To all whom it may concern:

Be it known that I, LEON J. LE PONTOS, a citizen of the Republic of France, residing at New Rochelle, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Systems of Ignition for Explosive-Engines, of which the following is a full, clear, and exact specification.

My invention relates to a system of ignition for explosive engines and more particularly to a system in which a battery and dynamo electric generator, preferably of the magneto-inductor type, are combined to act jointly to mutually assist each other, or to obtain ignition from either source when energy is not being derived from the other.

One object of my invention is the attainment of high efficiency in an ignition system with simplicity of apparatus and with a minimum amount of apparatus. In accomplishing this object, I preferably use an inductor-magneto alternator of such type that when connected in series with a suitable auxiliary source of direct current, such as a battery, each will assist the other to produce a relatively larger output of energy for the purpose of ignition and which energy will be available at very low speeds of rotation.

I further arrange the character of the apparatus so that when the rotating element of the magneto is stationary or inactive, the auxiliary direct current source may be utilized in conjunction with the winding or windings of the magneto to obtain proper ignition and thus avoid additional windings for this purpose.

A further object of my invention is to overcome weakening or demagnetizing of the permanent magnets of the magneto which has been one of the serious difficulties experienced in ignition systems dependent alone upon energy derived from a magneto. By my invention, not only is the difficulty of demagnetization of the magneto overcome, but the relation of the current flow in the winding or windings of the magneto is such as to tend to strengthen the permanent magnet or magnets. Moreover, the current obtained from auxiliary direct current source, such as a battery, is so conducted through the magneto windings as to also tend to strengthen or build up the permanent magnetization of the magneto, even though the magneto itself is inactive in the generation of electromotive force. When the battery cooperates with the magneto in the production of current, the relation of this battery current and the induced current in the magneto windings is such that the electromotive force of the two sources is additive, both currents flowing in the same direction but when the direction of the electromotive force generated in the magneto winding is reversed, the circuit is opened by the circuit controller or interrupter.

A further object of my invention is the provision of means whereby a wrong connection of the battery in the circuit is prevented, and although such means is not essential to the operation of my improved ignition system, it is very desirable in cases where the operator could not always be depended upon for making connection of the battery in proper relation in the circuit.

My invention further comprises an improved magneto alternator and parts related thereto, which are particularly well adapted for use in my improved system of ignition.

These, and other features of my invention will be understood from the following description and accompanying drawings, disclosed and shown for the purpose of illustrating one form of embodiment of my invention.

I preferably utilize an inductor-magneto alternator of a form in which the rotation of the inductor merely causes rapid variations in the density of the magnetic flux threading through the generating winding of windings, instead of causing the flux to vary both in density and direction through the windings. By an increase and decrease of magnetic flux density without reversal of direction, two waves of electromotive force of opposite direction are generated in the winding or windings, one corresponding to the increase in flux density and the other corresponding to the decrease in flux density. A current flow in the windings resulting from flux increase tends to oppose such increase, and so creates a counter-magneto motive force in the magnetic circuit which tends to weaken the magnetic field density. On the other hand, a current flow in the magneto winding or windings resulting from magnetic-flux decrease, is in such direction as to oppose such decrease, and conse-
quent the flow of such current in the wind-
ing or windings of the magneto induces a
magneto motive force in the magnetic circuit
which tends to increase the magnetic flux
density of the field element of the magneto.
Thus, if a suitable switch or current inter-
rupter be operated, as from the rotor shaft
of the magneto or by a shaft rotating at the
same speed or at a definitely related speed,
such as a multiple speed thereof, or in any
other suitable way, so that the circuit of the
generating winding be opened during the
period of generation of the wave of electro-
motive force resulting from flux increase,
and closed during the period of generation
of the wave of electromotive force due to
the decrease in flux density, the tendency of
the resulting current flow in the circuit will
always be such as to strengthen the magneto-
ization of the field element. I have dis-
covered, however, that for the conjoint use
of a battery or other direct current source
with an alternating current magneto gener-
ator connected in circuit with the battery, a
magneto of certain essential characteristics
of construction is necessary. For example,
in the case of a magneto alternator in which
the magnetic flux is successively reversed
through the generating winding or wind-
ings, the same beneficial effect cannot be as
readily obtained if, in fact at all, as is the
case with a magneto in which the magnetic
flux is not so reversed, but merely varies in
density.

In the accompanying drawings, Figure 1
is a diagram illustrating one form of my
invention as applied to a low tension or
make and break system of ignition; Fig. 2
is a vertical section of my improved magneto
with windings adapted for high tension, or
jump-spark ignition; Fig. 3, is a horizontal
section on the line 3—3 of Fig. 2; Fig. 4
is an end elevation of the magneto illustrated
in Figs. 2 and 3, showing the interrupter in
section; Fig. 5 is an opposite end elevation
showing the distributor and a protective de-
vice for the secondary circuit partly in sec-
tion; and Figs. 6 and 7, are diagrams show-
ing one form of connection and apparatus,
comprising my improved ignition system
adapted for high tension jump-spark igni-
tion.

