R. VARLEY.

ELECTRICAL SYSTEM.

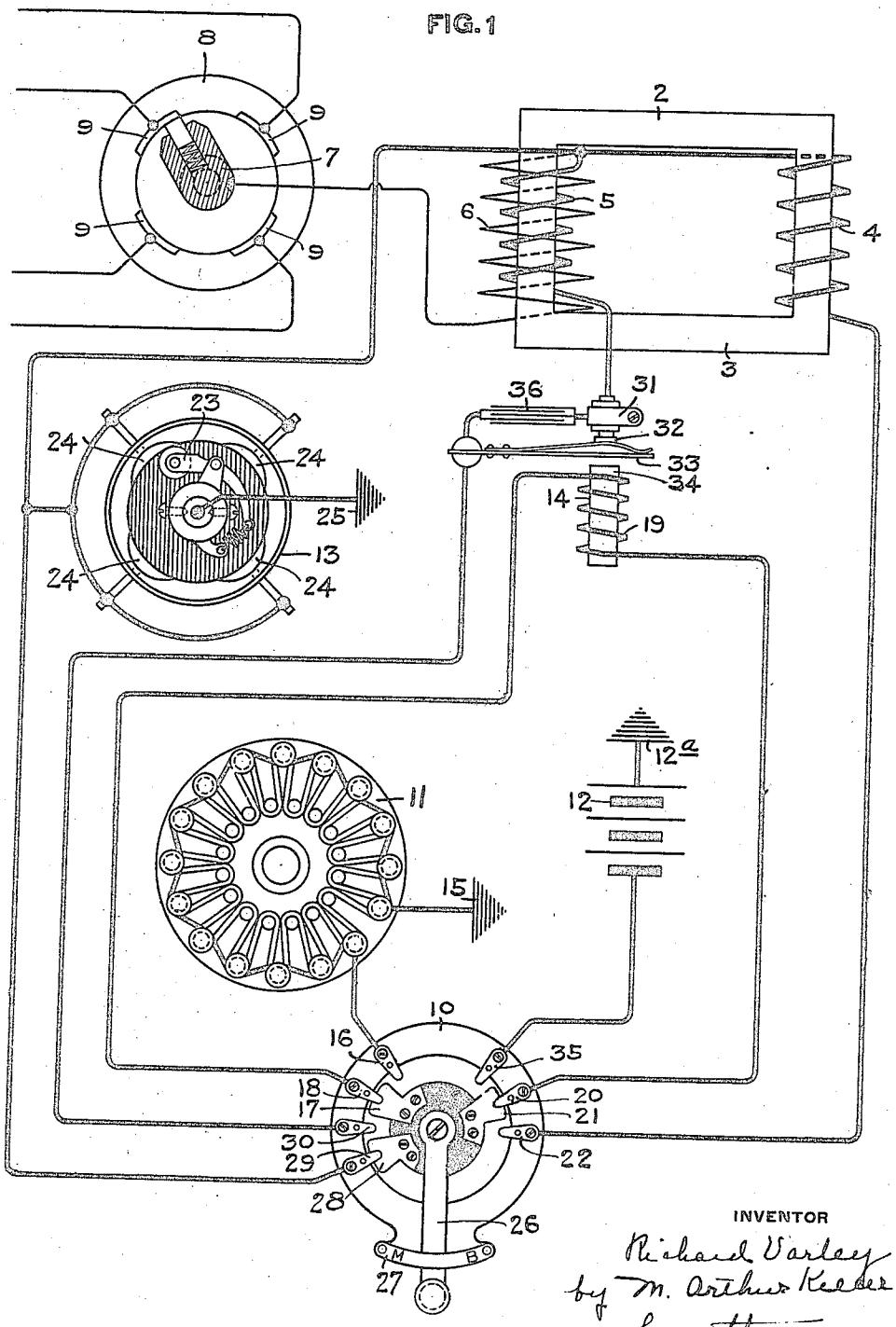
APPLICATION FILED APR. 27, 1915.

1,225,534.

Patented May 8, 1917.

4 SHEETS—SHEET 1.

FIG. 1



INVENTOR

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by M. Arthur Keeler

his attorney

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4 SHEETS—SHEET 2.

