E. S. LINCOLN.
IGNITION SYSTEM.
APPLICATION FILED MAY 9, 1910.

1,046,614.

Patented Dec. 10, 1912.

2 SHEETS—SHEET 1.

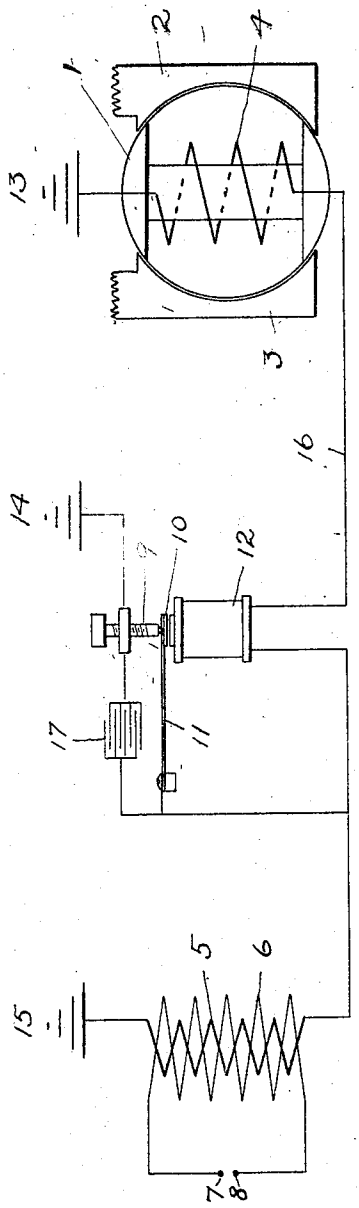

Fig. 1.

Attest:
Oscar F. Hill
Ellen O. Spring

Inventor:
Edwin S. Lincoln,
by Nathan B. Day,
Attorney.

E. S. LINCOLN.

IGNITION SYSTEM.

APPLICATION FILED MAY 9, 1910.

1,046,614.

Patented Dec. 10, 1912.