Referring to Fig. 1 illustrating my inven-
tion as applied to low tension or make and
break ignition, I will first describe the form
of magneto illustrated. This magneto pre-
ferably comprises a number of lamina 1, which
may be assembled in any preferred manner
for building up the field element. They are
shown to be held firmly together between
suitable end frames by bolts 2. Each of the
lamina or plates 1 is of the same form and
provided with polar extensions N' and S of
opposite polarity. Preferably each lamina
is formed from a sheet of steel, the main
portion of the lamina being hardened and
permanently magnetized and its integral
polar extensions N' S being relatively soft.
Such lamina may be made as described in
my prior United States Patent No. 902,449,
granted October 27, 1908. A second pole
piece N of the same polarity as the pole N'
is also provided of the general form shown,
and composed preferably of soft iron lamina
firmly held together between the end plates
by bolts 2, as in the case of the main por-
tion of the field element. Between the main
magnet portion and the auxiliary pole N
is accurately fitted a member, bridge or core
3 built up of soft iron lamina extending in
the plane of the field element and the lamina
comprising this member are held together
so as to be readily secured to the field ele-
ment by bolts or screws 4 and removable as
a unit. The member 3 carries a coil or
winding 5, and when this member and coil
is in position as shown in the drawing, the
coil is well protected from possible mechan-
ical injury, being also protected by a cover
plate 6, which may serve to support the in-
sulated terminals 7 of the winding 5.
9 is a magnetism distributor or inductor
preferably formed of soft iron, and mount-
ed to rotate between the polar faces N, N'
and S. The polar faces of this inductor are
proportioned relatively to the polar faces
N, N', S of the field magnet. The rotation
of the inductor 9 establishes two different
paths for the magnetic flux, the one being
from pole N' to S and thence returning
through the main portion of the field ele-
ment, and the other being through the
bridge piece 3, pole N through the inductor
to pole S, and thence returning through the
main portion of the magneto to the bridge
piece.

It becomes evident that by rotating or os-
cillating the inductor 9, the magnetic flux
density in the coil 5 will be varied and the
windings will become the seat of alternating
electromotive force, maximum and minimum
values of which will be twice attained dur-
ing each revolution of the inductor.

Of the four electromotive force waves pro-
duced per revolution, I make use only of the
two, the current of which has a magnetizing
action on the permanent magnet. Furth-
more, these two waves I find to be the only
ones which can properly be associated with
a direct current source of supply to have a
magnetizing effect on the permanent magnet
when in circuit with the generating winding
on the inductor alternator. The two waves,
namely negative waves, which would tend
to have a demagnetizing effect upon the per-
mumagnet are not allowed to pass, that
is the circuit opening and closing mechanism
hereinafter described, is so constructed as to
open the circuit during the generation of the
negative waves, thus insuring that they will
have no demagnetizing effect upon the permanent magnet.

In Fig. 1 I have illustrated one form of make and break ignition means, and it will be understood that any other suitable form of construction may be utilized. The numeral 10 indicates the engine cylinder. In the combustion chamber is located an insulated plug or terminal 11, and adapted to contact therewith is a lever 12 mounted upon a rock-shaft 13, the latter passing through a suitable stuffing box in the wall of the combustion chamber. The end of the terminal 11 and the contact end of the lever 12 will preferably be made of suitable material to resist the burning effect of the arc. The contact lever 12 is held in the position shown by the action of a spring 14, surrounding a reciprocating rod 15 supported in suitable guides, said spring bearing between one of said guides 16, integral with the cylinder, and a collar 17 on said rod. The rod 15 rests upon and is moved in one direction by the action of a lever 18 pivoted at 19 to a hand-controlled lever 20, which co-acts with a rack 21 for holding the lever in any desired position, the lever being pivoted at 22 to a bracket upon the casing. A cam 23 is mounted upon the cam shaft 24, which latter is driven positively by the engine and assuming that the engine is of the four-cycle type, the cam-shaft is driven at one half the speed of the engine crank shaft.