FIG. 2

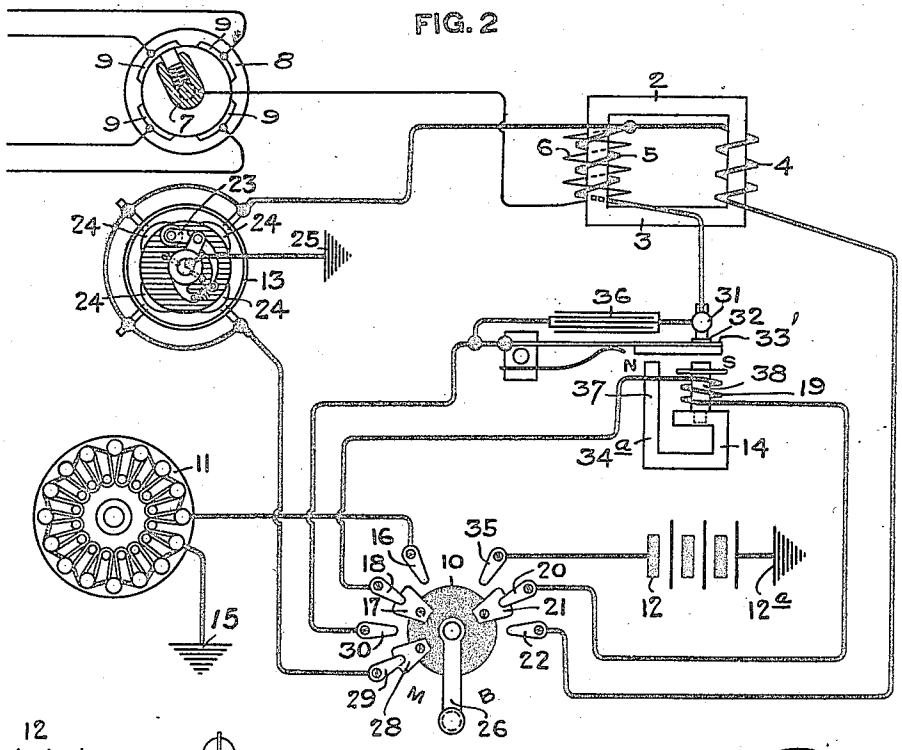
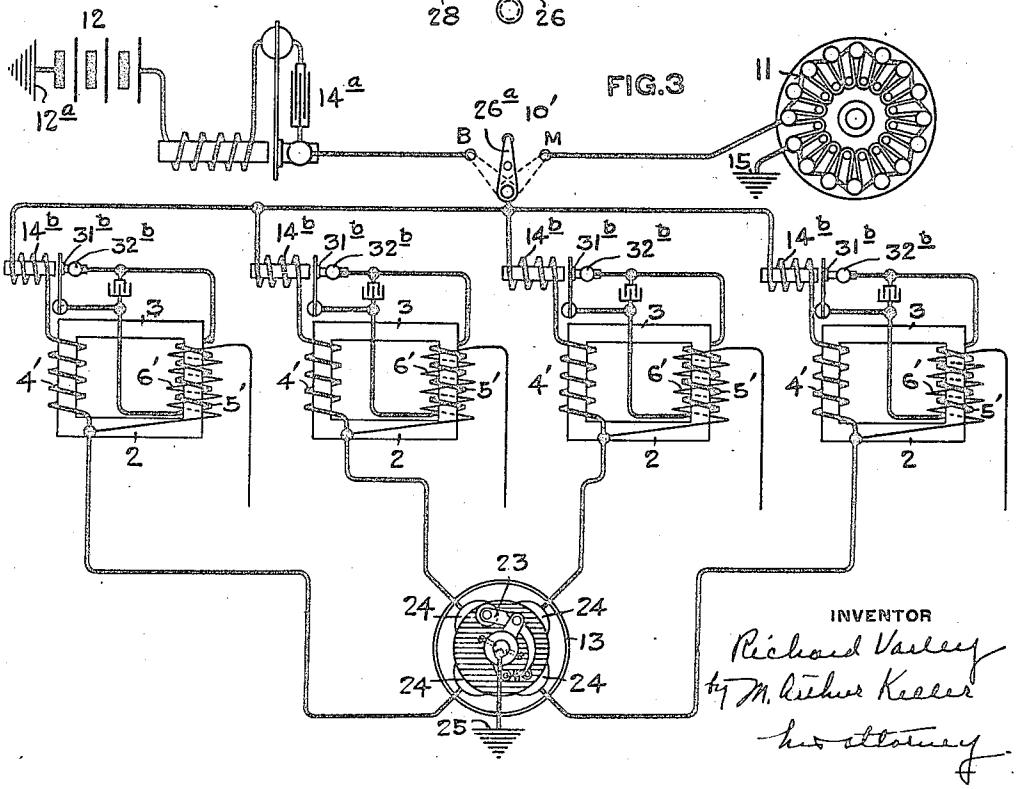


FIG. 3



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4 SHEETS—SHEET 3.

