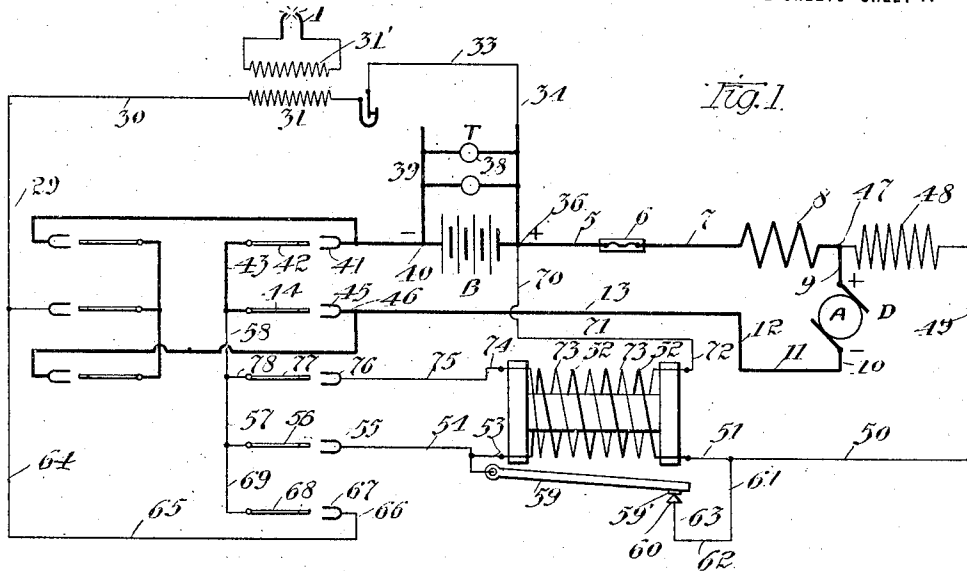
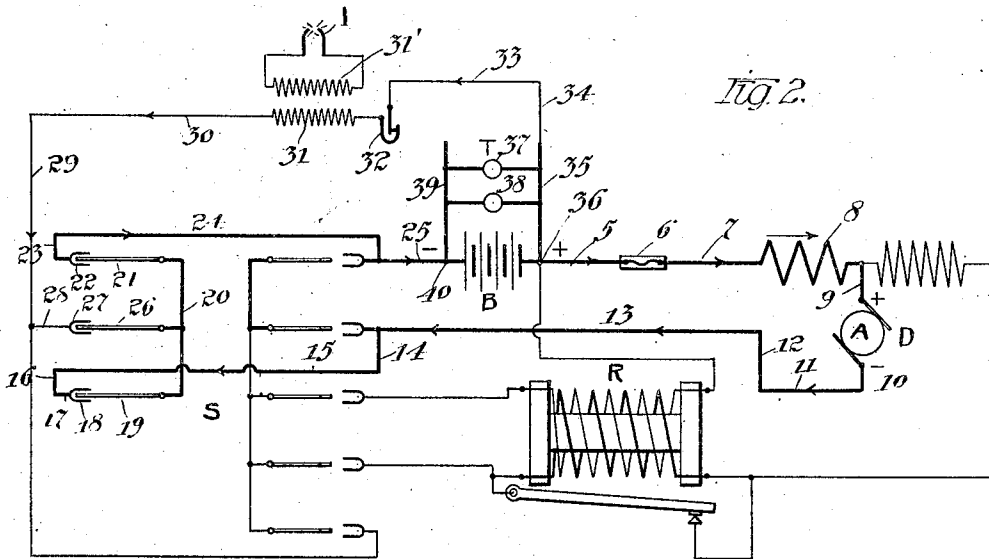


V. G. APPLE.  
ELECTRICAL EQUIPMENT FOR INTERNAL COMBUSTION ENGINES.  
APPLICATION FILED SEPT. 9, 1912.

1,142,791.

Patented June 15, 1915.

