Nov. 25, 1930. J. HASSELBRING, JR 1,783,015

STARTER FOR INTERNAL COMBUSTION ENGINES

Filed July 22, 1925

Fig. 1,

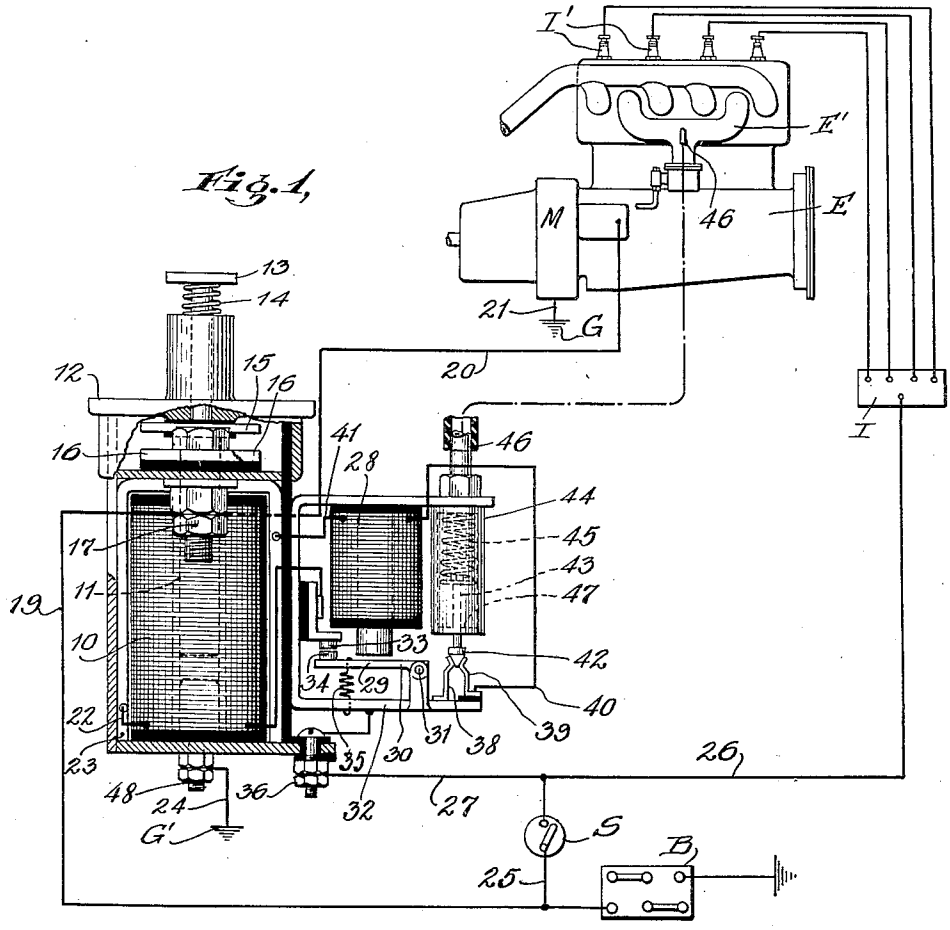
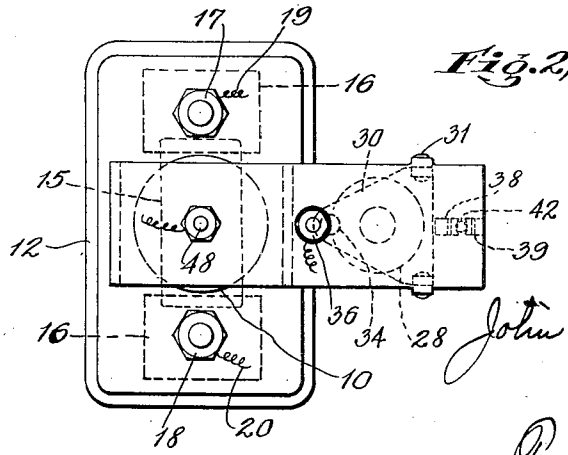


Fig. 2,



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Patented Nov. 25, 1930

1,783,015

UNITED STATES PATENT OFFICE

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STARTER FOR INTERNAL-COMBUSTION ENGINES

Application filed July 22, 1925. Serial No. 45,310.