The lever 18 is provided with a projection 25 which engages the cam 23, so that upon rotation of the cam in the direction of the arrow, it will raise the lever 18 and consequently the rod 15 against the action of spring 14. The rod 15 has a collar 26 at its upper end which rests upon the end 27 of a lever 28, which lever is secured to the rock shaft 13. A spring 29 is secured to the other or free end of lever 28 and to a fixed bracket or to the end of an arm 30 pivoted at 31 and resting at its inner end on the guide bracket 16. When the rod 15 is raised by the action of the cam 23 and lever 18, the collar 26 will be raised from contact with the end 27 of lever 28, thus permitting the outer end of said lever to be drawn down by the spring 29, rocking the shaft 13 and thereby bringing the contact end of lever 12 into contact with terminal 11. The face of the cam 23 is provided with a step 32 so as to suddenly release rod 15 as the cam passes from under the projection of lever 25, thus permitting the collar 26 to strike forcibly against the end 27 of lever 28 and so result in a sudden break between contacts 11 and 12. The making and breaking of the ignition circuit will thus be obtained and movement of the adjustable lever 20 will serve to vary the time of ignition as may be desired.

The ignition circuit is shown as including a battery 33, although other source of direct current may be used, the battery being connected in series with the generating winding 5, the circuit continuing from this winding to the insulated terminal 11 in the combustion chamber and thence when the ignition circuit is closed, to the contact 12 and then to the engine frame or ground connection, the circuit returning from ground to the battery 33 in simplified form. I prefer however to include an automatic switch in this circuit for insuring a proper connection of the battery. This switch is shown in the drawing as comprising a U-shaped permanent magnet 34 preferably built up of lamina and having pivoted thereto a soft iron member 35 carrying a contact 36 at its lower end. The contact 36 is adapted to engage a fixed contact 37 which in this instance is secured to or grounded upon the engine frame. The member 35 is enveloped by a coil 38, and when current passes through this coil in proper direction, the member 35 will be so magnetized that its lower end will be attracted by the right hand pole of the permanent magnet and so cause the contact 36 to engage the fixed contact 37 and thus close the ignition circuit from one terminal of the battery through the permanent magnet 34 and pivoted member 35 to contacts 36 and 37 and thence to ground or engine frame. When the current through the coil 38 is in the opposite direction the member 35 will be thrown to the left and cause the ignition circuit to be broken at contacts 36, 37, the magnetic force being sufficient to overcome the action of spring 39 which tends to close these contacts. The coil 38 is in shunt to the battery 33 with a resistance 40 connected in series with the coil, or if desired coil 38 may be a fine wire high resistance winding, thus allowing only a very small current to flow in this shunt circuit. The path of this shunt circuit is from one terminal of the battery through the resistance 40 if used, and coil 38 to the magnet 34 and thence to the other terminal of the battery. The coil 38 will be in such relation to the terminals between which the battery is to be connected that when the battery is properly connected, the effect will be to cause the contacts 36, 37 to be closed, and when improperly connected the effect will be to cause these contacts to be separated as above explained and so prevent the closing of the ignition circuit and prevent operation of the ignition system with an improper connection of the battery.

The relative angular position of the inductor 9 to the cam 23 should be such that when the positive current wave is being generated in winding 5 and is approximately at a maximum, the cam 23 will cause the breaking of the ignition circuit for creating the ignition spark, and the cam 23 should be so shaped as not to cause the closing of the igni-
tion circuit until the negative wave of electromotive force generated in winding 5 has been completed. When the battery 33 is in series with the generating winding, its electromotive force will be added to that of the winding and so cause the establishment of an ignition current of large value, and this conjoint action is especially desirable when the magneto is being driven at very low speeds as when starting certain explosive engines. After the engine is started, the battery will ordinarily be unnecessary and may be cut out of circuit as by means of a manual switch 41.

When the battery is acting in conjunction with the generating winding 5, the battery serves to cooperate with the electromotive force of the generating winding to produce a flow of current therein during the period when the ignition circuit is closed such that the current will tend to strengthen the magnetization of the magneto and avoid demagnetization.

It will be understood that when the inductor of the magneto is at rest or inactive for any reason, this improved system is of such character that the battery 33 may serve as the sole source of energy for ignition purposes. Thus, with the battery in circuit, the winding 5 will cooperate therewith to produce an effective spark discharge without the aid of other apparatus, the winding 5 then serving merely as the usual self-induction or choke coil and so avoid the use of any auxiliary coil or coils. With this method of operation it will also be noticed that the current flow in the ignition circuit due to the battery will then be such as to magnetize and maintain the magnetization of the field element of the magneto.

Referring now to the apparatus indicated in Figs. 2 to 7 illustrating my invention in one form for securing high tension ignition of a jumping-spark character, I will first describe the construction of the magneto and related parts as shown in Figs. 2 to 5, inclusive. The form of the field magnet 1 and its structure is the same in general as that described in connection with Fig. 1, having the bolts 2 for holding the lamina together, the poles N' and S' and auxiliary pole N, the laminated bridge piece 3 retained in place by screws 4 and also has a cover plate 6' for protecting the generating winding or windings. The end plates 42, 42' between which the lamina of the field element are clamped by the screw bolts 2 are illustrated in these figures and are shown as supporting ball bearings 43 for the rotor 40, which latter is of the same form as described in connection with Fig. 1. The bridge piece 3 in this magneto is shown as being enveloped by two coils or windings, a coarse winding 44 of comparatively few turns, and a fine wire secondary winding 45 of a comparatively large number of turns. These windings are well insulated from each other and from the magneto frame. One terminal of the winding 44 is grounded upon the magneto frame, and the other terminal is connected to a terminal 46 mounted upon the cover plate 6' and insulated therefrom. One terminal of the fine wire secondary winding 45 is also connected to this terminal 46, and the other terminal of winding 45 is in the form of a contact 47 located upon the outside of the coil, and when the coil is in position, the contact 47 engages a spring pressed contact 48 mounted in an insulating support 49 upon the opposite end of cover plate 6' from the terminal 46.