2 SHEETS—SHEET 1.



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Fig. 3.

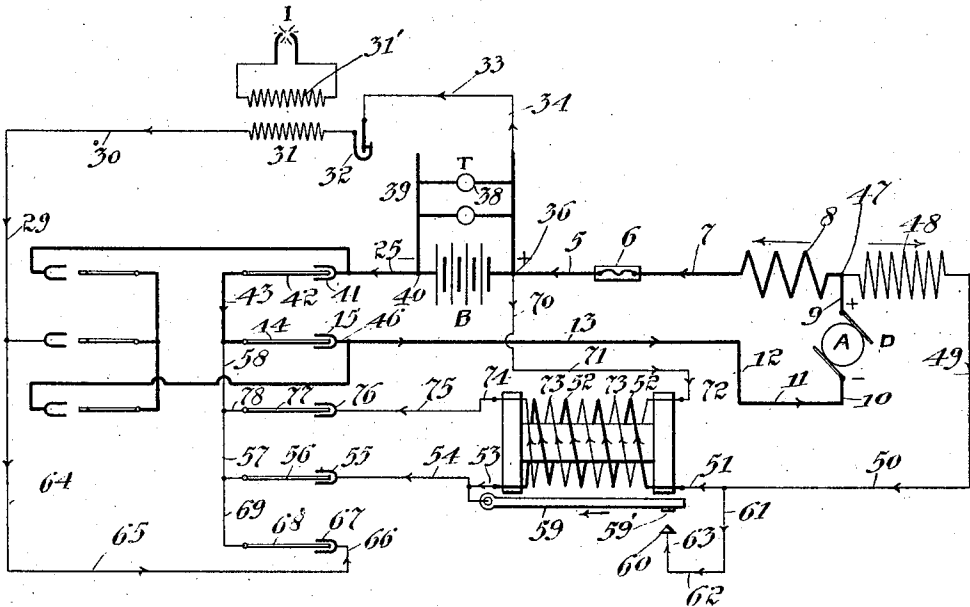
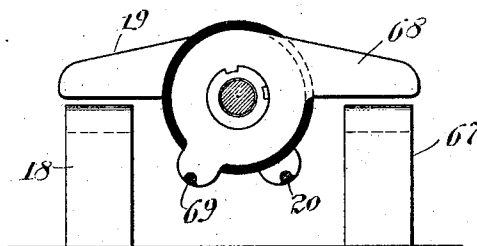


Fig. 4.



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# UNITED STATES PATENT OFFICE.

VINCENT G. APPLE, OF DAYTON, OHIO, ASSIGNOR TO THE APPLE ELECTRIC COMPANY,  
OF DAYTON, OHIO, A CORPORATION OF OHIO.

ELECTRICAL EQUIPMENT FOR INTERNAL-COMBUSTION ENGINES.

1,142,791.

Specification of Letters Patent. Patented June 15, 1915.

Application filed September 9, 1912. Serial No. 719,359.

*To all whom it may concern:*

Be it known that I, VINCENT G. APPLE, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Electrical Equipments for Internal-Combustion Engines, of which the following is a specification.

My invention relates to improvements in electrical equipments for internal combustion engines, comprising means for producing the spark for firing the fuel charge; for starting the engine; for charging a storage battery; for signaling; and for lighting the lamps that may be connected in circuits with these accompanying devices.

One of the general objects of my invention is to provide an equipment of this character to accompany an internal combustion engine that may be employed for propelling an automobile, or other like vehicle.

Another object of my invention is to provide, in a system of the character described, a dynamo-electric machine so constructed and arranged, with reference to the storage battery, that by their coöperation there will be maintained or slightly increased the electromotive force of the current output of said dynamo at times when the speed of the dynamo is increased below a given velocity and whereby said electromotive force will be automatically maintained, or prevented from being increased, by the operation of the dynamo alone when the speed of the dynamo has been increased above a given velocity, thereby to limit the current output of the dynamo under large variations of speed.