2 SHEETS—SHEET 2.

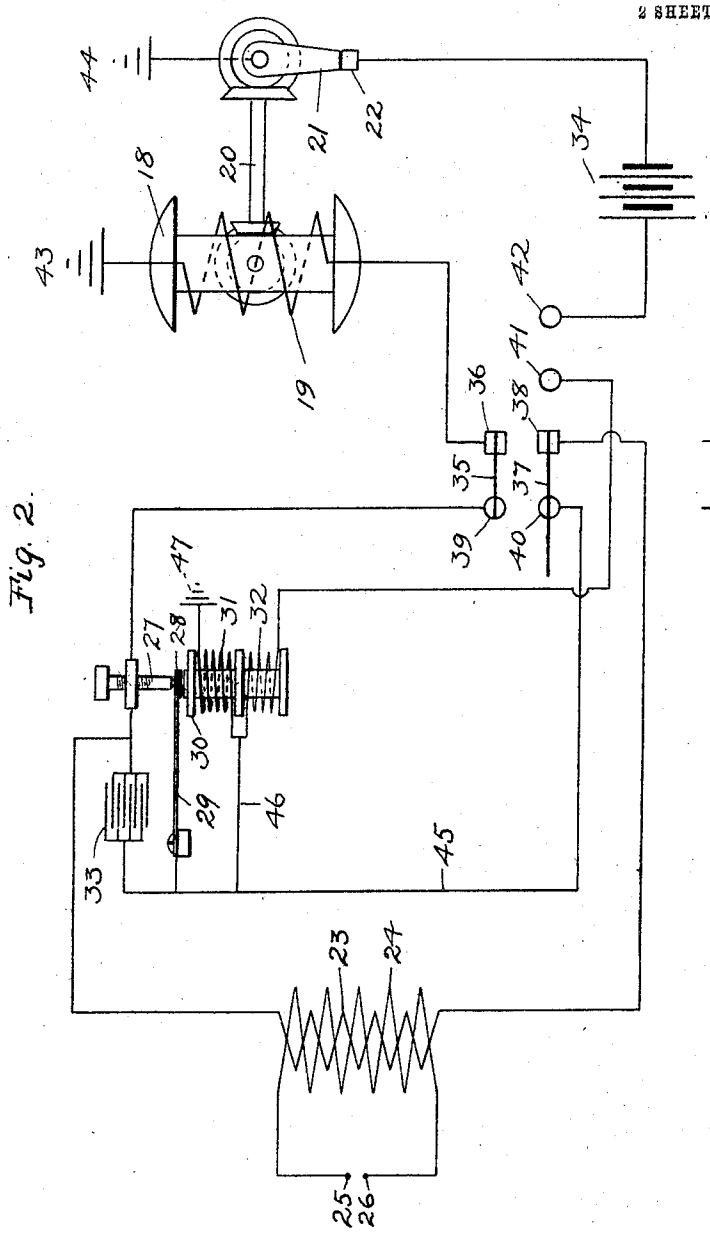

Fig. 2.

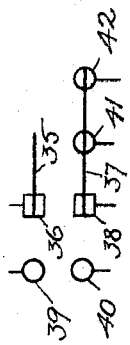

Fig. 3.

Attest:

Oscar F. Hill

Ellen D. Spring

Inventor:

Edwin S. Lincoln,

by Nathan B. Day,

Attorney

UNITED STATES PATENT OFFICE.

EDWIN S. LINCOLN, OF BROOKLINE, MASSACHUSETTS.

IGNITION SYSTEM.

1,046,614. Specification of Letters Patent. Patented Dec. 10, 1912.

Application filed May 9, 1910. Serial No. 560,288.

To all whom it may concern:

Be it known that I, EDWIN S. LINCOLN, citizen of the United States, residing at Brookline, in the county of Norfolk and State of Massachusetts, have invented certain new and useful Improvements in Ignition Systems, of which the following is a specification.

My invention relates to electrical systems adapted to produce a high tension electrical discharge at electrically separated spark points or electrodes, and more particularly it finds its application in electrical systems which have for their object the energization of an ignition system designed to produce an electric spark at a spark plug or similar devices, located in the cylinder of an internal combustion engine, for the purpose of igniting a charge of explosive combustible contained in said cylinder.

My invention is more especially designed for use in connection with ignition systems in which a source of electrical energy of the magneto type is employed for the purpose of generating the electric energy by which the ignition system is energized.

My invention consists essentially in the use, with a magneto-electric generator, and with an induction coil which is adapted to be energized thereby, of an electrically actuated circuit breaker embodying separable contacts by whose separation in consequence of the operation of the actuating means, the induction coil is rendered operative to produce a high tension discharge. In my invention said generator, induction coil, and circuit breaker are electrically so arranged and interconnected that the generating circuit is normally closed through the actuating circuit of the circuit breaker when said separable contacts of the same are in interengagement. Further, the current strength of the electric current generated by the generator and the winding turns of the actuating circuit are so proportioned that when the current generated by the magneto generator approaches a predetermined intensity, the flow of the current through said actuating circuit will serve to actuate the circuit breaker, thereby causing the said contacts to separate, whereupon said current is caused to energize the induction coil and to cause the same to produce an electric discharge.

My invention is shown in two of its preferred embodiments in the accompanying drawings, in which,—

Figure 1 represents diagrammatically my invention as applied to an ignition system. Fig. 2 represents diagrammatically an ignition system embodying my invention, in which a battery is arranged in combination with the magneto to serve as an alternative source of electric energy, and showing the switch blades of the manipulating switch used in said system in one of its selective operative positions. Fig. 3 is a diagrammatic view of the switch used in connection with the system shown in Fig. 2, but indicating the connections made by the switch blades in their alternate operative position.