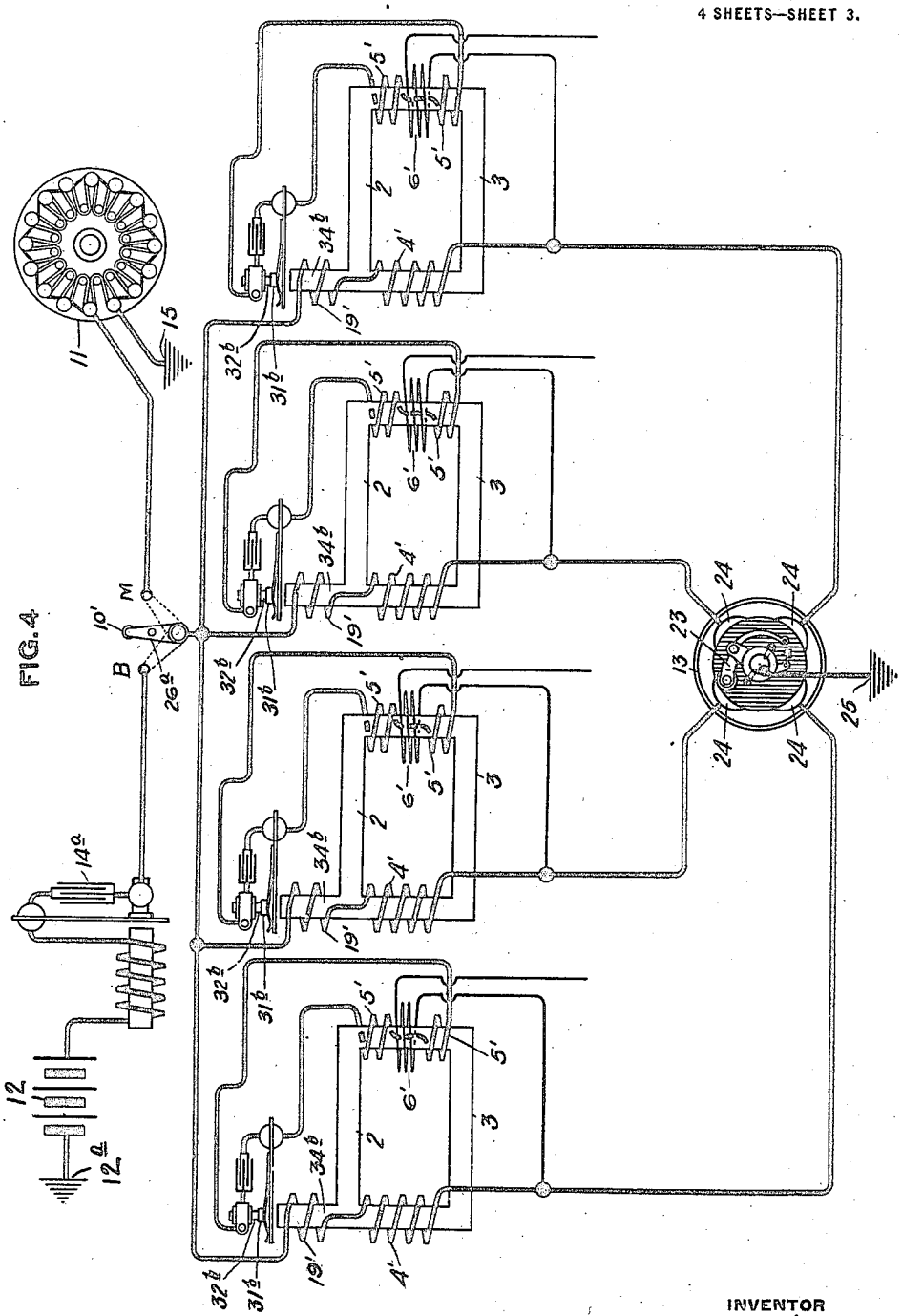

FIG. 4

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4 SHEETS—SHEET 4.