My invention relates to starters for internal combustion engines, and more particularly to a mechanism by means of which electrical energy will be automatically applied to a starting motor as a result of the actuation of a manually operative switch controlling the circuit to the ignition system of the engine, and the circuit to the starting motor will be automatically interrupted immediately when the engine comes to, and so long as it is running at, an operating speed, the circuit to the motor being automatically restored whenever the engine speed is materially reduced from causes other than the actuation of the switch to the ignition system.

The starter of my present invention is designed more particularly for use in an automobile which is not equipped with a generator, or with a shunt wound motor capable of operating as a generator. An essential characteristic of the invention is the provision of means in the circuit from a storage battery to one magnetic switch controlling a second magnetic switch which in turn controls the circuit from said battery to the starting motor, which means is subjected to variations in pressure conditions in the engine manifold so that the circuit to the starting motor will be kept open at all times while the engine is running, and will be automatically closed by the magnetic switch mechanisms when the speed of the engine becomes so low, from any cause, as to indicate immediate likelihood of its coming to a complete stop, or stalling.

I have found it essential to provide a magnetic switch control in the circuit from the storage battery to the starting motor, in which a magnet having a fairly high traction is used for actuating the switch in the circuit direct from the battery to the starting motor, and a magnet having a lower traction is used for actuating the switch in the circuit to the other magnet. This is due to the fact that the heavier amperage required by the motor, necessitates high efficiency in the contacts controlled by the magnet of the former switch, while the suction controlling the operation of the means controlling the circuit to the other magnet although sufficient to ensure reliability in the operation of the device, does not possess sufficient strength to permit the use of electrical contacts having sufficient weight and strength to carry a load sufficient to energize a magnet having the higher traction above referred to.

The suction controlled device embodied in the starter of my invention is so constructed that it will be responsive to slight variations in pressure conditions in the manifold, thus ensuring a continued operation of the motor so long as the engine is running at an effective speed for developing power. The suction or sub-atmospheric pressure conditions in the manifold acts in opposition to a spring which when the pressure in the manifold rises so as to approach atmospheric pressure, will automatically actuate the switch mechanism control to close the circuit.

It is apparent that the parts of the suction control in addition to being highly sensitive in response to pressure conditions in the manifold, must be so constructed, both as to those parts operative as a result of the effect of such suction or sub-atmospheric pressure, and as to the electrical contacts, as to avoid any material retardation in the functioning of the device.

It is essential to a starter embodying my invention, that the magnetic switch controls and the ignition system of the engine be under the control of a single manually operative switch so as to ensure reliability in the automatic functioning of the device, and to prevent the actuation of the starting motor except under conditions when the ignition system is also operating.

The invention consists primarily in a starter for internal combustion engines of the class in which power from an electric source is temporarily applied by an electric motor to an engine having an intake manifold, and an ignition system drawing its supply from said source, a normally open primary magnetic switch having a winding and contacts, said contacts being in circuit from said source to said starting motor, a normally open secondary magnetic switch having a winding and contacts, said contacts being in circuit from said source to the winding of said primary magnetic switch, a nor-

mally closed make and break mechanism having a movable contact, said contact being in a circuit from said source to the winding of said secondary magnetic switch, pneumatically actuated means operative upon said movable contact, connections between said means and said engine manifold, whereby said movable contact will be actuated to open the circuit to the winding of said secondary magnetic switch when an engine is operating under its own power, means operative upon said movable contact normally tending to close said make and break mechanism, and a manually operative switch in circuit between said source of power, the ignition system, and the windings of said primary and said secondary magnetic switches respectively; 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 view of a starter embodying my invention partly in section, with a conventional showing of the wiring of same and of an internal combustion engine in connection with which it is used;

Fig. 2 is an elevation of the control element from the right, Fig. 1.

Like numerals refer to like parts throughout the several views.

