

UNITED STATES PATENT OFFICE.

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STARTER FOR INTERNAL-COMBUSTION ENGINES.

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My invention relates to starters for internal combustion engines, and more particularly to an electric starter.

A starter made in accordance with my invention is so constructed that the closing of the circuit from an electric battery, ordinarily a secondary battery of the type usually included as a part of the equipment of an automobile, will simultaneously place the ignition system of an internal combustion engine and the starting motor, in circuit with the battery, the circuit to said motor remaining closed until the engine has started under its own power, and until a generator driven from said engine, will have developed sufficient E. M. F. to energize an electromagnet operative upon a make and break mechanism included in the circuit to a magnet the armature of which controls the circuit to said starting motor. The conditions are such that so long as the generator is developing power, the circuit to said motor will remain open, but immediately with the stoppage of said generator, as by the stalling of the engine, said make and break mechanism will be immediately closed and thus cause said battery to be connected with the starting motor, thus automatically applying the power of this motor to prevent the engine remaining dead.

The electrical conditions about a starter embodying my invention are so simple as to require no technical knowledge in the user thereof, the make and break mechanisms in the circuit to the motor and to the magnetic control for this circuit being a simple magnetic switch structure having a movable contact member in the form of an armature within the magnetic field of a magnet, in circuit with the generator, and adapted to normally engage, when said magnet is de-energized, a fixed contact connected with said battery and with a magnet in circuit with said battery which actuates a gravity contact member arranged in the circuit between said battery and the starting motor, said gravity contact member being so set as to automatically interrupt the circuit to the motor when the magnet of which it constitutes the armature, is de-energized.

All of the electrical appliances embodied in a starter of my invention are standard commercial products, the magnetically controlled make and break mechanisms including simple electromagnets each of which

is entirely independent of the other, so far as electrical conditions are concerned.

The construction and arrangement of parts is such that the starting mechanism will function automatically and as a result of the closing of an ordinary switch to the ignition system, requiring no attention from the driver after said ignition switch has once been closed either when first starting the engine or in the event of the engine stalling by reason of an improper handling of the engine controls, or from other reasons.

The electrical conditions are such that if desired the circuit from the generator in addition to actuating the magnetic make and break mechanism to interrupt the circuit to the magnet controlling the circuit to the starting motor, may be used to supply current for the ignition system and for recharging the storage battery when such is used.

The invention consists primarily in a starter for internal combustion engines embodying therein a motor adapted to be operatively connected with an engine shaft, a generator driven from the engine, an electric battery, a battery magnet arranged in circuit with said battery, a movable armature within the magnetic field of said magnet and in circuit between said battery and said motor, a generator magnet in circuit with said generator, a movable armature within the magnetic field of said generator magnet, said armature also being in circuit with said battery and said battery magnet, and a manually operative switch mechanism adapted to simultaneously close the circuit to the ignition system of an engine and to said last named armature, whereby the closing of said manually operative switch will energize said battery magnet, and cause the closing of the circuit to said starting motor, and said generator when the engine is operating under its own power, will energize said generator magnet to interrupt the circuit to said battery magnet, and cause the circuit to said motor to be interrupted; and in such other novel features of construction and combination of parts as are hereinafter set forth and described, and more particularly pointed out in the claims hereto appended.

Referring to the drawings,

Fig. 1 is a side elevation of the magneti-

cally actuated make and break mechanism for controlling the circuit to the starting motor;

Fig. 2 is a front view thereof; and

Fig. 3 is a diagrammatic view of the electrical conditions about the starter.

Like letters refer to like parts throughout the several views.

In the accompanying drawings, I have not shown the gas engine nor the details of construction thereof and of the starting motor by which power is transmitted from the motor to the engine, since this construction is old and well known in the art and its details are immaterial to my present invention.