Upon the bearing portion of end plate 42, the outer part of which is circular and provided with a groove 50, is mounted a casing 51 from which extends an arm 52 by which the casing may be adjusted angularly about the axis of the inductor, the casing being provided with screws 53 which enter the groove 50 and thus retain the casing in position while permitting angular adjustment. The casing 51 surrounds the rotor shaft and incloses a cam 54 fixed to or formed integral with the rotor shaft. The outer end of the rotor shaft is shown as provided with a clutch member 55 for driving from the engine shaft or from any shaft positively driven from the engine shaft at the required speed ratio. The casing 51 is open at its upper portion and is adapted to have united therewith a metal box frame 56 which carries positioning pins 57 which enter perforations in the upper part of casing 51, the box frame 56 being retained in position by springs 58 which carry pins 59 adapted to enter other perforations in the casing 51. In the upper part of box frame 56 are circular insulating bushings 60 which support the metallic strip 60 above them and a metal piece 61 below them, the parts being held together by screws 62. Fixed to the metal strip 60 is a terminal 63 preferably spherical in form and thus adapted to receive a clip terminal. The metal piece 61 has integral therewith a depending portion 64 adapted to receive an adjustable screw having at its inner end a contact 65, the screw being readily adjustable through an opening in the box 56 which is normally closed by the slide 66. When once adjusted, the screw may be held firmly in position by a screw 67 adapted to clamp parts of the portion 64 together and so bind the screw having contact 65. The screw 67 is accessible from the side of the box 56 which latter has removable sliding or cover plates. The box 56 is provided with two depending portions 68 between which extends the pivot 69 for supporting the pivoted member 70 formed of two side portions fixed to the hub.
91 and carrying at their upper end a contact 72, and at their lower ends a piece 73 of suitable material adapted to be engaged by the face of cam 54 on the rotor shaft. A spring 74 is secured at one end to the hub 71 and passes between the side members of the pivoted element 70 and is secured at its upper end to a part of the box 56. This spring tends to force contact 72 into engagement with contact 65 away from the backstop 75, and will cause the engagement of these contacts excepting when the cam 54 engages the piece 73 to force these contacts apart against the action of the spring. The cam 54 is arranged to separate these contacts and hold them separated a certain interval of time twice per revolution of the inductor and permits engagement of these contacts twice per revolution. These parts thus serve as the interrupter of the circuit of the primary generating winding 44 for producing spark ignition, the cam being so related to the position of the inductor 9 that the breaking of the circuit between contacts 72 and 65 will occur approximately when the positive current waves are a maximum and cause the circuit to be opened during the two periods when waves of negative electromotive force are being induced in the generating winding 44.