In the embodiment of my invention shown in the drawings, an internal combustion engine is shown conventionally at E, the manifold thereof at E′, and a starting motor cooperating with said engine is shown conventionally at M. The ignition system is indicated at I, and the source of power, an ordinary secondary battery at B. The spark plugs forming part of the ignition system are shown at I′.

The controlling mechanism of a starter embodying my invention, embodies therein a primary magnetic switch shown as being a solenoid 10, the core 11 of which extends beyond the casing 12 and has an enlarged head 13. Acting between the casing 12 and the enlarged head 13 is a spring 14 having a normal tendency to move said core outwardly of said casing. Carried by and insulated from said core is a bridge contact member 15, adapted to engage spaced contacts 16 carrying respectively binding posts 17 and 18, the former of which is in direct electrical connection with the source of power B through the lead 19, and the latter of which is in electrical connection with the motor M through the lead 20. The motor M is connected with ground through the lead 21.

The spring 14 maintains a condition in which the magnetic switch 10 is normally open, and will automatically return to this position upon the interruption of the circuit to the winding of said magnet. The winding of said magnet is connected with ground through the lead 22, a metallic yoke 23 and the lead 24.

The ground for the motor is indicated at G, and the ground for the winding of the magnet 10, which ground is also used for the secondary magnetic switch, as will appear hereinafter, is indicated at G′.

The source of energy B is in circuit with the ignition system I through a lead 25 connected with a manually operative ignition switch S, and by a lead 26 from said switch to said ignition system.

The ignition switch S also controls the circuit from the source of energy B to the winding of the magnet 10, through a lead 27 from said switch, this circuit having therein an automatically actuated secondary magnetic switch which I will now describe.

This secondary magnetic switch comprises an electro-magnet 28 having a fixed core 29 operative upon an armature 30 pivoted at 31 upon a yoke 32. Carried by and insulated from said yoke 32 is a fixed contact 33 with which a contact 34 carried by the armature 30, co-operates. The armature 30 is acted upon by a spring 35 having a normal tendency to separate the contacts 33—34 and thus interrupt the circuit to the winding of the magnet 10.

The armature 30 and contact 34 are in circuit with the source of power through the lead 25, switch S, lead 27, binding post 36 and lead 37 between said binding post and the armature 30 through the yoke 32.

Electrical energy from the source B is utilized to energize the magnet 28 as required with the operation of the starter, the energizing and de-energizing of said magnet being controlled by a normally closed make and break mechanism including therein automatically acting actuating means responsive to varying pressure conditions in the engine manifold E′ between which and said means is a suitable pipe connection.

The make and break mechanism above referred to consists of spaced flexible contacts 38 and 39, one of which as 38 is electrically connected with the yoke 32 and the other of which is carried by, but insulated from, said yoke and in electrical connection through the lead 40 with the winding of the secondary magnetic switch 28. The other end of this winding is in electrical connection with the yoke 23 through the lead 41 and is grounded at G′. Co-operating with the spring contacts 38 and 39 is a movable wedge contact 42 carried by a piston or plunger 43 slidably mounted in a cylinder 44, a spring 45 within this cylinder normally forcing the contact 42 into engaging relation with the contacts 38 and 39. One end of the cylinder 44 is suitably connected, as by means of the pipe 46, with the engine manifold E′ so as to place this make and break mechanism under the control of varying pressure condi-

tions determined by the operation of the engine E. The opposite end of the cylinder to that with which the pipe 46 is connected is provided with vent openings 47 of sufficient capacity to permit the free movement of the piston or plunger 43 in both directions under the control of sub-atmospheric pressure in the manifold E′ or of the spring 45, which must be of fairly light tension in order to permit the free movement of said piston under the control of such sub-atmospheric pressure.

The light tension of the spring 45 and the low power provided by the suction at the manifold E′ necessitates the use of light spring contact members 38 and 39 in order to ensure reliability in the action of this control. Since the circuit to said contacts is used solely for the purpose of moving the armature 30 against the tension of the light tension spring 35, the magnet 28 may be so made as to have a very low traction, thus permitting the use of light contacts 38 and 39 without likelihood of such sparking as would lead to the fouling of these contacts. Since the contacts 15 and 16, however, are required to carry a fairly heavy load, it is necessary that the solenoid 10 have relatively higher traction than the magnet 28, since a firm engagement of said contacts 15 and 16 is necessary and a strong spring 14 is required to ensure a sufficiently sharp break to avoid sparking at said contacts. To meet this condition, I have connected the magnets 28 and 10 in parallel.