In the embodiment of my invention shown in the drawings, I have shown conventionally at *a*, a starting motor adapted to be connected in any desired manner with the shaft of an internal combustion engine *A*, and at *b* a generator which may be driven from said engine in any desired manner. The power for the motor *a* is derived from a suitable electric battery, such as the storage battery illustrated at *c*, which battery is also adapted to supply current for the ignition system of the internal combustion engine, illustrated conventionally at *d*.

Arranged in circuit with the battery *c* and the motor *a* is a normally open, magnetically actuated make and break mechanism, one contact of which consists of the core *e*¹ of a simple electromagnet *e*, and the other contact of which consists in the armature for said magnet. The magnet *e* is also arranged in a normally closed circuit with the battery *c*, having therein a magnetically actuated make and break mechanism consisting of a movable armature *f*¹ preferably carried by a spring arm *f*² and adapted to co-operate with an opposed contact *e*² connected with one terminal of the magnet *e*. The electromagnet acting upon the armature *f*¹ is indicated at *f*, and is arranged in circuit with the generator *b*. Hence for convenience of expression the magnet *f* will be herein termed the "generator magnet", while the magnet *e*, being in circuit with the battery *c*, will be termed the "battery magnet".

The armature co-operating with the core *e*¹ of the magnet *e* is so mounted as to normally move out of engagement with said core preferably under the influence of gravity, so as to automatically interrupt the circuit to said motor when the magnet *e* is deenergized, irrespective of the manner of interrupting the circuit to said magnet. This armature is shown as being pivotally supported at one end so as to have a free movement toward and from said core *e*¹. Said armature is indicated at *g* in the drawings.

Arranged in circuit with the battery *c* is

a manually operative switch *h* of any desired construction, so wired with relation to said battery, the ignition system *d* and the magnet *e* as to act simultaneously in opening and closing the circuit to said system and said magnet, the circuit from the battery *c* to the motor *a* being controlled solely by the actuation of the armature *g*.

The motor *a*, battery *c*, generator *b*, ignition system *d* and the magnets *e* and *f* each have a ground connection although it is apparent that the method of wiring the starter is immaterial to the invention, and a complete metallic circuit could be used instead of this ground connection, as to each of the elements above referred to.

The generator *b* is provided with the usual cutout *i* and is wired in the usual manner with the ignition system *d* and battery *c* through the switch *h* so as to permit the generator current to be utilized in the ignition system and for recharging the battery *c* while the engine is running. By arranging the armature *f*¹ within the magnetic field of the magnet *f* and without the field of the magnet *e*, it will be apparent that the battery *c* will not be drawn upon while current is being delivered by the generator *b*, so that while the engine is running the normal functioning of the generator in supplying current to the ignition system and for the recharging of the battery *c* will not be interfered with by the starter mechanism.

The electromagnets *e* and *f* are mounted upon a suitable slab *j* of insulating material, upon which the armatures *f*¹ and *g* are also mounted.

Carried by said slab are fixed terminal fittings *k-m-n-o-p*. The terminal fitting *k* is in electrical connection with the core *e*¹ of the magnet *e* and through the wire *k*¹ with the motor *a*. The terminal fitting *m* is in electrical connection with the armature *g*; through the wire *m*¹ with the battery *c*, and through the wire *m*² with the manually operative switch *h*. The terminal fitting *n* is electrically connected through the wire *n*¹ with the generator *b* and with one terminal of the magnet *f*, the other terminal of which is in connection with the terminal fitting *o* which is connected with ground through the wire *o*¹. The terminal fitting *p* is connected by the wire *p*¹ with one contact of the manually operative switch *h* and is in electrical connection with the contact *e*² connected with one terminal of the magnet *e*, the other terminal of said magnet being grounded through the terminal fitting *o*.

The use of these terminal fittings permits the magnetic circuit controlling mechanisms to be completely assembled in the shop and by placing suitable insignia upon said fittings, the user is enabled to properly wire the starter mechanism without difficulty.

The operation of the herein described

starter mechanism is substantially as follows:—

When an engine is at rest the switch *h* is open, and no current is delivered by the battery *c*. When it is desired to start the engine, it is merely necessary to close the switch *h*, as a result of the closing of which switch the following conditions will be developed.