The adjustability of the casing 51 which carries and supports the box 56, has heretofore been referred to, the casing 51 being adjustable about a bearing portion of end plate 42, and it will now be seen that by slightly shifting arm 59 of this casing either manually or otherwise, the timing of the ignition may be varied. The interrupter above described is also readily adaptable to either direction of rotation of the magneto shaft because if the direction should be opposite from that contemplated in the position shown in Fig. 4, the springs 55 could be raised and the box 56 then removed and placed in the reversed position so as to cause the rear of the box 56 to become the front, proper relationship being secured in either case by the positioning pins 57 and securing springs 58. Upon the opposite end of the magneto from where the interrupter just described is located, I arrange the distributing controlling means for the ignition in the several cylinders and in the present instance I have assumed that the ignition in a four-cylinder engine is to be controlled. The end of the rotor shaft is provided with a spur gear 76 which meshes with an internal gear 77 which is supported by ball bearings located eccentrically to the axis of the rotor shaft. The internal gear directly drives the movable element of the distributor, which latter is arranged to cause the closing of the four ignition circuits in one revolution, and as the rotor of the magneto is adapted to cause two ignitions per revolution as above explained, the magneto shaft should make two revolutions per each revolution of the movable element of the distributor and the gear ratio between the gears 76 and 77 should therefore be 2 to 1. The internal gear 77 has fixed thereto a portion 78 of insulating material which carries fixed to its outer end a metal arm 79 forming the movable element of the distributor. The inner end of this arm is fixed to a metal sleeve 80 containing a contact 81 which is pressed outwardly by a spring within the sleeve 80. The part 78 driven by the internal gear is encircled by a ring 82 of insulating material which is fixed to the end plate 42 of the magneto and carries four fixed contacts 83 embedded in the insulating ring 82 and insulated from each other. Four wires are connected respectively to the four contacts 83 and lead to four insulated terminals 84 adapted to receive plug terminals which are connected respectively to the insulated terminals of the spark plugs in the four engine cylinders. The outer end of the rotatable element 79 passes successively over the face of the four contacts 83 for controlling the ignition circuits, but I preferably arrange the movable element so that it will not contact with the contacts 83 but pass over them and obtain a brush discharge. The outer end of element 79 is therefore shown as having a facing 85 with a large number of projecting points or ridges of platinum or other non-oxidizing material. There remains to be considered the means for connecting the high tension terminal 47 of the secondary coil 45 electrically to the movable element 79 of the distributor. The high tension terminal 47 of the coil 45 is connected when in place to the spring pressed contact 48 supported by the insulating member 49 fixed to one end of the cover plate 6', as above stated. The contact 48 is partially located within a metal sleeve containing the spring which forces this contact against the terminal 47 and the sleeve is fixed to a block of metal 56 which has connected thereto by a threaded engagement the split pin 87 which extends outwardly. A cover plate 88 of insulating material is secured to the insulating ring 82 and protects and incloses the contacts of the distributor. This plate 88 has embedded therein a metal sleeve 89 which receives the outer ends of the split pin 87 making electrical contact therewith, and the sleeve 89 is connected by a strip 90 of conducting material to a plug 91 embedded in the plate 88 opposite the outwardly pressed contact 81 of the distributor. Electrical connection 125 from the terminal 47 to the movable element 79 of the distributor is thus secured by these parts, and it will be noted that all of the parts are well protected and inclosed and also adapted to be easily inspected and re-
paired or renewed. I also prefer to mount upon the magneto, together with the ele
ments already described, means for protecting the secondary circuit from injury which
might result from high voltages induced when the contacts of the spark plugs or of a
spark plug have been damaged or if in any way a high tension terminal becomes dis
connected. I have shown this protective
means in the form of a safety air-gap of
higher resistance than the normal air-gaps
of the spark plugs, and thus when the spark plug terminals are so damaged that the re
sistance between contacts is considerably
higher than the normal amount or if any
high tension line is broken in any manner,
there will be afforded a path of discharge
through the safety air-gap and thereby
avoid possible breaking down or straining
of the insulation of winding or windings.
One terminal of the safety air-gap is pro
vided by a screw 92 engaging the metal
block 86 and extending upwardly as shown
in Fig. 5. The screw 92 is provided with a
suitable terminal tip and is inclosed by a
glass tube 93 which has an adjustable screw
94 supported in a cap at its upper end. The
screw 94 is provided at its lower end with a
suitable terminal such as a platinum wire,
and by turning this screw the distance be
tween its terminal and that of screw 92 may
be adjusted to proper amount so as to have
the required higher resistance between them
than between the terminals of the spark
plugs as above explained. The screw 94 is
grounded upon the magneto and engine frame in any suitable manner. A circula
tion of air is preferably insured by provid
ing holes 98' for carrying away metallic va
pors or ozone resulting from a spark dis
charge within the glass.
In conjunction with the apparatus already
described I utilize a condenser 95 which I
preferably conveniently locate and support
within the field element of the magneto as
indicated in Fig. 2, one terminal of the con
denser being grounded and the other con
nected to the exterior insulated terminal
95'. I also prefer to use the automatic
switch comprising the parts 94, 35, 98, etc.,
described in connection with Fig. 1, for in
suring the proper connection of the battery 92
or other source of direct current which is
used in conjunction with the magneto in this
high tension system of ignition in general in
the same manner as described in relation to
the low tension system of Fig. 1. These parts
are shown in Figs. 6 and 7 connected in relation to the other parts already de
scribed, and the devices indicated in diagram
in these figures are designated by numerals corresponding to those used in describing the structural part of Figs. 2 to 5.
I preferably use a controlling switch of
the character indicated in Figs. 6 and 7,
adapted to be turned by the operator and
mounted so as to be readily accessible to
him. This operator's switch comprises a
movable part carrying conducting strips 96,
97 insulated from each other, and in the cen
tral position the strip 96 is out of engage
ment with any fixed contacts while the strip 97 connects the segment 98 with the
fixed segment 99. When turned to the left
the connecting strip 97 electrically connects
segment 98 to segment 100 which is grounded.
When the switch is turned to the extreme
right the strip 96 connects the contacts 101
to each other, and the strip 97 connects the
segment 98 to the contact 102.
In Fig. 6, the position of the operator's
switch is such that the generating winding 44 of the magneto is the sole source of en
ergy for producing the spark ignition. The
circuit of the generating winding 44 which
also serves as a primary circuit for induc
ing current in the circuit of the secondary
coil 45, may be traced from the ground or
engine frame connection through the coil
44 to the terminal 46, thence to the segment
98 of the operator's switch to segment 99,
then by a connection to the terminal 63 of
the box 56 of the interrupter, and from this
terminal through the contacts 63, 72 of the
interrupter to ground. The condenser 95 is
connected from terminal 63 to ground and is
thus connected around or in parallel with
the contacts 65, 72 of the interrupter. The
circuit of the secondary coil or winding 45
may be traced from terminal 46 through the
winding to terminal 47, and thence through
the parts previously described to the move
able element 79 of the distributor and then
through the different ignition circuits and
spark plugs 103 to ground, the discharge
through the secondary circuit including the
primary winding 44 for improving the spark
discharge and for affording a path of dis
charge of the primary winding when the
breaker interrupts the primary circuit which
minimizes the arcing at the breaker termi
nals due to the presence of this other path,
and it will be noted from Fig. 6, that when
the circuits of the spark plugs or distrib
uter fail from any cause there will be a dis
charge from the secondary winding through
the safety air-gap comprising terminals 92
and 94 to ground. With the apparatus de
scribed and with these connections, the mag
neto will serve to supply sufficient energy to
produce excellent high tension spark dis
charges when the engine is operating at any
of the various driving speeds and indeed
many engines may be started with this ap
paratus without the aid of any battery or
other source of current supply external to
the magneto, itself.
When it is desired to use the battery 33 as
an auxiliary source to assist the magneto, the
operator's switch will be turned to the right.
and the connections secured as indicated in Fig. 7, the automatic protective switch serving to close contacts 36 and 37 when the battery 33 is connected in the circuit in proper direction and the automatic switch serving to prevent the closing of contacts 36, 37 when the battery 33 is improperly connected, the action being similar in this respect with that described in relation to Fig. 1. The circuit through the controlling coil 38 of the automatic switch may be traced from one terminal of the battery through contacts 101 and strip 96 of the operator's switch, then through resistance 40 if used and coil 78 to the permanent iron magnet 34 and thence to the other terminal of the battery, the coil 33 thus being connected in shunt to the battery through the resistance 40. The operator's switch is arranged so that the contacts 101 are connected with each other by conductor 98 before contacts 98 and 102 are connected and this insures the separation of contacts 36, 37 before the battery could be connected in series with the magneto even momentarily, in case the battery should be improperly connected in circuit. With the contacts 36 and 37 closed, the primary or generating circuit of the system may be traced as follows: from ground through generating winding 44 of the magneto, terminal 46, segment 98, conductor 97, segment 102, to contact 97, which in the present instance should be insulated, thence to contact 36, pivoted member 35, magnet 34 which is also insulated from other parts of the apparatus, thence to battery 33, terminal 63 and through the breaker to ground. This circuit therefore includes the generating winding 44 and the battery 33 in series with each other and they will now act jointly to supply energy for ignition as more fully described with reference to the system shown in Fig. 1. When operating with the winding 44 and battery connected in series with each other, the connections of the secondary or ignition circuit will of course remain as before and need not be again described.