Other and further objects of my invention will become readily apparent to persons skilled in the art from a consideration of the following description when taken in conjunction with the drawings, wherein—

Figure 1 is a diagrammatic representation of the devices and circuits included in my electrical equipment. In this diagram all of the circuits are shown to be open; Fig. 2 is a similar view of the devices and circuits showing certain circuits closed which are necessary to be closed when the dynamo is to be used as a motor as when it is being supplied with current from the battery for the purpose of starting or cranking the engine; Fig. 3 is a similar view showing the circuits, that are necessary for charging the

storage battery, closed, when the dynamo becomes a generator; Fig. 4 shows a general form of the switch that may be employed in connection with the circuits for producing the desired results.

The specific construction of this switch is fully disclosed and claimed in a copending application filed by me on the 8th day of August, 1912, and identified by Serial No. 714,086, for an electric circuit controller.

In all the views the same reference characters are employed to indicate similar parts.

In the use of my equipment the circuit is first closed so that the battery will furnish energy for the purpose of energizing the dynamo electric machine for operating said dynamo electric machine as a motor for starting the engine. To accomplish this the circuits are completed, as shown in Fig. 2, whereby the double throw switch S is thrown so that the blades on the left side make contact with their respective clips. The circuit will then be completed directly from the battery to the dynamo.

D is a dynamo provided with the armature A.

B is a storage battery comprising any desired number of cells.

S is a double throw switch.

R is a relay, I is the igniting device and T indicates the translating devices to be maintained between the mains directly connected to the storage battery terminals.

When the switch is thrown to the left, as shown in Fig. 2, and the circuit is completed the current will flow in the direction shown by the arrows, beginning at the positive terminal of the battery and flowing over the wires 5 to the main line fuse 6, over the wire 7 to the series field winding 8 in the direction opposite to that in which the current will pass through this winding when the dynamo is operating as a generator, thereby causing the armature of the dynamo to rotate in the same direction that it is rotated by the engine, when the dynamo is functioning as a generator; through the wire 9 to the positive brush of the dynamo, through the armature A to the negative brush of the dynamo, then over the wires 10, 11, 12, 13 and 14, thence over the wires 15, 16, 17, to the clip 18 of the switch S, thence over the blade 19 and the connector 20 to the blade 21 to the clip 22 thence over the wires 23, 24, 25, to the negative terminal

of the battery, thus including the armature of the dynamo and its series field only in circuit with the battery, causing the dynamo to operate as a motor to rotate the engine until the engine becomes self propelling. The series field is provided with considerable number of ampere-turns, thereby producing considerable torque which is a quality highly essential for the purpose of starting a dead load.

After the engine has become self propelling, the current passing through the circuit just described is reversed, as shown by the arrows in Fig. 3, during this time the series field winding of the dynamo will act to magnetically differentiate the shunt field winding.

After the engine becomes self propelling, and is capable of rotating the dynamo at a given speed, the switch S is thrown in opposite direction or reversed so that the blades of the switch on the right side make contact with their respective clips and the blades of the switch on the opposite side are separated from their clips.

Before the switch has been thrown for the purpose of making a generator of the dynamo, the ignition circuit may be traced as follows: from the connecting wire 20, over the switch blade 26 to the clip 27 over the wires 28, 29, 30, to the primary coil 31 of the igniting device, through the circuit-breaker 32, over the wires 33 and 34, to the main 35 which is connected to the wire 5 at the point 36. It will, of course, be observed that the connector 20 is connected to the negative side of the battery by the circuits heretofore traced.

