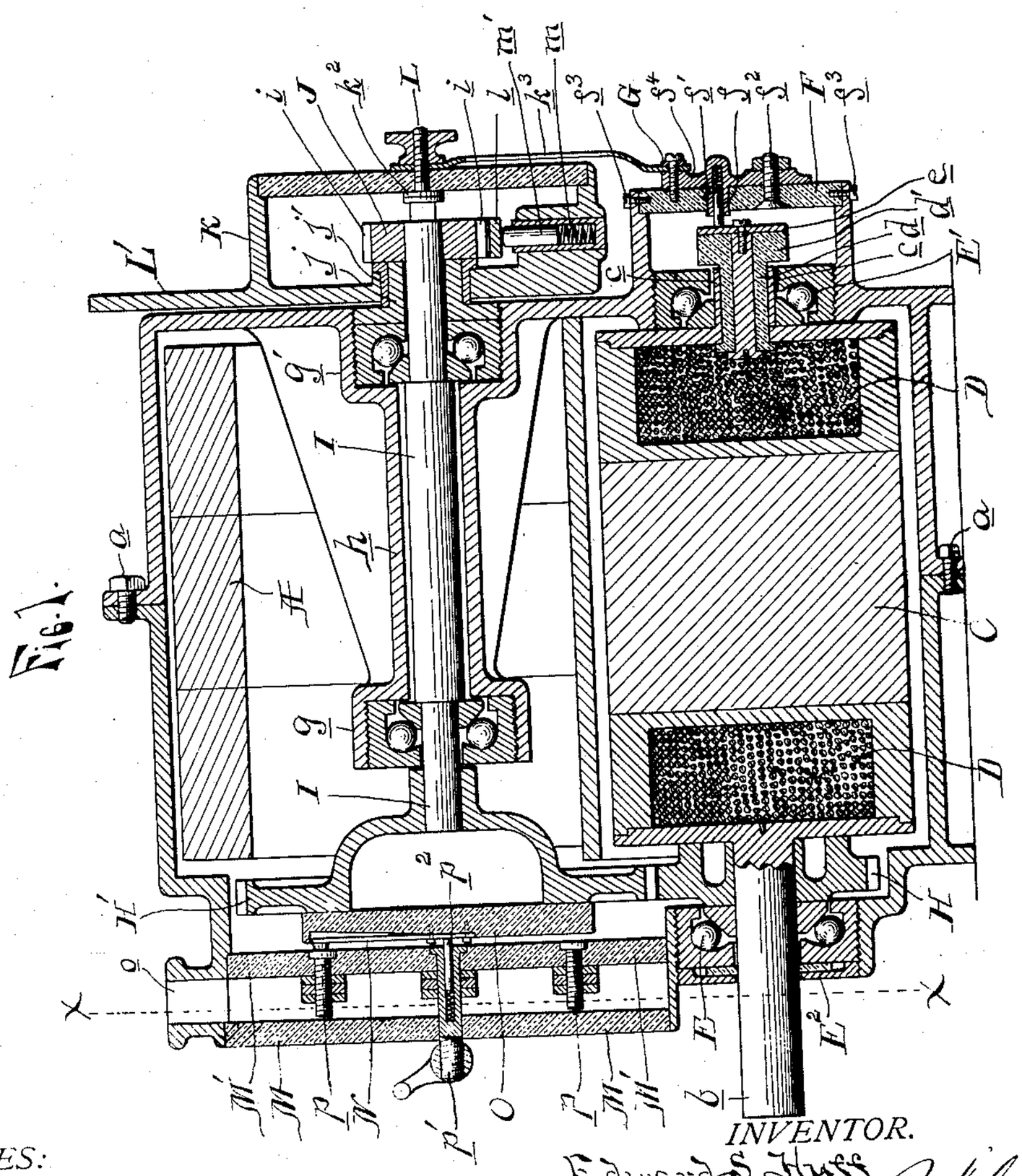


Fig. 1.