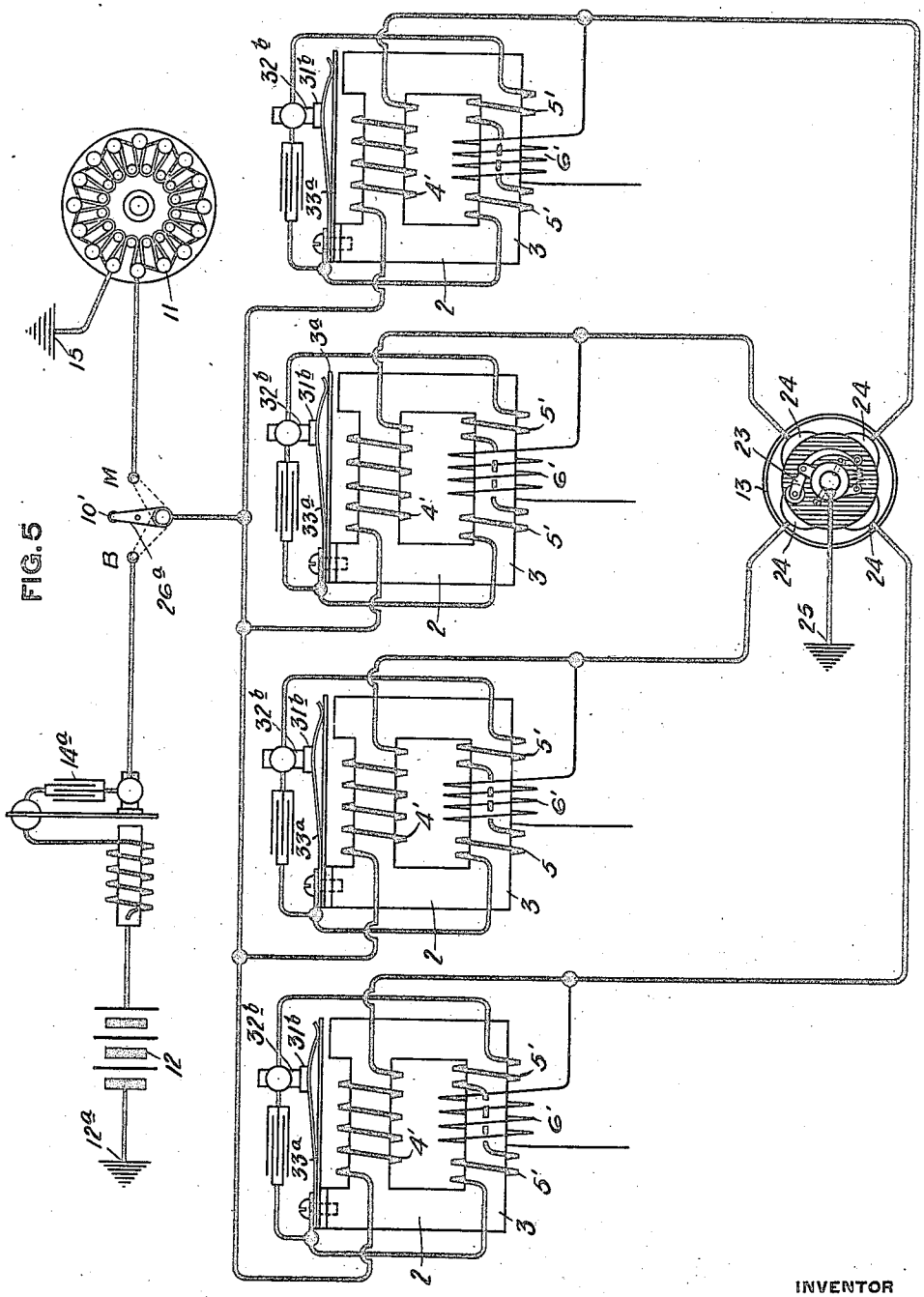

FIG. 5

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UNITED STATES PATENT OFFICE.

RICHARD VARLEY, OF ENGLEWOOD, NEW JERSEY.

ELECTRICAL SYSTEM.

1,225,534. Specification of Letters Patent. Patented May 8, 1917.

Application filed April 27, 1915. Serial No. 24,252.

To all whom it may concern:

Be it known that I, RICHARD VARLEY, a citizen of the United States of America, residing at Englewood, in the county of Bergen and State of New Jersey, have invented new and useful Improvements in Electrical Systems, of which the following is a specification.

This invention is an electrical system wherein a high tension flow or discharge of current is effected at a current using instrumentality, such as a spark gap or the spark plug of a cylinder of an internal combustion engine.

As such a system I aim for high efficiency in spark discharge or energizing of the current using instrument, simplicity of construction and arrangement and flexibility in control.

In Letters Patent 1,081,413, granted to me on December 16th, 1913, I disclose an electrical system employing a transformer wherein the magnetic flux may be built up to a supernormal state of intensity for prolonged energizing thereby of a current using instrumentality. In said Letters Patent I show means for controlling the flux and comprising essentially a circuit adapted to be opened and closed at desired intervals to effect periodical discharges of current at the instrument, and issued on applications divided from the disclosure of the specification of the said Letters Patent are Letters Patent No. 1,103,385, granted to me July 14th, 1914, and No. 1,112,177, granted to me September 29th 1914, and wherein are disclosed means, comprising a plurality of circuits, one or more of which are used in building up and in controlling the state of flux in the transformer.

In the latter two Letters Patent said circuits are shown as comprising windings on a plurality of legs of the transformer core. These windings may both be energized from a source of alternating current or from a source of continuous current. When connected with the source of alternating current, preferably the circuit of only one of the windings is interrupted to obtain current discharge, and when connected with the source of continuous current preferably both circuits are interrupted.

In the present case I disclose a system employing a transformer having a plurality of windings one of which comprises a choke winding or circuit when the transformer is energized from a source of alternating current, but which may be used as an energizing winding for the transformer for energizing the current using instrumentality from a source of continuous current, such as a battery.