The translating devices T, shown by the two lamps 37 and 38 are connected in parallel between the mains 35 and 39 as usual. The main 39 is connected to the wire 25 and the negative terminal of the battery, as at 40. It will therefore, be observed that the translating devices may be energized directly by the batteries irrespective of the operation of the dynamo electric machine, whether it is functioning as a generator or as a motor and quite independently of the switch S. Now when the circuits are completed, as shown in Fig. 3, by throwing the switch S so as to complete all of the circuits necessary for the dynamo to operate as a generator, the current will pass from the dynamo D, from the positive brush, over the wire 9 through the series winding 8, in the opposite direction to that taken by the current from the battery, when the dynamo is functioning as a motor, over the wire 7 to fuse 6 and the wire 5 to the positive terminal of the battery, through the battery and the translating devices to the point 40, thence over the wire 25 to the clip 41, through the switch blade 42 and over the connector 43 to the blade 44 to the switch clip 45 and by wire

46 to the wire 13, thence back by wires 12, 11, 10, to the negative brush of the dynamo. Current will now pass through the shunt field winding circuit as follows: from the positive brush of the dynamo over wire 9 to the point 47 thence through the shunt winding 48 in a direction opposite to that taken by the current in the series winding, over the wires 49, 50 and 51, to the relay R, through the relatively heavy resistance winding 52 of said relay, by wire 53 to wire 54, thence to clip 55 of the switch blade 56 to the connectors 57 and 58 to the switch blade 44 and thence back to the negative terminal of the dynamo, through the portion of the circuit which has heretofore been traced, thereby energizing the shunt field winding and including therewith the resistance coil 52.

When the armature 59, of the relay R, is attracted to the electromagnet, the circuit is broken between the contact point 59' of the armature and the stationary contact 60, therefore the resistance coil 52 is included in the series circuit with the shunt winding 48. If, however, the relay is not sufficiently energized as to attract its armature 59, contact will be made between the point 59' and 60, the circuit will then be complete from the wire 50 through the wire 61, the wires 62 and 63, to the contact 60, from thence to the contact 59' and through the armature 59 to the wire 54, thus short circuiting the resistance coil 52 of the relay and decreasing the resistance of the circuit including the shunt field winding, proportionately.

During this time the field windings 8 and 48 are operating in such manner as to magnetically oppose each other, so that the increase of current flowing through the series winding 8 will tend to decrease the magnetic effect of the shunt winding 48 thereby to limit the current to prevent abnormal rise thereof under highest conditions of speed.

The ignition circuit is now completed from the wire 29 over the wires 64, 65, 66, to the clip 67, over the switch blade 68 to the connector 69 and thence as heretofore traced. It will therefore be observed that the ignition circuit, as well as the translating devices is independent of the operation of the switch to close the respective circuits for the purpose of causing the dynamo to operate as a motor or as a generator.

When the storage battery needs charging, as for instance, after it has been used for the purpose of starting the engine, and the electromotive force has thereby been decreased below normal, it is very important to have the dynamo produce current of greater value for the purpose of restoring the battery to its normal charge than will subsequently be required or desired. I therefore, provide the relay R for the purpose of automatically reducing the value of the current output of

the dynamo, at such times, and to this end, the current from the battery, starting at the positive terminal, as from the point 36, would pass over the wires 70, 71, 72, to the resistance coil 73 of the relay R, in the same direction that the current passes through coil 52 of the said relay, thence by wires 74, 75, to the switch clip 76, over the blade 77, by wire 78, to the connector 58 and thence back to the negative terminal of the battery over a portion of the circuit heretofore traced. The coil 73 is connected directly across the terminals of the battery when the dynamo-electric machine is functioning as a generator, but the circuit through the coil is broken when the dynamo-electric machine is functioning as a motor. When the electromotive force of the battery is below normal, as when it is partly discharged, sufficient current will not pass through the coil 73 to attract the armature 59, therefore, the contact 59' of the armature remains in contact with the point 60, and the circuit through the shunt winding 48 does not include the resistance coil 52 of the relay so that by this means, the differential effect of the shunt winding 48, with respect to the series winding 8, is greater and the electromotive force of the dynamo will be greater at a given speed, and consequently a larger current will flow into the battery from the dynamo until the electromotive force of the battery is sufficient to energize the relay R and cause its armature 59 to be attracted, thereby breaking the circuit at the contacts 59' and 60, and causing the current to flow through the resistance coil 52, thereby increasing the resistance of the shunt field circuit and correspondingly decreasing the current, flowing through the shunt winding 48, allowing the series winding 8 to have a larger differential effect and thereby causing a current of smaller value to flow through the main circuit from the dynamo to the battery and under the same conditions of speed.