WITNESSES:

Lewis E. Flanders

Thos. S. Longstaff.

INVENTOR.

Edward S. Huff

BY Baldwin & Baldwin

ATTORNEYS

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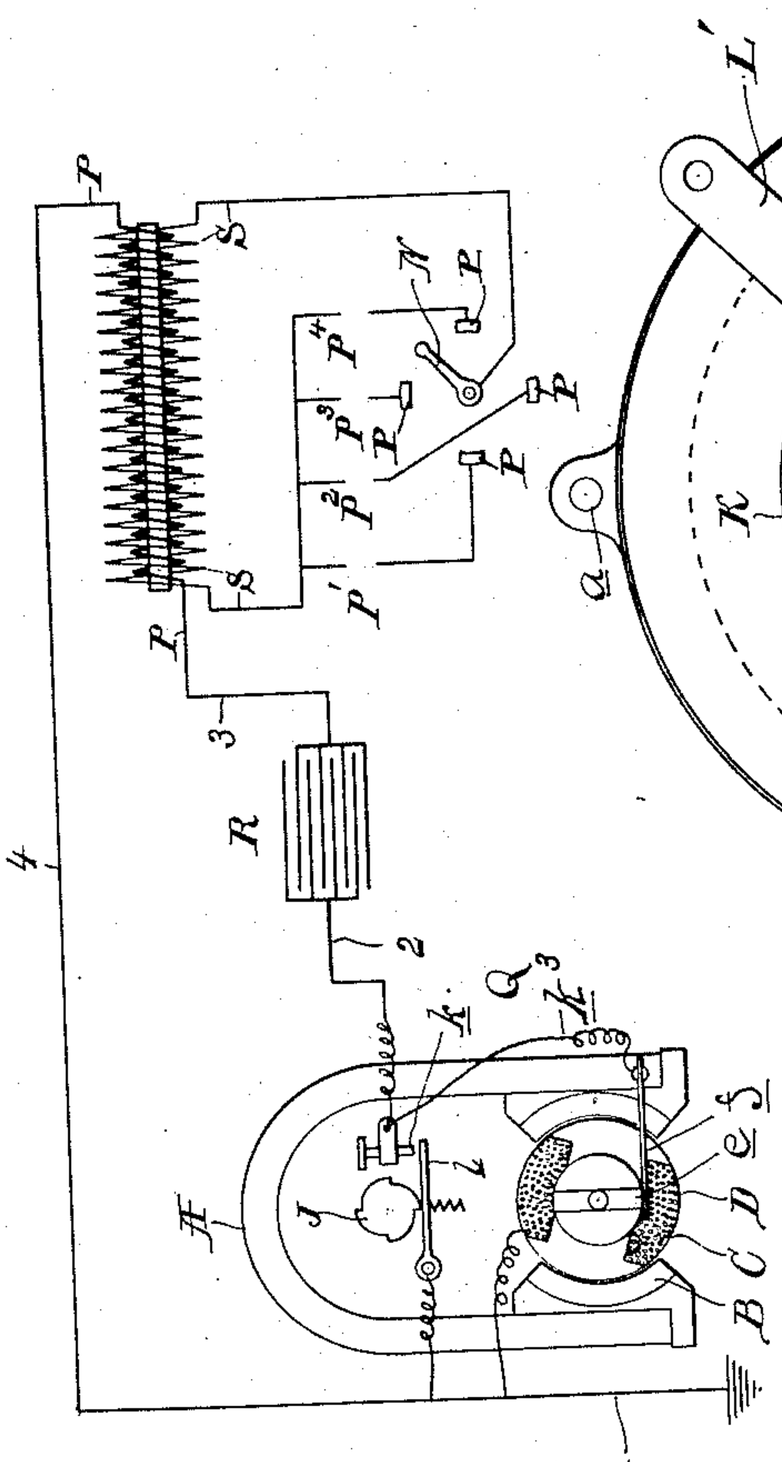

Fig. 2.