It will further be understood that when the magneto is inactive or at rest, the battery 33 may serve as the sole source of energy by acting in conjunction with the windings 44, 45 of the magneto which then serve as induction or transformer coils and thus avoids the necessity of additional or auxiliary induction coils. For example, if the engine and magneto should be at rest and happened to stop with the contacts 65, 72 of the breaker closed, a discharge could be obtained by oscillating the interrupter casing by means of the arm 52 which would cause the primary circuit to be broken and the energy from the battery would then act through the coils 44, 45 to produce ignition, and the engine would start itself if the cylinder affected contained an explosive mixture. In lieu of oscillating the casing of the breaker, the switch 104 might be momentarily closed and opened which would close and open the primary circuit in case the breaker happened to be opened, the battery and windings 44, 45 acting the same in each case.

It will also be understood that with a magneto embodying my invention and herein described and illustrated, any necessary repair or inspection of the generating winding may be readily made by removing the bridge-piece and winding as a unit after removing the screws 4, and in case of damage of the winding beyond repair, a new winding and bridge-piece may be easily substituted.

It will also be understood that the form of the magneto is simple in construction and secures the advantage of occupying a small amount of space. Also that it is not necessary to remove the inductor or pole pieces in order to remove the winding and that the inductor may be used to keep the magnetic circuit closed, while the winding is removed, thus avoiding demagnetization of the permanent magnet.