Referring to said Fig. 1, 1 represents the armature of a magneto generator which is revolubly mounted and rotatably driven, by means not shown in the drawings, in a magnetic field produced by the two field magnets 2 and 3, and carries the current generating armature windings 4. An induction coil is provided preferably having a primary or energizing winding 5, and a secondary winding 6 associated in inductive relation with the said primary winding and having its terminals electrically connected to the spark points 7 and 8, which are preferably embodied in a spark plug, located in the cylinder of the internal combustion engine to which the ignition system is applied. Said coil is of the vibratorless type, the energizing circuit through the same not being subject to interruption by a vibrator or similar device. The circuit breaker may be embodied in any approved form. As shown, it embodies separable contacts, carried in part at the tip of a contact screw 9 and in part on a movable armature 10 which is mounted on a resilient supporting strip by which the contact carried by the same is normally held in electric engagement with that carried upon the contact screw 9. For the purpose of actuating the circuit breaker so as to cause the separation of said separable contacts, preferably an

electro-magnet 12 is provided which is located adjacent said movable armature and is adapted to magnetically attract the same when current flows through the winding of the magnet. The winding of said electro-magnet is preferably of course wire and so wound as to avoid as far as possible electrical inductance which, if present would operate to retard the flow of current through the winding. Electrical connections are provided for the purpose of electrically interconnecting the winding of the said electro-magnet, the said induction coil, and the operative parts of the circuit breaker. Said connections are preferably arranged in the following manner: One terminal of the magneto armature winding is preferably grounded in any approved manner, as at 13. The contact screw 9 is connected with a ground 14. One terminal of the primary winding 5 of the induction coil is also grounded as at 15. The second terminal of said armature winding is electrically connected, as by a conductor 16, so as to place said winding in series with the winding of said electro-magnet. After traversing the magnet winding the circuit divides, one branch being in electrical connection with ground 14 through the resilient strip 11, and the separable contacts carried by the armature 10 and the contact screw 9, when in their interengaged relation; and another branch being connected with ground 15 through the primary winding of the induction coil. A condenser 17 is connected in shunt around the separable contacts in usual manner.

For the purpose of distinction I have hereinafter referred to the circuit in which are included the magnet winding and the separable contacts, as an "interruptible" circuit, while the circuit in which is included the induction coil is termed a "non-interruptible" circuit, meaning thereby that the circuit by which the generator is connected in energizing relation to the induction coil is permanently continuous at the moment of ignition and is not designed to be subjected to interruption, as by a vibrator or other type of circuit breaker, for the purpose of rendering the same operative to produce an igniting spark.

My invention operates in the following manner: The rotation of the magnet armature 1 in the magnetic field produced by the field magnets 2 and 3 generates current in the armature winding 4 carried thereon. Said current flows from one terminal of said winding into conductor 16 and traverses the electro-magnet 12. After passing through the same the current returns through both the grounds 14 and 15 to the second terminal of said armature winding 4 by way of ground 13. Since, however, the resistance offered to the flow of current through the induction coil is relatively high as compared with that offered by the circuit in which the separable contacts carried by screw 9 and by armature 10 are included, substantially all of the current generated by the magneto will pass through said separable contacts so long as they remain in engagement and said induction coil will remain practically inert. The winding of said electro-magnet 12 is so calculated with respect to the strength of the current generated by the rotation of said armature and with reference to the elasticity of resilient strip 11, that as the flow of current generated in said armature winding 4 approaches a predetermined value the magnetic attraction produced by the flow of current through said magnet winding will overcome such elasticity and will cause said movable armature 10 to separate from said contact screw 9. In consequence of the sudden interruption of the flow of the current through the circuit breaker produced as a result of the actuation of the same by the electro-magnet 12, the only course available for the current generated by said armature winding will be that through the primary winding of the induction coil. In consequence said induction coil will be suddenly energized, the current from the magneto, owing to the non-inductive character of the magnet winding 12 being substantially undiminished in amount by reason of its traversing the same. As a result a high tension current will be induced in the secondary winding of the induction coil which will cause an igniting discharge at the spark points 7 and 8. When the rotation of the magneto armature has progressed to such an extent that the generation of current has passed the predetermined value, the diminution in the magnetic attraction resulting from the decreased flow of current through the electro-magnet 12 will enable the elasticity of strip 11 to again restore said armature 10 into its original position so that said separable contacts are again placed in interengagement. In consequence the current generated by the magneto will again flow through said circuit breaker, and the same will again operate as before described when the generation of current in the armature winding 4 has reached the required intensity, although its direction of flow be in the opposite phase.