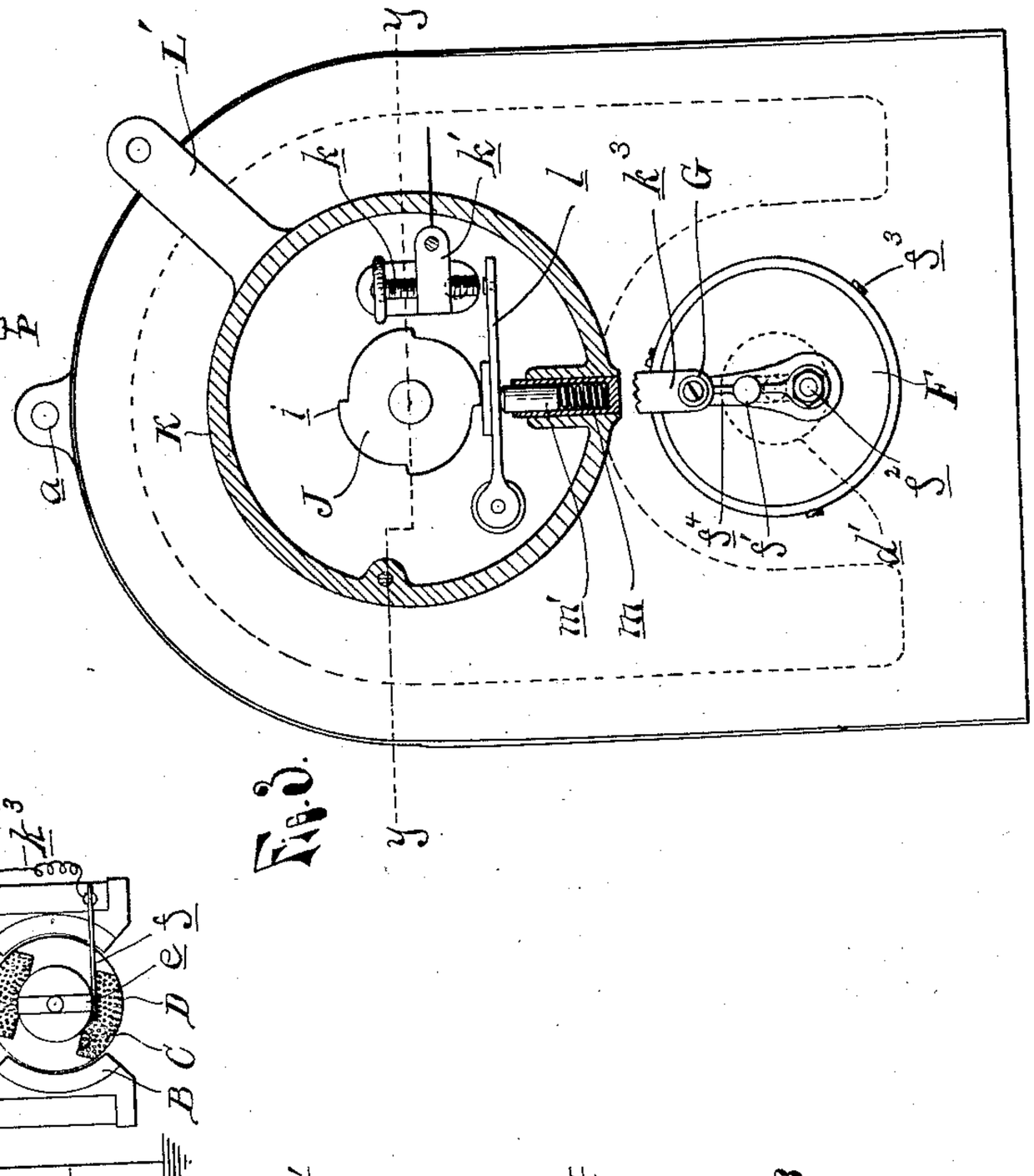

Fig. 3.