I also herein disclose other novel features of construction, all of which will be hereinafter more fully set forth in the following description in which reference is made to the accompanying drawings and which is addressed to those skilled in the art.

In the drawings I have shown my invention as applied to an ignition system whereby the gaseous charges in the cylinders of an internal combustion engine, may be exploded. However, my invention is not limited in use but, on account of the advantages obtained thereby, it finds desired embodiment in ignition systems. It also will be apparent that many changes may be made in the construction and arrangement shown, without departing from my invention.

Figure 1 is a diagrammatic view of an ignition system embodying my invention; Fig. 2 is a similar view showing a modified form of interrupter mechanism; Fig. 3 is a diagrammatic view showing an arrangement wherein a plurality of transformers are employed to energize a plurality of spark plugs or current using instruments; Fig. 4 is a similar view, showing a manner of utilizing the magnetic flux of the transformer core, to operate the current responsive interrupter mechanism; and Fig. 5 is a similar view showing a modified manner of mounting the interrupter mechanism and of disposing the windings on the legs of the transformers.

In Fig. 1, the numeral 2 indicates the core of a transformer 3 that corresponds generally with that disclosed in my several above mentioned Letters Patent in that it is provided with a plurality of windings, herein indicated by the numerals 4 and 5, by means of which a magnetic flux is caused to be built up in the core to a supernormal state for energizing of a secondary winding 6, which is grounded and leads to the rotatable arm 7 of distributer apparatus 8 the segments 9 of which connect with the spark plugs of the cylinders of the engine (not shown) in the usual manner. Switch mechanism 10 is employed to establish between the winding 4 and an alternating current generator 11 and between winding 5

and a source of direct current, such as battery 12, circuit connections under control of roller timer apparatus 13 and interrupter or contact mechanism 14, in the manner hereinafter more fully described.

The alternating current generator 11 (here shown as of a type for a four cylinder four cycle engine) has its energizing circuit or inductive winding grounded at one end, as at 15, while the other end is adapted to connect through switch contacts 16 and 17 and 18 of switch 10 with winding 19 of the interrupter mechanism 14 which in turn through switch contacts 20, 21, and 22 may be brought into circuit with transformer winding 4 when the rotatable arm 23 of the roller timer 13 passes to a timer segment 24, grounding the circuit, as at 25 in common with ground 15; the switch blades 17 and 21 being movable into bridging contact with the respective associated contacts 16 and 18 and 20 and 22, when arm 26 of the switch 10 is shifted to "magneto" position marked "M" on the index plate 27 of the switch mounting. When the switch arm is shifted to this magneto position, switch contact 28 bridges contacts 29 and 30, thereby causing the winding 5 of the transformer to be normally short circuited through a fixed contact 31 and contact 32 carried by an armature blade 33 arranged in attractive juxtaposition to the electro-magnet core 34 of said interrupter mechanism.

The roller timer mechanism 13 is geared to be driven in synchronism with the engine, as in the usual manner, and with the switch mechanism 10 adjusted for magneto connections in the manner above described, it will be apparent that, with driving by the engine of the generator 11 to produce a suitable alternating current, travel of the timer arm 23 into engagement with the segment 24 will close the circuit of the transformer winding 4, setting up a flux in the core thereof. With the circuit of the winding 5 closed by the interrupter mechanism 14, said winding acts as a choke upon the travel of the magnetic lines of force set up in the transformer core, causing a repression thereof from that particular portion of the core in such manner that, with sufficient source strength, the lines of force tend to take a leakage path intermediate the sides or legs of the transformer. As the current wave approaches or reaches its maximum point or period of flow the core of the electromagnet 14 will be sufficiently energized, by reason of the magnet winding 19 in the circuit of the generator winding, to attract the armature 33 and separate contact 32 from contact 31, and thus suddenly opening the circuit of the winding 5. Opening of the circuit of this winding 5 causes the repressed flux to assume the normal magnetic path of the core, causing in the leg carrying the secondary winding 6, a magnetic surge of great intensity which immediately builds up in the secondary winding 6 a voltage capable of instantly breaking down or bridging the gap of a spark plug connected in circuit through the distributer arm 7 and a segment 9. During the time the roller timer arm 23 is in engagement with a segment 24, the winding 4 of the transformer remains in active circuit with the generator so that during and after the first disruptive movement of the flux in the core, the tendency is to maintenance of an active state of flux for prolonged energizing of the current using instrumentality, all as clearly set forth in my above mentioned Letters Patent 1,081,413.