Current will flow through the wires *m'*—*m*² to the switch *h*, and through this switch to the ignition system *d*, and through the wire *p'* to the armature *f'*, contact *e*², ground fitting *o* and wire connection *o'* to ground, thus completing the circuit to the magnet *e*.

With the resulting energizing of said magnet, the armature *g* will be attracted by the core *e*¹, thus closing the circuit from the battery *c* to the motor *a* through the connecting wire *m'*, fitting *m*, core *e*¹, fitting *k* and wire *k'*.

As the said motor is energized, the power therefrom will be applied to turn over the engine in the usual manner, current from the battery continuing to flow to the ignition system while power is being applied to the motor *a*.

When the engine is once running under its own power, and up to speed, current will be produced by the generator *b* and as a result of the direct connection between said generator and the magnet *f*, said magnet will be energized. With the initial energizing of said magnet *f* the core *f'* will be attracted thereby and the continuing traction of said magnet will hold said armature out of engagement with the contact *e*² so long as the generator is functioning. It will be observed that there is no magnetic traction acting upon the armature *f'* counter to that of the magnet *f*, thus eliminating any complicated electrical conditions in the functioning of the mechanism for de-energizing the magnet *e*. Said magnet will be de-energized substantially simultaneously with the energizing of the magnet *f*.

As the magnet *e* is de-energized, the armature *g* will automatically move out of electrical engagement with the core *e*¹ of said magnet, thus interrupting the flow of current from the battery *c* to the motor *a*.

So long as the engine continues to run under its own power, and the generator *b* is functioning, the circuit to the magnet *e* will be kept open and the armature *g* will be in its normal position out of engagement with its opposed contact *e*¹, the circuit to the motor *a* being normally open.

It will be noted that the circuit from the generator *b* is entirely independent of that to the magnet *e*, and that when the generator circuit is flowing to the magnet *f*, the circuit to the magnet *e* will of necessity be open, thus avoiding any interference between the generator circuit and the battery circuit

at any time while the generator is operating. The current therefrom will flow to the ignition system *d* and the battery *c* unless the cutout *i* is used to prevent such condition. It will be observed, however, that the connection between the generator and the magnet *f* is entirely independent of said cutout, so that while the generator circuit for recharging the battery and for use in the ignition system may be interrupted, the flow of current to the magnet *f* will be constant while the generator is in operation.

The essential characteristics of my invention are a normally open, magnetically controlled make and break mechanism arranged in circuit between an electric battery and a starting motor with a controlling battery magnet therefor arranged in circuit with said battery alone, said last named circuit having a normally closed, magnetically controlled make and break mechanism, the generator magnet for breaking which is arranged in circuit with a generator driven from the engine, the circuit from said battery to said motor and said battery magnet having a control in common with the circuit therefrom with the ignition system of the engine, so that the closing of a single switch will ensure the actuation of the starting motor and of the ignition mechanism. By this arrangement the circuit to the battery will be closed except when the engine is running, or it is desired to start same, so that the battery cannot be accidentally exhausted. Furthermore, while the manually operative switch *h* is closed, the engine will continuously run without power being applied to the motor *a*, but instantly with the slowing down of the engine to a point where it is about to stall, power will be applied thereto without any attention from the driver, through the motor *a* whether the engine stoppage is due to load conditions or an improper adjustment of the controls.

The general wiring shown in the drawings is that now commonly in use, the terminal wires merely being required to be connected to the terminal fittings carried by the slab *j*, and the wires *n'*, *o'* and *p'* added to the equipment.

It is not my intention to limit the invention to the precise details of construction shown in the drawings, it being apparent that such may be varied without departing from the spirit and scope of the invention.