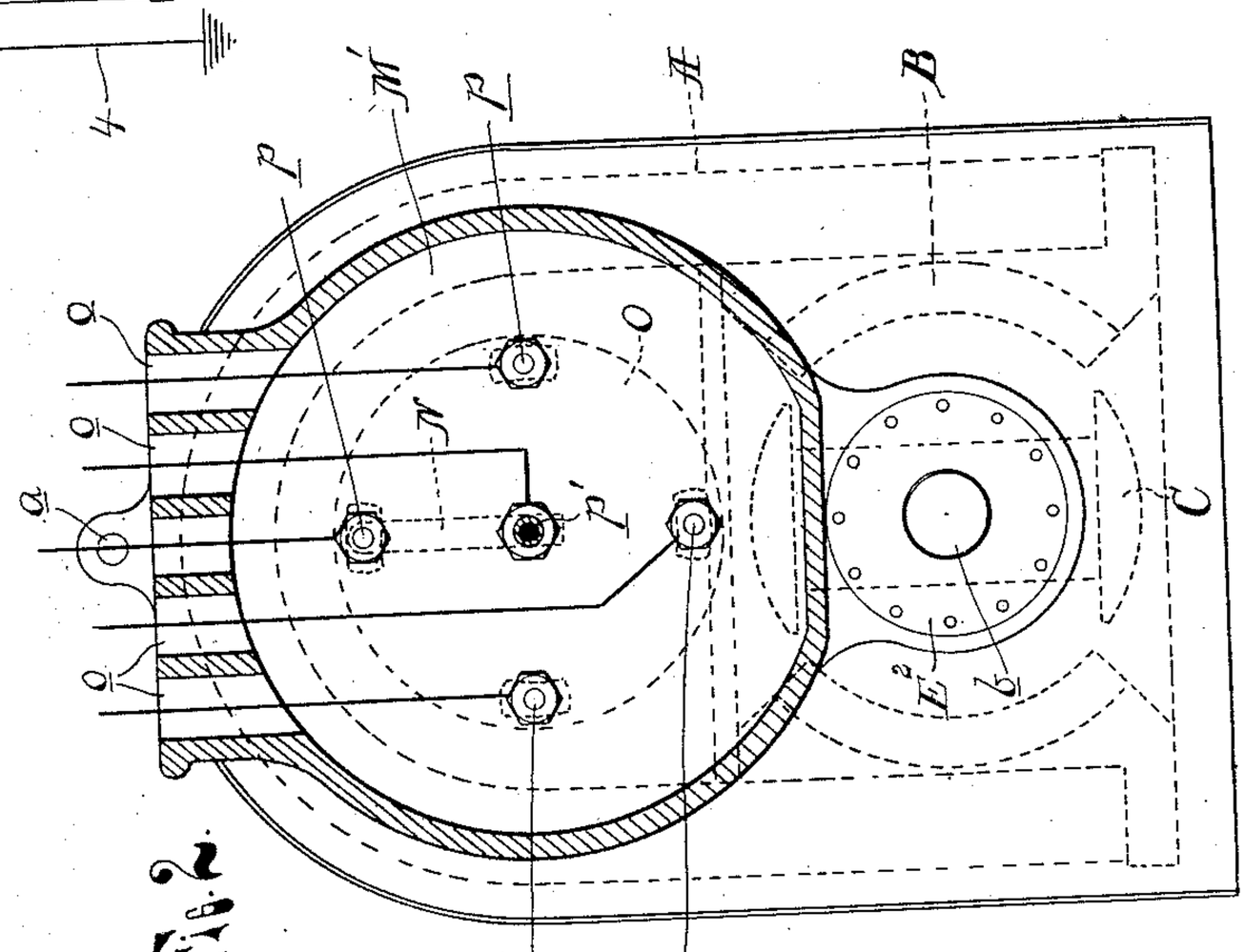

Fig. 4.

WITNESSES:

Lewis E. Flanders

Thos. S. Longstaff.