By employing the roller timer 13 or other suitable contact mechanism for intermittently establishing the above mentioned circuit closure, I provide means for bringing the transformer winding 5 into circuit with the source of continuous current or battery 12, when the switch arm 26 is shifted in an opposite direction or to battery position marked "B" on the indicator plate 27. Shifting of the switch arm to battery position causes the switch blade 21 to connect contact 20 with contact 35 and to cause contact 17 to bridge contacts 18 and 30. As a result the interrupter winding 19 is connected in circuit with the contacts 31 and 32 so that the armature blade 33 vibratorily responds to cause a pulsative flow of current from the battery through the transformer winding 5 when the roller timer arm 23 passes to a segment 24 and completes said battery circuit through grounds 25 and 12^a. Energizing of the winding 5, of course, induces a high potential current in the secondary winding 6, as is well understood, when the circuit of winding 4 is open, for energizing of the spark plug connected in circuit by the synchronously driven distributer mechanism 8. A usual condenser 36 is preferably connected across the contacts 31 and 32.

With the switch arm 26 shifted to "B" or battery connection, it will be seen that the generator 11 and the transformer winding 4 are brought out of active circuit. The arrangement shown is such that the battery current may be utilized through this same transformer in starting the engine or at such times when the generator is running at a speed non-productive of effective energizing of the transformer by the alternating current.

In Fig. 2 I have shown the system illustrated in Fig. 1 but have also shown a modified form of interrupter mechanism 14 embodying a polarized magneto or relay selective of a certain portion of the alternating current. Said portion may be either the positive or the negative part, the interrupter

preferably being operated by the higher tension values of the portion employed, that is, being responsive at or near the peak of the current wave. This selective interrupter comprises, more specifically stated, a magnet 34ª the leg 37 of which has a permanent magnetism. Another leg or pole piece 38 of the magnet carries the winding 19 above described in connection with Fig. 1. Either pole or leg 37 or 38 singly is ineffective to attract the armature 33′. The arrangement is such that the interrupter will respond to interrupt the circuit of the transformer winding 5 to currents flowing in one direction only. It will be assumed that the leg 37 is of "N" or "north" polarity and the leg or pole 38 of "S" or "south" polarity. The winding 19 may be so arranged as to cause an increase in the energizing of the pole 38 when the positive portion of the current wave traverses the winding 19, so that when it rises to its maximum value it will attract the armature blade 33′ for opening of the circuit of the winding 5, for the purpose above set forth, but when the negative portion of the current wave traverses said winding 19, the pole 37 will be weakened, so that the armature 33′ does not attractively respond for separation of the contacts 31 and 32, or the arrangement may be reversed, if desired, so that the negative portion only of the wave may operate to actuate the interrupter mechanism, it being premised that my invention is not limited to utilization of any particular portion of the current wave. It also will be apparent that I may use any suitable form of magnet functionally corresponding to the magnet above described.

Among the advantages of the arrangement shown in Fig. 2 is the following: In Fig. 1 it will be seen that with the employment of a generator of the high frequency type, a plurality of pulsations may traverse the winding 19 of the current responsive interrupter during travel of the controller of timer arm 23 over a segment 24. As a result the current interrupter mechanism 14, unless otherwise controlled, responds to separate the contacts 31 and 32 at each impulse or rise of the current to maximum value, causing the transformer to deliver a succession of sparks at the plug during the engagement of the distributer arm with the respective plug segment 9. In the present arrangement of Fig. 2, the selective or polarized interrupter is responsive to only the positive pulsations or the negative pulsations (as desired) of current, with the result that the frequency of discharge of the transformer is cut down with resultant reduction of stresses and saving of the interrupter contacts.

It will of course be understood that the arrangement in Fig. 2 is such that when the switch arm 26 is shifted to battery position and the roller timer otherwise completes the circuit, as above described in connection with Fig. 1, the current from the battery is made to flow through the interrupter winding 19 in the right direction so that said interrupter is vibratorily responsive to said continuous current.

Inasmuch as the system shown in Fig. 2 in other respects corresponds with the system shown in Fig. 1, further description of this second arrangement is rendered unnecessary, like reference numerals being used to indicate like parts.

In Fig. 3 I have shown a system wherein a plurality of transformer units are employed and in which each transformer may be energized from the source of continuous current without bringing the controlling coil or choke coil (indicated in Figs. 1 and 2 as the coil or winding 5) into circuit with said source of current. Each transformer 3 is provided with an energizing winding 4′ which by means of switch mechanism 10′ and the roller timer mechanism 13, may be brought into circuit with the generator 11 or with the source of continuous current 12, in the circuit of which last named source is vibrator mechanism 14ª. Each transformer is provided with an auxiliary interrupter mechanism 14ᵇ the winding of which is in series with the transformer winding 4′. The secondary winding 6′ of each transformer is suitably grounded and leads to a spark plug (not shown).