While I have herein described two preferred applications of my improved method and system of ignition, and while I have described particularly certain forms of magneto construction and related apparatus, yet it will be understood that my invention is capable of various other applications and forms of construction without departing from the scope thereof.

Having thus described my invention, I declare that what I claim as new and desire to secure by Letters Patent, is,—

1. An ignition system comprising in the generating circuit, a source of direct current, an inductor alternator, having a permanently magnetized portion and a plurality of poles of the same polarity, the stationary coil of the alternator being disposed about a magnetic portion between said plurality of poles of the same polarity, and means for connecting the direct current source in series with said stationary winding.

2. An ignition system comprising in the generating circuit a source of direct current, an inductor magneto alternator having a permanently magnetized portion and a plurality of poles of the same polarity, the stationary coil of the alternator embracing a magnetic portion in the magnetic path between said poles of the same polarity, and means for connecting the direct current source in series with said stationary winding.

3. An ignition system comprising in the generating circuit, a source of direct current and a source of alternating electromotive force connected in series relatively to each.
other, the said source of alternating electromotive force having a stationary generating winding and means for causing an increase and decrease of magnetic flux through said winding in one direction only.

4. An ignition system comprising in the generating circuit, a source of direct current and an inductor alternator connected in series relatively to each other, the said alternator having a stationary generating winding and means for causing an increase and decrease of magnetic flux through said winding in one direction only.

5. An ignition system comprising in the generating circuit, a source of direct current and an inductor magneto alternator connected in series relatively to each other, the said alternator having a stationary generating winding and means for causing an increase and decrease of magnetic flux through said winding in one direction only.

6. An ignition system comprising in the generating circuit, a source of direct current and a source of alternating electromotive force connected in series relatively to each other, and an intermittently operated breaker for closing and opening the circuit during generation of waves by said source of electromotive force in the same direction as the electromotive force of the direct current source and in a direction tending to strengthen the magnetization of the source of alternating electromotive force and for causing the circuit to be opened during generation of waves of opposite direction.

7. An ignition system comprising in the generating circuit, a source of direct current and an inductor alternator having stationary generating winding connected in series with said direct current source, and an intermittently operated breaker for closing and opening the circuit during generation of waves by said alternator in the same direction as the electromotive force of the direct current source and in a direction tending to strengthen the magnetization of the alternator and for causing the circuit to be opened during generation of waves of opposite direction.

8. An ignition system comprising in the generating circuit, a source of direct current and an inductor magneto alternator having its stationary generating winding connected in series with said direct current source, and an intermittently operated breaker for opening and closing the circuit during generation of waves by said alternator in the same direction as the electromotive force of the direct current source and in a direction tending to strengthen the magnetization of the alternator and for causing the circuit to be opened during generation of waves of opposite direction.

9. An ignition system comprising in the generating circuit, a source of direct current and a source of alternating electromotive force connected in series relatively to each other, the said source of alternating electromotive force having a stationary generating winding means for causing an increase and decrease of magnetic flux through said winding in one direction only, and an intermittently operated breaker for closing and opening the circuit during generation of waves by said source of alternating electromotive force in the same direct direction as the electromotive force of the direct current source and in a direction tending to strengthen the magnetization of the source of alternating electromotive force and for causing the circuit to be opened during generation of waves of opposite direction.

10. An ignition system comprising in the generating circuit, a source of direct current and an inductor alternator connected in series relatively to each other, the said alternator having a stationary generating winding means for causing an increase and decrease of magnetic flux through said winding in one direction only, and an intermittently operated breaker for closing and opening the circuit during generation of waves by said alternator in the same direction as the electromotive force of the direct current source and in a direction tending to strengthen the magnetization of the alternator and for causing the circuit to be opened during generation of waves of opposite direction.

11. An ignition system comprising in the generating circuit, a source of direct current and an inductor magneto alternator having its stationary generating winding connected in series with said direct current source, means for causing an increase and decrease of magnetic flux through said winding in one direction only, and an intermittently operated breaker for closing and opening the circuit during generation of waves by said alternator in the same direction as the electromotive force of the direct current source and in a direction tending to strengthen the magnetization of the alternator and for causing the circuit to be opened during generation of waves of opposite direction.

12. An ignition system comprising in the generating circuit, a source of direct current and a source of alternating electromotive force connected in series relatively to each other, and a polarized switch having a winding for automatically preventing the closing of the circuit when the source of direct current is improperly connected.

13. An ignition system comprising in the generating circuit, a source of direct current and an inductor alternator having its stationary generating winding connected in series with said direct current source, and a polarized switch having a winding for auto-
matically preventing the closing of the circuit when the source of direct current is improperly connected.

14. An ignition system comprising in the generating circuit, a source of direct current and a source of alternating electromotive force having a generating winding connected in series with said direct current source, means for causing an increase and decrease of magnetic flux in said generating winding in one direction only, and a polarized switch having a winding for preventing the closing of the circuit when the source of direct current is improperly connected.