INVENTOR.

Edward S. Huff

BY Bartlett & Bartlett

ATTORNEYS

UNITED STATES PATENT OFFICE.

EDWARD S. HUFF, OF DETROIT, MICHIGAN, ASSIGNOR TO HENRY FORD, OF DETROIT, MICHIGAN.

ELECTRICAL IGNITING APPARATUS.

No. 882,003.

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Application filed July 1, 1905. Serial No. 267,923.

To all whom it may concern:

Be it known that I, EDWARD S. HUFF, a citizen of the United States of America, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Electrical Igniting Apparatus, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to electric igniters for explosive engines and the like and has for its particular object to provide a simple compact and effective apparatus for the successive firing of the charges in multi-cylinder engines. To this end I have devised an improved apparatus which involves the production of a jump spark at the respective sparking terminals in the different cylinders of the engine at the moment required wholly from the periodic discharges of a condenser in the primary of an induction coil, the secondary of which contains in different branches thereof the aforesaid sparking terminals. As the discharges from a condenser are instantaneous an efficient spark will always be produced at the proper moment and means are provided in connection therewith to advance or retard it as may be desired for the control of the engine.

My invention also involves the use of a magneto-electro-machine operating in connection with a charging circuit for charging the condenser in the interval between the discharges, all as more fully hereinafter described and shown in the accompanying drawings, in which

Figure 1, is a vertical central section through the magneto generator of the apparatus; Fig. 2, a vertical cross section thereof substantially in the plane *x*—*x* Fig. 1; Fig. 3, an end elevation of Fig. 1, partly in section; Fig. 4, a diagrammatic representation of the whole apparatus, and Fig. 5, a horizontal section on line *y*—*y* Fig. 3.

A represents the permanent magnet of an electro-magnetic generator, B the pole pieces thereof between which the armature rotates, C the armature and D the conductor wound thereon, the armature being of the common H type.

The whole generator is inclosed in a dust proof outer casing preferably of cast aluminium and constructed in two halves secured together by bolts *a*. The lower part of this casing has openings in its opposite ends concentric with the armature shaft and E is a ball bearing secured in one of the openings for the support of the end *b* of the armature shaft which passes through the bearing and carries on its free outer end the drive connection (not shown) of the armature with a moving part of the engine. In the opposite opening of the casing are secured the ball bearing E′ and the insulating disk F. The end *c* of the armature shaft is supported in the ball bearing E′; it is hollow and contains an insulating bushing *d* terminating in a contact disk *d*′ which carries a metallic contact strip *e* extending diametrically across it and in electrical connection with one terminal of the conductor D, the other terminal being secured to the end *b*, which grounds it on the frame of the generator.

The insulating disk F carries a binding post G which is electrically connected through an arm f^4 with the fixed brush or contact pin *f* contained in a bushing *f*′ formed on the arm, the free end of the latter being secured to the disk by a binding screw f^2. The contact pin is pressed against the contact disk by a small coil spring and operates to periodically contact with the contact strip twice in each revolution of the armature during the periods when the potential of the generated current rises to its highest point.

The disk F is removably held in position by screws f^3 and fits tight into the opening on the casing while at the opposite end of the armature shaft a dust guard E^2 is secured in the opening of the casing. Upon the end *b* of the armature shaft is secured a gear wheel H and this meshes with a gear wheel H′ fast upon one end of the shaft I directly above the gear wheel H. The shaft I is journaled in ball bearings *g g*′ which are supported in opposite ends of a hollow arm *h* integrally cast with one of the halves of the casing and projecting into the casing. The shaft I projects at one end through the casing and carries upon its free end a cam wheel J which carries as many cam projections *i* as there are spark plugs to the engine. This cam is inclosed within a housing K rotatively and adjustably mounted upon the generator casing by means of a hollow nipple *j* secured in the hollow arm and having a bearing sleeve *j*′ mounted upon it. The front wall of the housing, which is removable and of insulating material carries a binding post L in elec-

trical connection through a copper strip k^2 with a post k' secured to but insulated from the housing and carrying the adjustable contact screw k adapted to contact with a movable contact l pivotally secured at l' in electrical connection with the housing and thereby with the frame of the generator. The binding post G is also connected through a copper strip k^3 with the binding post L. The movable contact l is urged into contact with k by a small coil spring m pressing upon the movable pin m', but it is periodically forced out of contact therewith by the cam projections i on the revolving cam J.