With the switch arm 26ª shifted to either generator or battery connection, passage of the synchronously driven roller timer arm 23 into engagement with a segment 24 of the timer, completes the circuit of a respective coil or winding 4′ of the transformer through ground 12ª or 15 and ground 25. Energizing of the winding 4′ besides setting up a state of flux in the respective transformer in the manner already described, causes energizing of the winding of the auxiliary interrupter or vibrator 14ᵇ for opening of the circuit of the winding 5′ and energizing of the spark plug connected in circuit of the respective secondary winding 6′, as is understood, energizing of a transformer by the generator causing the respective interrupter or controller 14ᵇ to respond at or near the peak of the current wave.

When the switch arm 26ª is shifted for utilization of the battery current, the vibrator 14ª causes a trembled flow of current through a transformer winding 4′ connected in circuit through grounds 12ª and 25 as the roller timer arm 23 engages a segment 24. The interrupter 14ª is preferably "lagged" slightly behind the vibrators 14ᵇ so that the choke coil circuit of any transformer is opened before the battery circuit is opened by means of the interrupter 14ᵇ.

In Fig. 4 I show a system corresponding with that shown in Fig. 3 (and like parts of which accordingly bear like reference numerals) with the exception that the auxiliary vibrator or current responsive interrupter 14^b is here disclosed as having its electro-magnet forming part of the transformer. This is preferably done by extending from the transformer core a leg portion 34^b carrying the energizing winding 19′ in series with the winding 4′. The arrangement is such that the flux of the transformer core assists the flux set up in the leg 34^b by the winding 19′ so that very few ampere turns of winding 19′ are required. Furthermore, it provides a compact, self-contained arrangement. In this system shown in Fig. 4 it also will be noticed that the choke winding or controlling circuit 5′ is disposed at opposite ends or sides of the secondary winding 6′. This brings the secondary winding into a more intimate and therefore influentially receptive inductive relationship to the core of the transformer and operates to reduce the copper content or bulk of winding of both choke winding and secondary winding, resulting in compactness and saving in cost of production.

In lieu of extending the transformer core in the manner shown in Fig. 4 to form a core 34^b for the magnet of the interrupter mechanism, I may cause the rise and fall of the flux in the main core of the transformer to actuate the interrupter blade or armature. Such an arrangement is shown in Fig. 5 the parts of which correspond with those of Fig. 4 and bear like reference numerals. In this system, the transformer core carries the armature blade 33^a in such manner that it lies attractively adjacent the end of a leg carrying the active winding 4′. It thus will be seen that control of the interrupter is effected solely through the transformer *per se*, the extra winding 19′ shown in the preceding arrangements, being eliminated. This direct action results in positiveness and dependence in operation besides having structural advantages in compactness of form and simplicity of mounting of the interrupter blade or armature.

The broad features herein described of building up a high state of flux from a source of energy and causing said flux to inductively energize a current using instrumentality are not claimed herein as the same are covered by my above mentioned Letters Patent No. 1,081,413.

The arrangements shown in Figs. 2, 3, 4 and 5, except as hereinafter may be claimed, are not claimed herein as the same form subject matter of my applications Serial Nos. 41,427, and 53,196.

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

1. A source of energy and a circuit therefor, a coil inductively related to said circuit and a second coil inductively related to the other coil, of current responsive means for intermittently short circuiting said first coil.

2. A source of energy and a circuit therefor, a plurality of coils inductively related to said circuit, one of said coils having in circuit a spark gap, and current actuated means for intermittently short circuiting another of said coils.

3. A source of energy and a circuit therefor, a plurality of coils inductively related to said circuit and to one another, and current actuated means for intermittently short circuiting one of said coils.

4. A source of energy and a circuit therefor, a plurality of coils inductively related to said circuit and to one another, one of said coils having in circuit a spark gap, and current actuated means for intermittently short circuiting another of said coils.

5. A source of energy and a circuit therefor, a coil inductively related to said circuit and having in circuit a spark gap, a coil for controlling said inductive relationship, and current responsive apparatus for intermittently short circuiting said controlling coil.

6. A source of energy and a circuit therefor, a coil inductively related to said circuit and having in circuit a spark gap, a coil for controlling said inductive relationship, and apparatus for controlling the circuit of the last named coil and having electrically actuable means in circuit with said source.

7. A source of energy and a circuit therefor, a coil inductively related to said circuit, a second coil inductively related to said other coil, and means for intermittently short circuiting one of said coils and comprising electro-magnetic means in circuit with said source.

8. A source of energy and a circuit therefor, a coil inductively related to said circuit, a second coil inductively related to said other coil and having in circuit a spark gap, and means for intermittently short circuiting said first coil and comprising electro-magnetic means in circuit with said source.

9. A source of energy and a circuit therefor, a coil inductively related to said circuit, a second coil inductively related to the other coil, and current responsive means for short circuiting one of said coils and operatively connected in the first named circuit.