It will be noted that the circuit to the magnet 28 when the make and break mechanism 38, 39 and 42 is closed is entirely independent of the circuit in which the magnet 10 is included, and also of the circuit from the battery B to the motor, and that the latter circuit is entirely independent of the circuit to the magnet 10. Hence, said magnets are merely actuating means for magnetic switches and do not have any inter-relation so far as electrical conditions in the controller are concerned. The ground lead 24 is connected with a binding post 48. The electrical connections where binding posts are not used may be permanent, but where binding posts are employed, it is for the purpose of connecting wires from various other parts of the starting system, to the control.

The starter of my invention is designed primarily for installation in starting systems, being merely in the nature of a control for these systems, which systems may take a variety of different forms both as to the construction of the motor and the manner of connecting same with the engine shaft.

The operation of the herein described mechanism is substantially as follows:—

As shown in Fig. 1 of the drawings, the ignition switch S is open and the lines leading therefrom to the ignition system I, to the magnet 10, and to the magnet 28 are dead. The make and break mechanism 38, 39 and 42 is closed, and the contacts 33 and 34 are separated so as to have a break in the circuit to the magnet 10 at this point. The piston or plunger 43 is held by the spring 45 in a position to ensure the engagement of the contact 42 with the contacts 38 and 39, the spring 35 holding the armature 30 so as to space the contacts 33 and 34 apart.

The spring 14 also maintains the bridge contact 15 out of engagement with the fixed contacts 16, so that the circuit from the battery B to the motor M is also open.

This is the normal relation of parts when the engine is at rest, the electro-magnetic switch controlling the circuit from the battery B to the motor M being open, the electro-magnetic switch controlling the circuit to the magnet 10 also being open, and the make and break mechanism controllable by varying pressure conditions in the engine manifold E′ being closed.

When it is desired to start the motor, the operator merely closes the ignition switch S, which action will supply the ignition system I with the necessary electrical energy to ensure the action of the spark plugs I′ in the usual manner, and also close the circuit from the battery B through the leads 27, binding post 36, lead 37, yoke 32, contacts 38, 42 and 39, and lead 40 to the magnet 28, this circuit being completed through the lead 41, yoke 23, binding post 48 and lead 24 to ground G′. The magnet 28 is thus energized substantially simultaneously with the closing of the circuit to the ignition system. As said magnet is energized, it will attract the armature 30, thus engaging the contact 34 with the contact 33 through the movement of said armature against the tension of the spring 35 and closing the circuit from the battery B through the lead 25, switch S, lead 27, binding post 36, lead 37, yoke 32, armature 30, and contacts 34 and 33, the circuit to said magnet 10 being completed through the lead 22, yoke 23, binding post 48, and lead 24 to ground at G′. The energizing of the magnet 10 by a direct current from the battery B, as described, will draw the movable core 11 inwardly against the tension of the spring 14 until the bridge contact 15 firmly contacts with the spaced contacts 16, thus closing the circuit from the battery B through the lead 19, binding post 17, one contact 16, bridge contact 15, the other contact 16, binding post 18, and lead 20, to the motor M, which circuit is completed through the lead 21 to ground at G. This will apply energy from the source, or battery, B to the motor M. Said motor may either be mechanically connected directly with the shaft of the engine E, or connected therewith through an automatic coupling, according to the starting system employed.