The housing K has an arm L' which is suitably connected with operating mechanism (not shown) whereby its rotative adjustment is brought under the control of the driver for the purpose of advancing or retarding the spark as will be more fully hereinafter described.

The gear wheel H' revolves within an extended opening in the side of the casing and in the outer end thereof are removably secured two insulating disks M M' spaced apart by suitable shoulders formed in the opening of the casing and contact studs p are carried by the disk M' and circularly grouped around the center thereof. These studs form binding posts for the branches of the secondary circuit of an induction coil which leads to one of each pair of electrodes of the spark plugs of the engine, the other electrode of each pair being as usual in electrical connection with the frame of the engine. The contact studs p pass through the inner disk M' and form enlarged contacts upon the inner wall thereof and a central contact stud p' which forms one terminal of the secondary circuit is formed with a socket in its inner end containing a small coil spring and a loose pin p^2 which is urged inwardly by the spring into contact with a spring contact arm N. This contact arm N is secured upon an insulating plate O carried by the gear wheel H' all so arranged that at each revolution of the shaft I the contact arm N successively makes contact with one of the contact studs p synchronously with that of the contact plate l and contact k and as the gear wheel H' is just twice the diameter of the gear wheel H the arm N will successively contact with the contacts p at the same intervals of time as between the closing of the contacts e and f, however the closing does not take place at the same time but at intervals one after another as will be more fully explained hereinafter.

The wall of the casing inclosing the insulating disks M and M' closes the space between the disks except on top which is formed with openings c through which the conducting wires from the contact studs p p' are carried to their different connections. By this construction and arrangement of parts the electrical contact devices together with the generator are all inclosed within a dust proof casing of non-magnetic but conducting material and at the same time all the parts are readily accessible for inspection or other attention required, all of which is an important advantage for the efficient and reliable working of the apparatus, special attention being given to light running obviating the use of a lubricant, and for fastening all parts securely together, so that vibrations or jars cannot affect them.

My apparatus embodies further an induction coil and a condenser, these may be of any known construction and being of known operation no special description thereof is necessary further than to say that they will be inclosed by themselves in a tight casing (not shown).

Passing now to the description of the apparatus as a whole reference is made to Fig. 4, wherein Q denotes the generator, R the condenser, P and S the primary and secondary respectively of an induction coil and P' P^2 P^3 P^4 the pairs of electrodes forming the spark gaps of the igniting circuits, the other reference letters referring to the corresponding parts of the other figures except that the reference numerals 2, 3 and 4 are used to designate the conductors of the primary circuit.

The circuit connections are made as follows: One terminal of the armature conductor is connected to the contact e and the other is grounded on the frame; the brush f is electrically connected by conductor k^3 to the contact screw k; a conductor 2 connects the contact k with one side of the condenser and the other side of the condenser is connected through a conductor 3 with the primary P of the induction coil. The other terminal of the primary and the movable contact l are grounded on the frame of the generator (or engine) which is represented by conductor 4 and the secondary S has one terminal in electrical connecton with the arm N and the other terminal thereof is in electrical connection with one electrode of each spark plug, the other electrode of said plugs being in electrical connection with the contacts p through separate branches. By means of these connections, the generator is serially connected with the primary and with the condenser into a circuit which forms the charging circuit of the condenser and this circuit is wholly controlled by the circuit controller formed of the contacts e f; the condenser however is included in a separate circuit with the primary through the conductors 2, 3 and 4 whenever the contacts k l are closed by the cam J and this circuit forms the discharge circuit of the condenser and its closing and opening is wholly controlled by the cam J in connection with the contacts k l.