Referring now to Fig. 2, my invention is shown in one of its preferred forms more especially adapted to an ignition system in which either a magneto or a battery may be alternatively employed to supply current for energizing said system. In said figure, 18 represents the revolving armature of a magneto generator carrying the curernt generating armature winding 19, and revolubly

driven in a magnetic field produced by magnets, not shown in the said figure. Positively driven with the said magneto armature, as by bevel gearing interconnected by shaft 20, is the rotating arm 21 of a timing device, which may be of any approved construction, said arm being adapted to engage in the course of its rotation with the timer segment 22, at the instants when ignition is to take place. As shown said arm is adapted to complete two revolutions while the armature 18 revolves once. At 23 is represented the primary winding of an induction coil, the secondary winding 24 of the same being electrically connected to the spark points 25 and 26, preferably carried in a spark plug of usual type. A circuit breaker is employed which preferably is substantially the same as that hereinbefore described in connection with Fig. 1; the same embodying separable contacts carried in part at the tip of an adjustable contact screw 27, and in part on a movable armature 28 which is mounted on a supporting strip 29 having a resiliency by which the contact carried on the armature 28 is normally held in electrical engagement with that carried upon the contact screw 27. For the purpose of actuating the circuit breaker when it is desired to cause separation of the said separable contacts, an electro-magnet 30 is provided which is located adjacent said movable armature and which is adapted, when magnetized, to attract the same. The windings of said magnet are preferably comprised in two groups, as shown in said Fig. 2. One group is preferably composed of convolutions of low resistance wire, wound with especial reference to the elimination of inductance, while the other group 32 is of finer wire of a higher resistance. A condenser 33 is connected in any approved manner in shunt around the separable contacts embodied in the circuit breaker. At 34 is represented a battery or similar source of electric energy of any approved type. For the purpose of placing the circuit breaker and the induction coil in operative relation with respect either to the magneto or the battery, an electric switch is employed. As shown in Fig. 2 said switch is preferably a specially modified form of the double-pole double-throw type, preferably embodying one short switch blade 35 pivoted at hinge post 36, and another long switch blade 37 pivoted at a second hinge post 38. When said switch blades are thrown to the left as shown in said Fig. 2, the switch is in its "magneto" position, wherein the magneto is electrically connected in energizing relation with the system. In such position said switch blade 35 is in engagement with switch elements comprising the hinge post 36 and with the contact block 39; said hinge blade 37 being in engagement with hinge post 38 and contact block 40. When said switch blades 35 and 27 are swung toward the right as indicated in Fig. 3, so as to occupy their "battery" position, blade 35 makes contact only with the hinge post 36 at which it is pivoted. Switch blade 37, however, engages simultaneously with hinge post 38 and with both contact blocks 41 and 42. When in such position the battery is connected in energizing relation with the circuit breaker and with the induction coil. The electrical apparatus and switch elements hereinbefore mentioned are electrically interconnected preferably as follows: One terminal of the armature winding 19 is grounded in any approved manner, as at 43. The second terminal of said winding is electrically connected with the hinge post 36. The timer arm 21 is also grounded, as at 44. The timer segment 22 is electrically connected with one pole of battery 34, the other pole of said battery being connected with the contact block 42. The contact block 39 is in electrical connection with the adjustable contact screw 27, said screw being also in electrical connection through the primary winding 23 of the induction coil with hinge post 38. The contact block 40 is electrically connected by conductor 45, to resilient strip 29, thence through the interengaged separable contacts embodied in the circuit breaker with the contact block 39. Contact block 40 is also electrically connected through conductor 45 with the electro-magnet 30, by a conductor 46, which branches and connects with one terminal of each of said magnet windings 31 and 32. The unengaged terminal of winding 31 is grounded, as at 47, while the unengaged terminal of winding 32 is electrically connected with contact block 41.