15. An ignition system comprising in the generating circuit, a source of direct current and an inductor alternator having a stationary generating winding connected in series with said direct current source, means for causing an increase and decrease of magnetic flux through said winding in one direction only, and a polarized switch having a winding connected in said circuit for automatically preventing the closing of said circuit when the source of direct current is improperly connected.

16. An ignition system comprising in the generating circuit, a source of direct current and a source of alternating electromotive force connected in series relatively to each other, and an intermittently operated breaker for closing and opening the circuit during generation of waves by said source of electromotive force in the same direction as the electromotive force of the direct current source, and in a direction tending to strengthen the magnetization of the source of alternating electromotive force and for causing the circuit to be opened during generation of waves of opposite direction, and a polarized switch having a winding for automatically preventing the closing of the circuit when the source of direct current is improperly connected.

17. An ignition system comprising in the generating circuit, a source of direct current and a source of alternating electromotive force having a generating winding connected in series with said direct current source, means for causing an increase and decrease of magnetic flux through said winding in one direction only, and an intermittently operated breaker for closing and opening the circuit during generation of waves by said source of alternating electromotive force in the same direction as the electromotive force of the direct current source and in a direction tending to strengthen the magnetization of the source of alternating electromotive force and for preventing the closing of the circuit when the source of direct current is improperly connected.

18. An ignition system comprising in the generating circuit, a source of direct current and an inductor alternator having its stationary generating winding connected in series with said direct current source, means for causing an increase and decrease of magnetic flux in one direction only, and an intermittently operated breaker for opening the circuit during generation of waves by said alternator in the same direction as the electromotive force of the direct current source and in a direction tending to strengthen the magnetization of the alternator and for causing the circuit to be opened during generation of waves of opposite direction, and a polarized switch having a winding connected to prevent the closing of the circuit through said alternator when the source of direct current is improperly connected.

19. An ignition system comprising in the generating circuit a source of direct current, a source of alternating electromotive force, a manually operated switch for connecting said source of direct current in series with a generating winding of said alternator source, and a switch comprising a controlling coil for preventing the closing of the circuit when the source of direct current is improperly connected, said manually operated switch being arranged to close said controlling coil of said automatic switch before the source of direct current is connected to said generating winding by said first named switch.

20. An ignition system comprising in the generating circuit a source of direct current, an inductor alternator, a manually operated switch for connecting said direct current source in series with a generating winding of said alternator, and a polarized switch comprising a controlling coil for preventing the closing of the circuit when the source of direct current is improperly connected, said manually operated switch being arranged to close the circuit of said controlling coil of said automatic switch before the connection of said direct current source to said generating winding by the first named switch.

21. An ignition system comprising in the generating circuit, a source of direct current and an inductor alternator having its stationary primary winding connected in series with said direct current source, and a secondary winding on said alternator connected in the spark discharge circuit, and a polarized switch comprising a controlling coil for preventing the closing of the circuit when said direct current source is improperly connected.

22. An ignition system comprising in the
generating circuit, a source of direct current and an inductor magneto alternator having its stationary primary winding connected in series with said direct current source, a secondary winding on said alternator connected in the spark discharge circuit, and means for causing an increase and decrease of magnetic flux through said windings in one direction only.

23. An ignition system comprising in the generating circuit, a source of direct current and an inductor alternator having its stationary primary winding connected in series with said direct current source, means for causing an increase and decrease of magnetic flux through said primary winding in one direction only, and a secondary winding on said alternator connected in the spark discharge circuit.

24. An ignition system comprising in the generating circuit, a source of direct current and an inductor alternator having a primary winding connected in series with said direct current source, and an intermittently operated breaker for closing and opening the circuit during generation of waves by said alternator in the same direction as the electromotive force of the direct current source and in a direction tending to strengthen the magnetization of the alternator and for causing the circuit to be opened during generation of waves of opposite direction, and a secondary winding on said alternator connected in the spark discharge circuit.

25. An ignition system comprising a source of alternating electromotive force, said source having a generating winding, means for causing an increase and decrease of magnetic flux through said generating winding in one direction only, and means for closing the circuit of said winding during the period when current flows in a direction tending to magnetize the magnetic field element of the source and for opening the circuit of said winding during the generation of electromotive force in the opposite direction.

26. An ignition system comprising a source of alternating electromotive force, said source having a generating winding, means for causing an increase and decrease of magnetic flux through said generating winding in one direction only, a breaker for closing and opening the circuit of said winding, and means for causing said breaker to be closed during the generation of waves by said winding in a direction tending to strengthen the magnetization of the field element of the source and for causing said breaker to be opened during generation of waves of opposite direction.

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

LEON J. LE PONTOIS.

Witnesses:

L. K. SAGER,
Geo. N. Kerr.