The armature which is round with a con-

ductor of very high resistance is driven by suitable connection with the engine and generates a current of very high voltage and the only circuit provided for it is at the moment when the contacts *e* coincide with the brush *f* which occurs twice in the revolution of the armature at the time when its potential is the highest. During these periods the cam J holds the contact plate *l* out of contact with the fixed contact *k* and the armature is therefor connected into the charging circuit of the condenser which is formed by the conductors 2, 3, 4 and the primary of the induction coil and through this circuit the condenser will be charged to its full capacity with the high voltage the generator is capable of producing. Before the cam J has revolved far enough to release the contact plate *l* the brush *f* has run off the contact strip *e* and the charge in the condenser thus becomes trapped till the projection *i* of the cam which has actuated the contact *l* has passed over it and permits it to drop back upon the contact *k* thereby closing the discharge circuit for the condenser by way of the primary through conductors 2, 4 and 3. This sets up a current in the secondary which is synchronously closed by the arm N through the branches thereof and thereby produces the igniting spark in the different cylinders of the engine in the order in which the charges are to be ignited. As the housing K of the circuit controller of the discharge circuit is rotatively adjustable under the control of the driver, the time for making and breaking this circuit can be advanced or retarded and the circuit controller of the discharge circuit thus forms a timing device for the spark within the limits desired. To insure the proper closing of the secondary which has to be closed at the same time, the contacts *p* are suitably enlarged to produce electrical contact with the arm N at any adjustment of this circuit controller.

In the operation of my device the two circuits are never closed at the same time, thus the primary circuit is always open when the discharge circuit closes and the discharge from the condenser will thus take place through a circuit of low resistance and be instantaneous, while at the other hand the charging circuit being a circuit of high resistance will charge the condenser with a very high potential which is further raised by the secondary and thus produce very powerful sparks.

Having thus fully described my invention, what I claim is:—

1. In an electric igniting apparatus, the combination with an induction coil, of a condenser having its opposite ends connected with the opposite ends of the primary, one of said connections being formed through two branches, one of which includes a source of electricity and forms part of a charging circuit and the other of which forms part of a discharging circuit, each including the primary, and means in each of said branches adapted to periodically open and close said charging and discharging circuits, one circuit being open while the other is closed.

2. In an electric igniting apparatus, the combination with an induction coil, of a condenser having its opposite ends connected with the opposite ends of the primary, one of said connections being formed through two branches one of which includes a source of electricity and forms part of a charging circuit for the condenser and the other of which forms part of its discharging circuit, each including the primary, and means in each of said branches adapted to periodically open and close said charging and discharging circuits, the means in the discharging circuit being variable in relation to those in the charging circuit.

3. In an electric igniting apparatus, the combination with the primary of an induction coil, of a condenser, a source of electricity therefor adapted to charge the same, charging and discharging circuits connecting the condenser with the source and with the primary respectively, circuit controlling devices operating in unison with each other and adapted to periodically make and break said circuits at intervals apart and means for timing the making and breaking of the discharge circuit in relation to that of the charging circuit.

4. In an electric igniting apparatus, the combination with an induction coil having in its secondary circuit a plurality of electrodes forming spark gaps in different branches of the circuit, of a condenser having its opposite ends connected with the opposite ends of the primary, one of said connections being formed through two branches one of which includes a source of electricity and forms part of a charging circuit for the condenser and the other of which forms part of its discharging circuit, means in each of said branches adapted to periodically open and close said charging and discharging circuits and means in the secondary circuit to periodically open and close said circuit successively through its different branches in unison with the discharge circuit of the condenser.