When the engine is operating at fairly high speed, the suction developed within said manifold, or the sub-atmospheric pressure resulting from the suction due to the movement of the engine piston, will evacuate the cylinder 44, thus causing atmospheric pressure at the ports 47 to overcome the tension of the spring 45 and move the piston or plunger 44 inwardly of said cylinder and thus disengage the contact 42 from the contacts 38 and 39, and interrupt the circuit to the magnet 28. As said magnet 28 is de-energized, the armature 30 will be relieved from the traction of said magnet, and will be substantially instantly moved away from the core 29 by the spring 35, which is tensioned as a result of the attraction of the armature to the magnet. This movement of the armature will separate the contacts 33 and 34, and interrupt the circuit to the magnet 10, de-energizing same, and permitting the spring 14 to move the contact 15 out of engagement with the contacts 16 and interrupt the circuit from the source or battery B to the motor M. With this condition the only line through which the current is flowing from the source or battery B is that to the ignition system I, although since the ignition switch S is still closed, the electrical conditions are such as to permit a repetition of the action resulting in the closing of the circuit from the battery B to the motor M as above described, immediately that the sub-atmospheric pressure or suction in the manifold E′ is relieved to an extent to permit the spring 45 to move the piston or plunger 43 in the cylinder 44 towards the ports 47 to an extent to engage the contact 42 with the contacts 38 and 39.

So long as the engine is operating at a speed which will maintain a sub-atmospheric pressure or suction in the manifold sufficient to overcome the tension of the light spring 45, the circuit to the motor M will be maintained open, but instantly with the increase in the pressure within the manifold, due to the abnormal slowing down of the engine, the make and break mechanism 38, 39 and 42 will resume its normally closed position, thus instantly energizing the magnets 28 and 10 so as to engage the contact 15 with the contact 16 to close the normally open circuit from the source or battery B to the motor M.

It will be noted that each electro-receptive device is arranged in a circuit which to all intentions and purposes is entirely independent of, and unaffected by, the circuit in which other electro-receptive devices are located, and that there are three separate and distinct automatic controls and a manually operative switch S, which must function in order to close the circuit from the battery B to the motor M.

So long as the engine is operating at speed, there is no current flowing from the battery B except to the ignition system I, which in a system having no generator is a factor of economy in the operation of the starter.

Notwithstanding the multiplicity of controls, a starter embodying my invention acts reliably to prevent stalling of the engine under conditions when power is required for propelling the vehicle.

The automatic features of the starter will, so long as the ignition switch S is closed, apply the power of the motor to the engine to prevent its complete stalling when a vehicle is stopped in traffic, or is climbing a hill, there ordinarily being sufficient power in the battery B to carry the vehicle under the power of the motor M a sufficient distance to move it from a point of danger as when the engine stalls upon a railroad crossing.

The enlarged head 13 of the core 11 is normally closed by a removable cover, which construction forms no part of my present invention, but is utilized to permit the manual engagement of the contact 15 with the contact 16 in the event of a failure of electrical connections in the various controls for operating said contact 15.

The showing in the drawings of various parts of the control mechanism is substantially full sized, and while the arrangement shown and described permits compactness in the device, it is not essential to the invention.

The device may be mounted upon the foot board, flooring or instrument board of a vehicle, although its automatic features act with sufficient reliability to permit it, if desired, to be located closely adjacent the engine, or at any point which is not as readily accessible as the points heretofore referred to.

Where the term "magnetic switch" is herein used, it has reference to a switch employing an electro-magnet of any well known type, either solenoid or fixed core for determining the movements of a movable contact member, and when the term "make and break mechanism" is used, reference is had to a non-magnetic switch.

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. In a starter for internal combustion engines of the class in which power from an electric source is temporarily applied by an electric motor to an engine having an intake manifold, and an ignition system drawing its supply from said source, a normally open primary magnetic switch having a winding and contacts, said contacts being in circuit from said source to said starting motor, a normally open secondary magnetic switch

having a winding and contacts, said contacts being in circuit from said source to the winding of said primary magnetic switch, a normally closed make and break mechanism having a movable contact, said contact being in circuit from said source to the winding of said secondary magnetic switch, pneumatically actuated means operative upon said movable contact, connections between said means and said engine manifold, whereby said movable contact will be actuated to de-energize the winding of said secondary magnetic switch when the engine is operating under its own power, means operative upon said movable contact normally tending to close said make and break mechanism, and a manually operative switch in circuit between said source of power, the ignition system, and the windings of said primary and said secondary magnetic switches respectively.