The modification of my invention just hereinbefore described operates in the following manner: Assuming that the switch is in its "magneto" position, its switch blades being thrown to the left, as shown in Fig. 2, so as to electrically connect hinge post 36 with contact block 39, and hinge post 38 with contact block 40, the current generated in the armature winding 19, by the rotation of the magneto armature 18 will pass into ground 43. Said current will be again picked up at ground 47, and proceeding thence will traverse winding 31 and enter the conductor 46. At this point the current will divide, a part of the same passing by way of conductor 45, contact block 40, and switch blade 37 into hinge post 38; whence it will traverse the primary winding 23 of the induction coil into the contact screw 27. The balance of the current leaving conductor 46 will pass through the resilient strip 29 and through the interengaged separable contacts of the circuit breaker, into the said con-

tact screw 27 and uniting there with such current as may have traversed the induction coil, both will return by way of contact block 39, switch blade 35, and hinge post 36, back to the armature winding. Since the resistance offered to the flow of current through the induction coil is relatively high as compared with that offered by the cricuit in which the interengaged separable contacts of the circuit breaker are included, substantially all of the current generated by the magneto will pass through said separable contacts, so long as they remain in engagement, and said induction coil will remain practically inert. As in the system shown in Fig. 1 the winding 31 of said electromagnet 30 is so computed with respect to the strength of the current generated by the rotation of the magneto armature and with reference to the elasticity of resilient strip 29 that as the flow of current generated in said armature winding approaches a predetermined value, the magnetization produced by the current flow through the magnet winding 31 will cause the separation of said movable contacts. When such separation takes place the only available course for the current generated by the armature winding 19 is through the primary winding of the induction coil. In consequence said induction coil will be suddenly energized, thereby inducing a high tension current in its secondary winding which will cause a discharge at the spark points 25 and 26. It will therefore be apparent that in the "magneto" position of the switch the ignition system will operate substantially as that illustrated in Fig. 1. Assuming now, that the switch blades are swung toward the right so that the switch is in its "battery" position, as indicated in Fig. 3, switch blade 37 will be seen to interconnect hinge post 38 with contact blocks 41 and 42. Switch blade 35 is entirely inoperative. In such position it will be observed that magneto winding 19 is disconnected from the induction coil and the circuit breaker and the magneto-generator is inoperative.

Referring again to Fig. 2, and bearing in mind the changed position of the switch blades indicated in Fig. 3, it will be seen that one pole of battery 34 is in connection through contact block 42 and switch blade 37 both with contact block 41 and hinge post 38. A part of the battery current will pass from hinge post 38 and will traverse the primary winding 23 of the induction coil into contact screw 27. Thence it will pass through the interengaged separable contacts of the circuit breaker into the resilient strip 29. From here the circuit will proceed by way of conductor 46 through the winding 31 to ground 47, whence the current will return by way of ground 44 to the other pole of the battery through the timer, when the timer arm 21 and timer segment 22 are in engagement. Contemporaneously, with the energization of the induction coil by the battery 34, the engagement of the timer arm 21 with timer segment 22 will operate to place said battery in series with the magnet winding 32; the circuit proceeding by way of switch blade 37 and contact block 41, first through magnet winding 32, and then through winding 31 to ground 47 and back to the battery by way of ground 44 and the timer. The magnetic attraction produced by the combined flow of current in both windings will operate the circuit breaker, disengaging the separable contacts. In consequence the circuit through the primary winding of induction coil will be suddenly interrupted and the induction coil will operate to induce a spark at the spark points in the usual manner. After the interruption to the flow of current through the primary winding by the separation of the separable contacts of the circuit breaker, current will continue to flow through the fine magnetizing winding, the quantity of such current being, however, limited by the high resistance of said winding, but being sufficient to keep the separable contacts apart during the continuance of the engagement of the timer arm and segment. Since the magneto will generate current for operating the circuit breaker once in every half revolution of the magneto armature, the timer arm 21 should preferably be arranged to rotate once during each such half revolution of the magneto. Furthermore the said timer arm should preferably be angularly so adjusted with reference to the magneto armature that the interengagement of the timer arm and timer segment occurs at substantially the instant when the armature reaches the angular position wherein its generated current would, in the "magneto" position of the switch, operate the circuit breaker and so produce an ignition discharge. By the proper interconnection and angular adjustment of the magneto armature and the timer arm, as just described the instant of spark production is substantially the same whether the system is energized by the magneto or by the battery.

If desired a timer having a plurality of timer segments may be employed, with appropriate electric connections so arranged that the interengagement of the revolving arm with any one of the timer segments will complete the battery circuit and effect the operation of the spark producing instrumentalities. In such case the timer arm should be arranged to rotate at a rate of revolution which is reduced in inverse proportion to the increased number of timer segments, so that the interval between the

engagement of the timer arm with two successive timer segments will correspond to the interval between the discharge producing positions of the magneto armature.