Having described the invention, what I claim as new and desire to have protected by Letters Patent, is:—

1. A starter for internal combustion engines embodying therein a motor adapted to be operatively connected with an engine shaft, a generator driven from the engine, an electric battery, a battery magnet arranged in circuit with said battery, a movable armature within the magnetic field of said

magnet and in circuit between said battery and said motor, a generator magnet in circuit with said generator, a movable armature within the magnetic field of said generator magnet, said armature also being in circuit with said battery and said battery magnet, and a manually operative switch mechanism adapted to simultaneously close the circuit to the ignition system of an engine and to said last named armature, whereby the closing of said manually operative switch will energize said battery magnet, and cause the closing of the circuit to said starting motor, and said generator when the engine is operating under its own power, will energize said generator magnet to interrupt the circuit to said battery magnet, and cause the circuit to said motor to be interrupted.

2. A starter for internal combustion engines embodying therein a motor adapted to be operatively connected with an engine shaft, a generator driven from the engine, an electric battery, means forming a normally open circuit between said battery and said motor, a battery magnet co-operating therewith and arranged in a normally closed circuit to said battery, a generator magnet arranged in a constantly closed circuit with said generator, means co-operating therewith adapted to open the circuit to said battery magnet, and a manually operative switch adapted to simultaneously open or close the circuit to the ignition system of an engine and the circuit to said battery magnet, whereby with the closing of said manually operative switch said battery magnet will be energized to cause the closing of the circuit from said battery to said motor, and the actuation of said generator will energize said generator magnet and cause the interruption of the circuit to said battery magnet, and the opening of the circuit to said motor.

3. A starter for internal combustion engines embodying therein a motor adapted to be operatively connected with an engine shaft, a generator driven from the engine, an electric battery, a battery magnet arranged in circuit with said battery, a movable armature within the magnetic field of said magnet and in circuit between said battery and said motor, a generator magnet in circuit with said generator, a movable armature within the magnetic field of said generator magnet, said armature also being in circuit with said battery and said battery magnet, a manually operative switch mechanism adapted to simultaneously close the circuit to the ignition system of an engine and to said last named armature, whereby the closing of said manually operative switch will energize said battery magnet, and cause the closing of the circuit to said starting motor, and said generator when the

engine is operating under its own power, will energize said generator magnet to interrupt the circuit to said battery magnet, and cause the circuit to said motor to be interrupted, and means placing said generator in circuit with said ignition system and said battery independently of the circuits to said battery magnet and said motor.

4. A starter for internal combustion engines embodying therein a motor adapted to be operatively connected with an engine shaft, a generator driven from the engine, an electric battery, a battery magnet arranged in circuit with said battery, a movable armature within the magnetic field of said magnet and in circuit between said battery and said motor, a generator magnet in circuit with said generator, a movable armature within the magnetic field of said generator magnet, said armature also being in circuit with said battery and said battery magnet, a manually operative switch mechanism adapted to simultaneously close the circuit to the ignition system of an engine and to said last named armature, whereby the closing of said manually operative switch will energize said battery magnet, and cause the closing of the circuit to said starting motor, and said generator when the engine is operating under its own power, will energize said generator magnet to interrupt the circuit to said battery magnet, and cause the circuit to said motor to be interrupted, means placing said generator in circuit with said ignition system and said battery independently of the circuits to said battery magnet and said motor, and a cutout arranged in said last named circuit, the connection between said generator magnet and said generator being intermediate said cutout and said generator.

5. A starter for internal combustion engines embodying therein a motor adapted to be operatively connected with an engine shaft, a generator driven from the engine, an electric battery, a normally open, magnetically controlled make and break mechanism arranged in the circuit between said battery and said motor, a battery magnet co-operating therewith arranged in a normally closed circuit with said battery, a magnetically actuated make and break mechanism arranged in the circuit to said battery magnet, a magnet co-operating therewith arranged in a normally closed circuit to said generator, an ignition system for an engine in circuit with said battery, and a manually operative switch adapted to simultaneously control the circuits between said battery and said ignition system, and between said battery and said battery magnet.

In witness whereof I have hereunto affixed my signature, this 20th day of April, 1921.

JOHN HASSELBRING, JR.