2. In a starter for internal combustion engines of the class in which power from an electric source is temporarily applied by an electric motor to an engine having an intake manifold, and an ignition system drawing its supply from said source, a normally open primary magnetic switch having a winding and contacts, said contacts being in circuit from said source to said starting motor, a normally open secondary magnetic switch having a winding and contacts, said contacts being in circuit from said source to the winding of said primary magnetic switch, spaced electrical contacts, one of which is electrically connected with said source, and the other of which is electrically connected with the winding of said secondary magnetic switch, a movable contact adapted to bridge said spaced contacts, means operative to normally engage said movable contact with said fixed contacts, means responsive to sub-atmospheric pressure adapted to move said movable contact away from said spaced contacts, connections between said means and said engine manifold, whereby said movable contact will be actuated to de-energize the winding of said secondary magnetic switch when the engine is operating under its own power, means operative upon said movable contact normally tending to close said make and break mechanism, and a manually operative switch in circuit between said source of power, the ignition system, and the windings of said primary and said secondary magnetic switches respectively.

3. In a starter for internal combustion engines of the class in which power from an electric source is temporarily applied by an electric motor to an engine having an intake manifold, and an ignition system drawing its supply from said source, a normally open primary magnetic switch having a winding and contacts, said contacts being in circuit from said source to said starting motor, a normally open secondary magnetic switch having a winding and contacts, said contacts being in circuit from said source to the winding of said primary magnetic switch, spaced electrical contacts, one of which is electrically connected with said source, and the other of which is electrically connected with the winding of said secondary magnetic switch, a movable contact adapted to bridge said spaced contacts, a cylinder, a pipe connection between said cylinder and said manifold, a piston carrying said movable contact mounted in said cylinder, a spring in said cylinder between said piston and said pipe connection, whereby said movable contact will be actuated to de-energize the winding of said secondary magnetic switch when the engine is operating under its own power, means operative upon said movable contact normally tending to close said make and break mechanism, and a manually operative switch in circuit between said source of power, the ignition system, and the windings of said primary and said secondary magnetic switches respectively.

4. In a starter for internal combustion engines of the class in which power from an electric source is temporarily applied by an electric motor to an engine having an intake manifold, and an ignition system drawing its supply from said source, a normally open primary magnetic switch having a winding and contacts, said contacts being in circuit from said source to said starting motor, a normally open secondary magnetic switch having a winding and contacts, said contacts being in circuit from said source to the winding of said primary magnetic switch, spaced light tensioned spring electrical contacts, one of which is electrically connected with said source, and the other of which is electrically connected with the winding of said secondary magnetic switch, a movable wedge contact adapted to enter the space between, and engage, said spring contacts, means operative to normally engage said wedge contact with said spring contacts, means responsive to sub-atmospheric pressure adapted to move said wedge contact away from said spring contacts, connections between said means and said engine manifold, whereby said wedge contact will be actuated to de-energize the winding of said secondary magnetic switch when the engine is operating under its own power, means operative upon said wedge contact normally tending to close said make and break mechanism, and a manually operative switch in circuit between said source of power, the ignition system, and the windings of said primary and said secondary magnetic switches respectively.

5. In a starter for internal combustion engines of the class in which power from an electric source is temporarily applied by an electric motor to an engine having an intake manifold, and an ignition system drawing

its supply from said source, a normally open primary magnetic switch having a winding and contacts, said contacts being in circuit from said source to said starting motor, a normally open secondary magnetic switch comprising an electro-magnet having a winding and a fixed core, a pivotally mounted armature within the field of said magnet, a contact carried thereby, a fixed contact in electrical connection with the winding of said primary magnetic switch, electrical connections between said source and said armature, and a spring acting upon said armature to normally disengage the contact carried thereby from said fixed contact, a normally closed make and break mechanism having a movable contact, said contact being in circuit from said source to the winding of said secondary magnetic switch, pneumatically actuated means operative upon said movable contact, connections between said means and said engine manifold, whereby said movable contact will be actuated to de-energize the winding of said secondary magnetic switch when the engine is operating under its own power, means operative upon said movable contact normally tending to close said make and break mechanism, and a manually operative switch in circuit between said source of power, the ignition system, and the windings of said primary and said secondary magnetic switches respectively.