While I have described my invention as applied more particularly to an ignition system having a single set of spark-points such as would be employed in a motor having a single cylinder, my ignition system may be adapted for use in connection with a multi-cylindered motor by employing in connection therewith a distributor of any approved type connected into the secondary circuit of the induction coil, or by using a plurality of induction units in combination with a low tension distributer by which a selected induction unit may be operatively connected into the ignition system as desired. The manner of applying such distributer in either case, will be clear to any workman familiar with ignition system installations, and I do not deem it necessary to describe the application of the same to my system in further detail.

Having described my invention I claim,

1. An ignition system comprising in combination a generator, an induction coil, a circuit breaker having separable contacts and an electro-magnet for separating said contacts, a circuit connecting the generator with the coil through the magnet, and an interruptible circuit including said separable contacts and short circuiting said coil.

2. An ignition system comprising a generator, an induction coil, a circuit breaker having normally contacting separable contacts, and an electro-magnet for separating said contacts, a non-interruptible circuit connecting the generator with the coil through the magnet, and an interruptible circuit including said separable contacts and connected across the terminals of said coil.

3. An ignition system comprising a generator, an induction coil, and a circuit breaker embodying normally contacting separable contacts and having an electro-magnet for separating said contacts, a non-interruptible circuit including the generator, the magnet winding and the coil, and an interruptible circuit independent of the magnet connected across the terminals of the coil and having the separable contacts intercalated therein.

4. In combination, an electric generator having a generating winding, a circuit breaker having separable contacts and embodying a magnet winding for causing the separation of said contacts, a vibratorless induction coil having an energizing winding, an interruptible circuit normally interconnecting the terminals of said generating windings through said magnet circuit and said separable contacts, and a permanently continuous circuit, arranged in parallel with said interruptible circuit and including said energizing winding, said generating winding being connected in energizing relation with both said circuits.

5. In an ignition system, in combination, an electric generator having a generating winding, an induction coil, a circuit breaker having separable contacts and embodying a magnet having low and high resistance windings and adapted to separate said contacts, an interruptible electric circuit including said generating winding, said separable contacts, and said low resistance magnet winding, a non-interruptible electric circuit including said generating winding, and the induction coil, a source of energy, a timer driven in synchronism with the generating winding, a third electric circuit including the source of energy, the timer, said separable contacts and said induction coil, and the low resistance magnet winding, a fourth circuit including the timer, the source of energy, and the high resistance magnet winding, and an electric switch embodying movable conductors adapted to occupy two operative positions, said switch having one set of switch elements engaged by the conductors in one operative position, and a second set of switch elements engaged by the conductors in the second operative position, the first and second circuits being contemporaneously closed in one switch position through said switch conductors and the switch elements comprised in said first set, and said third and fourth circuits being closed in the second switch position, through said switch conductors and the switch elements comprised in said second set.

6. In an ignition system, in combination, an electric generator having a generating winding, an induction coil having a primary winding, a circuit breaker having separable contacts, and embodying an electro-magnet, having a high resistance magnet winding and a low resistance magnet winding, for separating said contacts, an interruptible electric circuit including said generating winding, said separable contacts, and said low resistance magnet winding, a non-interruptible electric circuit including said generating winding, the primary winding, and said low resistance magnet winding, a source of energy, a timer driven in synchronism with the generating winding, a third electric circuit including the source of energy, the timer, the said separable contacts, said induction coil, said low resistance magnet winding, and the timer, a fourth circuit including the timer, the source of energy and said fine magnetizing windings, and an electric switch embodying movable conductors adapted to occupy two operative positions, and having one set of switch elements engaged by the conductors in one operative po

sition, and a second set of switch elements engaged by the conductors in the second operative position, the first and second circuits being contemporaneously closed in one switch position through said switch conductors and the switch elements comprised in said first set, and said third and fourth circuits being closed in the second switch position through said switch conductors and the switch elements comprised in said second set, and through said timer.

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

EDWIN S. LINCOLN.

Witnesses:
NATHAN B. DAY,
CHAS. F. RANDALL.