10. A source of energy and a circuit therefor, a coil inductively related to said circuit, a second coil inductively related to said circuit and having in circuit a spark gap, and electro-magnetic means connected in said first circuit, for short circuiting said first coil.

11. A source of energy, a plurality of windings one of which is provided with a spark gap and another of which is connected in circuit with said source of energy, means for short circuiting a third of said windings and comprising electro-magnetic means in circuit with said source of energy and said second named winding.

12. A source of energy and a winding connected thereto, a second coil or winding inductively related to said first winding, a third coil inductively related to said second winding, and electromagnetic means in series with said source, for intermittently short circuiting another of said coils or windings.

13. A source of energy and a coil connected thereto, a second coil inductively related to said coil, a third coil inductively related to said second coil, and electro-magnetic means in series with said source and one of said coils, for intermittently short circuiting another of said coils.

14. A transformer core provided with a plurality of windings one of which is for connection with a source of energy and another of which is connected in circuit with a current using instrumentality, and a current responsive contact mechanism for intermittently short circuiting another of said windings.

15. A magnetizable core, a winding thereon adapted for connection with a source of energy, a second winding thereon having in circuit a spark gap and, by reason of said core inductively related to said other winding, a third winding for controlling said inductive relationship, and a current actuated device for intermittently short circuiting said third winding.

16. A magnetizable member provided with a plurality of windings one of which is for connection with a source of energy and another of which is connected in circuit with a current using instrumentality, and current responsive contact mechanism connected in circuit with said first named winding, for intermittently short circuiting another of said windings.

17. A source of energy and a circuit therefor, a coil inductively related to said circuit and a second coil inductively related to the other coil, of current responsive means for intermittently short circuiting said first coil, and means for also bringing said first coil into and out of energizing connection with a source of energy.

18. A source of energy and a circuit therefor, a plurality of coils inductively related to said circuit, one of said coils having in circuit a spark gap, current actuable means for intermittently short circuiting another of said coils, a separate source of energy, and means for connecting said last named coil in circuit with said separate source of energy.

19. A source of energy and a circuit therefor, a plurality of coils inductively related to said circuit, one of said coils having in circuit a spark gap, current actuable means for intermittently short circuiting another of said coils, a separate source of current and means for connecting said short circuiting means in circuit with said second source of energy.

20. A source of energy and a circuit therefor, a plurality of windings inductively related to said circuit, one of said windings having in circuit a current using instrumentality, contact mechanism for intermittently short circuiting another of said windings, and means, including said contact mechanism, for connecting said last named winding in circuit with a separate source of energy.

21. A source of alternating current and a circuit therefor, a coil inductively related to said circuit, a coil inductively related to said coil and having in circuit a spark gap, a third coil for controlling said inductive relationship between the other coils, contact mechanism for short circuiting said third coil, a source of continuous current, and means for connecting said third coil in circuit with said source of continuous current.

22. A source of alternating current and a circuit therefor, a coil inductively related to said circuit, a winding inductively related to said coil and having in circuit a spark gap, a circuit for controlling said inductive relationship between said first two coils or windings, contact mechanism for short closing said circuit, a source of continuous current, and means for connecting said contact mechanism in said controlling circuit and in circuit with the source of continuous current.

23. A transformer having a plurality of windings one of which has in circuit a spark gap, means for connecting another of said windings in circuit with a source of alternating current, means for short circuiting a third of said windings, and means for bringing said third winding into circuit with a source of continuous current.

24. A transformer having a plurality of windings one of which has in circuit a spark gap, means for connecting another of said windings in circuit with a source of alternating current, means for short circuiting a third of said windings and comprising current responsive contact mechanism, and means for bringing said third winding into circuit with a source of continuous current.

25. A plurality of inductively related windings one of which has connected in circuit a current using instrumentality, means for connecting another of said windings in circuit with a source of alternating current, current responsive interrupter mechanism adapted to be connected in circuit with said source of alternating current, for intermit-

tently short circuiting a third of said windings, and means for connecting said current responsive interrupter mechanism in circuit with a source of continuous current to cause it to vibratorily energize said third winding.

26. A plurality of inductively related windings one of which comprises essentially a high tension winding and another of which is adapted for connection with a source of alternating current, vibrator mechanism for intermittently short circuiting another of said windings and actuable by the alternating current source, and means for bringing said vibrator mechanism out of energizing relationship with the alternating source and into circuit with a source of continuous current for causing a pulsative flow of current through said last named winding.

27. A plurality of windings, current responsive contact mechanism having winding adapted for connection with a source of alternating current and responsive to the higher values of tension of said alternating current to interrupt and short circuit one of said windings, and means for connecting the contacts and the winding of said contact mechanism, in circuit with a source of continuous current.

In testimony whereof I have hereunto set my hand.

RICHARD VARLEY.