After the armature 59 has been attracted by the relay and the circuit between 59' and 60 opened the current that flows through the coil 52 is in the same direction as the current that flows through the coils 73, so that these coils will magnetically assist each other causing the armature 59 to be held more firmly out of contact with contact 60, so that the jarring of the vehicle will not have the effect of rendering the armature 59 unstable and causing accidental connection between the contacts 59' and 60.

At any time during the operation of the dynamo, as a generator, should the electromotive force of the dynamo become lower than that of the battery, due to decreased speed, then the current from the battery will reverse through the series field winding 8, or tend to reverse, and cause the current that passes through the field winding from the

dynamo to become correspondingly reduced, thereby decreasing the differential effect of the series winding 8 and increasing the generating effect of the shunt winding 48, causing the electromotive force of the dynamo to be increased, or to be maintained during the time when the speed has been so decreased, so that when the speed of the dynamo is decreased the battery comes to the assistance of the dynamo and tends to boost the electromotive force thereof at the lower velocity. For this reason an automatic circuit closing device, to be operated when the electromotive force of the dynamo has exceeded that of the battery, is not essential and thereby the equipment is greatly simplified and its operation improved.

Fig. 4 shows the type of switch that may be employed in connection with my electrical equipment and in this figure the circuits are shown to be open as they are displayed in Fig. 1.

This form of double throw switch is very convenient, for the purpose described, but, of course, my invention is not limited to any particular form of switch or any means by which the circuits may be closed, for the purposes described, and while I have described a single embodiment of my invention, for purpose of complete disclosure it is evident that changes may be made, from the exemplification shown, without departing from the spirit and scope of the appended claims.

Having described my invention, what I claim is:

1. An electrical equipment for an internal combustion engine comprising a dynamo electric machine having a series field winding and a shunt field winding in combination with, a manual double throw switch; circuit connections through said switch to connect the armature of the dynamo, field series winding and battery in series relation so that current from said battery will rotate the armature in the same direction as when said armature is driven as a generator when said switch is thrown in one direction; an automatic switch having an operating coil connected across the terminals of said battery when said manual switch is thrown in the opposite direction; a resistance normally out of circuit and connectible by said automatic switch in series with the shunt field windings when the potential of the battery rises to a predetermined value.

2. An electrical equipment for an internal combustion engine comprising a dynamo electric machine having a series field winding and a shunt field winding in combination with a manual double throw switch; circuit connections through said switch to connect the armature of the dynamo, field series windings and battery in series relation when said switch is thrown in one di-

rejection; an automatic switch having an operating coil connected across the terminals of said battery when said manual switch is thrown in the opposite direction; a resistance coil adapted to assist the magnetic field created by the first mentioned coil and normally out of circuit and connectible by said automatic switch in series with the shunt field windings when the potential of the battery rises to a predetermined value.

3. An electrical system comprising a dynamo adapted to operate either as a motor or generator, and having a series field winding and a shunt field winding, a battery adapted to be charged thereby and to supply current for the same when operated as a motor,

circuit connections therefor, an automatic switch having a high resistance operating coil connected across the terminals of the battery when the latter is being charged by the dynamo, and a resistance normally out of circuit and connectible by said automatic switch in series with the shunt field winding when the potential of the battery rises to a predetermined value.

In testimony whereof I hereunto set my hand in the presence of two witnesses.

VINCENT G. APPLE.

In the presence of—

N. E. SNYDER,  
S. R. PURGH.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."