5. In an electric igniting apparatus, the combination with an induction coil having a plurality of pairs of electrodes forming spark gaps included in different branches of its secondary circuit, of a condenser connected in circuit with the primary thereof, said circuit being formed with two separate branches between one end of said condenser and its connection with the primary, a source of electricity in one of said branches, a circuit controlling device in each of said

branches adapted to periodically open and close the circuit through said branches, one being open while the other is closed and a switch in the secondary circuit operating in unison with the circuit controlling devices to successively close the secondary circuit through its different branches.

6. In an electric igniting apparatus, the combination with an induction coil and a pair of electrodes included in the secondary circuit thereof and forming a spark gap, of a condenser, a magneto adapted to charge the same, charging and discharging circuits connecting said condenser with the magneto and with the primary of the induction coil respectively, and circuit controlling devices operating in unison with the magneto and adapted to periodically make and break the charging and discharging circuits, the charging circuit being made and broken at predetermined points in the revolution of the armature of the magneto in advance of making and breaking the discharge circuit and means for timing the making and breaking of the discharge circuit.

7. In an electric igniting apparatus for multiple cylinder explosive engines, the combination with a condenser, a charging circuit therefor, a magneto in said charging circuit operated by the engine and adapted to periodically produce an electric discharge in said circuit at a predetermined point in the intervals between the firing of the charges in the cylinders of the engine, the charging circuit being open in the intervals between the charging of the condenser, an induction coil, a discharging circuit connecting the condenser in circuit with the primary thereof, a circuit controller in said discharging circuit operating to periodically open said circuit when the condenser is being charged and to close said circuit at the time when the spark is required, a secondary circuit containing pairs of electrodes in different branches of the circuit and a switch operating in unison with the circuit controller to close the secondary circuit successively through the different branches of said circuit simultaneously with the closing of the discharge circuit of the condenser.

8. In an electric igniting apparatus for multiple cylinder explosion engines, the combination with an induction coil including in separate branches of its circuit pairs of electrodes forming spark gaps in the cylinders of the engine and a switch operating in unison with the engine for closing said secondary successively through its different branches, of a condenser, a magneto driven by the engine, charging and discharging circuits for the condenser and circuit controlling devices operating in unison with the engine to periodically make and break the charging and discharging circuits at intervals apart, the former at predetermined points in the revolution of the moving part of the magneto and the latter at determinable points in the travel of the pistons of the engines.

9. In an electric igniting apparatus for multiple cylinder explosion engines, the combination with an induction coil including in separate branches of its secondary circuit pairs of electrodes forming spark gaps in the cylinders of the engine and a condenser in its primary circuit, of a magneto of the interrupted pole type inclosed within a tight housing forming bearings for the armature shaft, means for operating said magneto in unison with the engine, a circuit controller having a rotary member carried by the armature shaft and adapted to periodically connect he magneto into circuit with the condenser and charge the same, a second circuit controller inclosed within the housing of the magneto and having a rotary member driven by the armature shaft and a stationary member rotatively adjustable around the rotary member, said circuit controller adapted to periodically make and break the primary circuit, and a switch inclosed within the housing and having a movable member actuated by the shaft of the second controller and adapted to successively close the secondary circuit through its different branches.

10. In an electric igniting apparatus for multiple cylinder explosive engines in which the sparks are produced by the periodic discharges of a condenser through the primary of an induction coil containing the igniting devices in separate branches of its secondary circuit, the combination of a magneto having actuating connection with the engine, a tight casing inclosing said magneto, a circuit controller having its rotary member carried by the armature shaft and adapted to periodically make and break the charging circuit of the condenser, a shaft journaled in the casing of the magneto above the armature, intermediate gearing for driving said shaft from the armature shaft, a switch having its movable member carried by one end of said shaft and adapted to periodically close the secondary circuit through the different branches thereof and a circuit controller in the primary of the induction coil having a rotary member carried by the other end of the shaft and a fixed member rotatively adjustable on said shaft.

In testimony whereof I affix my signature in presence of two witnesses.

EDWARD S. HUFF.

Witnesses:
J. C. HAYES,
OTTO F. BARTHEL.