6. In a starter for internal combustion engines of the class in which power from an electric source is temporarily applied by an electric motor to an engine having an intake manifold, and an ignition system drawing its supply from said source, a normally open primary magnetic switch having a winding and contacts, said contacts being in circuit from said source to said starting motor, a normally open secondary magnetic switch comprising an electro-magnet having a winding and a fixed core, a pivotally mounted armature within the field of said magnet, a contact carried thereby, a fixed contact in electrical connection with the winding of said primary magnetic switch, electrical connections between said source and said armature, and a spring acting upon said armature to normally disengage the contact carried thereby from said fixed contact, spaced light tensioned spring electrical contacts, one of which is electrically connected with said source, and the other of which is electrically connected with the winding of said secondary magnetic switch, a movable wedge contact adapted to enter the space between, and engage, said spring contacts, means operative to normally engage said wedge contact with said spring contacts, means responsive to sub-atmospheric pressure adapted to move said wedge contact away from said spring contacts, connections between said means and said engine manifold, whereby said wedge contact will be actuated to de-energize the winding of said secondary magnetic switch when the engine is operating under its own power, means operative upon said wedge contact normally tending to close said make and break mechanism, and a manually operative switch in circuit between said source of power, the ignition system, and the windings of said primary and said secondary magnetic switches respectively.

7. In a starter for internal combustion engines of the class in which power from an electric source is temporarily applied by an electric motor to an engine having an intake manifold, and an ignition system drawing its supply from said source, a normally open primary magnetic switch having a winding and contacts, said contacts being in circuit from said source to said starting motor, a normally open secondary magnetic switch comprising an electro-magnet having a winding and a fixed core, a pivotally mounted armature within the field of said magnet, a contact carried thereby, a fixed contact in electrical connection with the winding of said primary magnetic switch, electrical connections between said source and said armature, and a spring acting upon said armature to normally disengage the contact carried thereby from said fixed contact, spaced light tensioned spring electrical contacts, one of which is electrically connected with said source, and the other of which is electrically connected with the winding of said secondary magnetic switch, a movable wedge contact adapted to enter the space between, and engage, said spring contacts, a cylinder, a pipe connection between said cylinder and said manifold, a piston carrying said wedge contact mounted in said cylinder, a spring in said cylinder between said piston and said pipe connection, whereby said wedge contact will be actuated to de-energize the winding of said secondary magnetic switch when the engine is operating under its own power, means operative upon said wedge contact normally tending to close said make and break mechanism, and a manually operative switch in circuit between said source of power, the ignition system, and the widings of said primary and said secondary magnetic switches respectively.

8. In a starter for internal combustion engines of the class in which power from an electric source is temporarily applied by an electric motor to an engine having an intake manifold, and an ignition system drawing its supply from said source, a primary magetic switch comprising a solenoid, fixed spaced contacts, one of which is electrically connected with said source, and the other of which is electrically connected with said electric motor, a movable contact actuated by the core of said solenoid, and a spring acting to normally disengage said movable contact from said fixed contacts, a secondary mag-

netic switch comprising an electro-magnet of relatively lower traction than said solenoid having a fixed core and a winding, an armature within the field of said magnet, a contact carried thereby, a fixed contact co-operating with the contact carried by said armature, and a spring acting upon said armature to normally disengage said contacts from each other, electrical connections between one of said contacts and the winding of said solenoid, a normally closed make and break mechanism in circuit between said source and the winding of said electro-magnet, pneumatically actuated means operative upon said movable contact, connections between said means and said engine manifold, whereby said movable contact will be actuated to de-energize the winding of said secondary magnetic switch when the engine is operating under its own power, means operative upon said movable contact normally tending to close said make and break mechanism, and a manually operative switch in circuit between said source of power, the ignition system, and the windings of said primary and said secondary magnetic switches.

In witness whereof I have hereunto affixed my signature, this 16th day of June, 1925.

JOHN HASSELBRING, JR.