

Nov. 27, 1934.

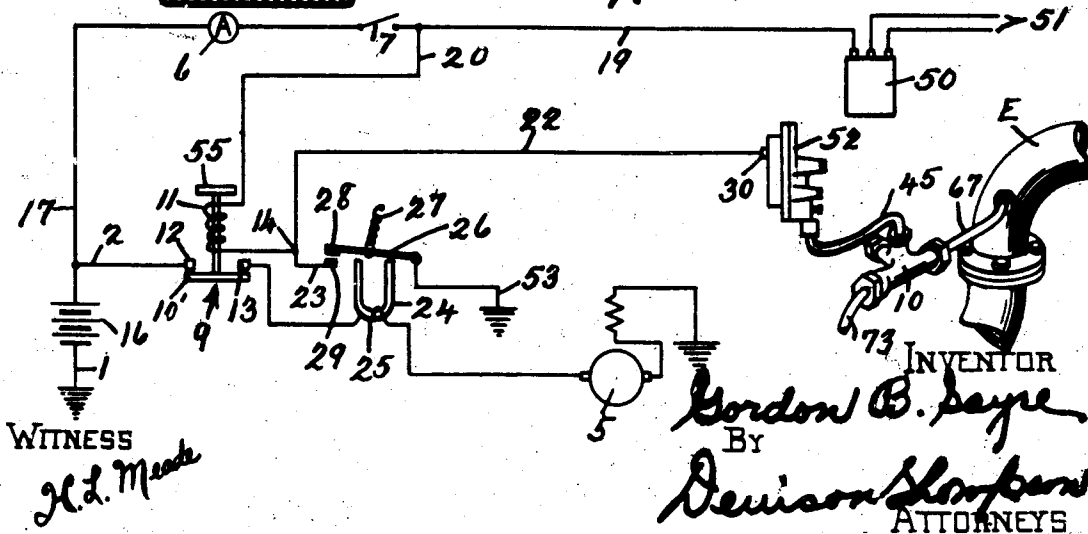
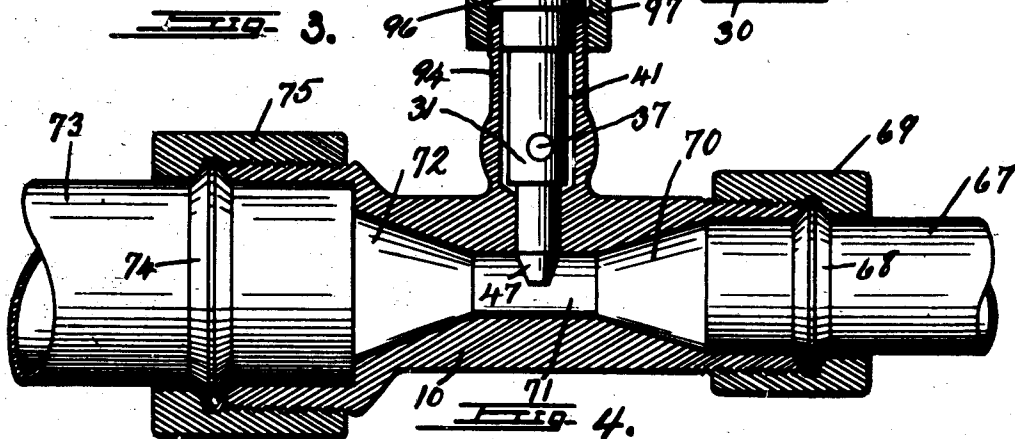
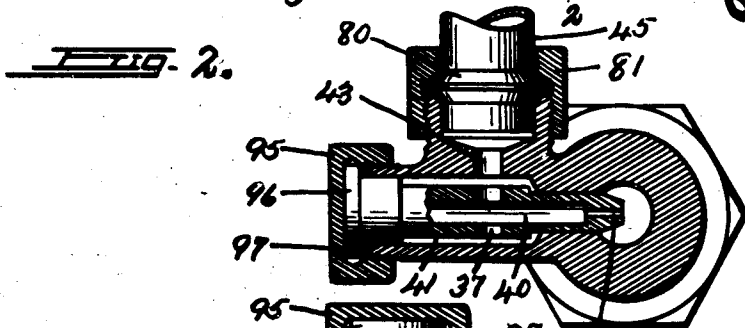
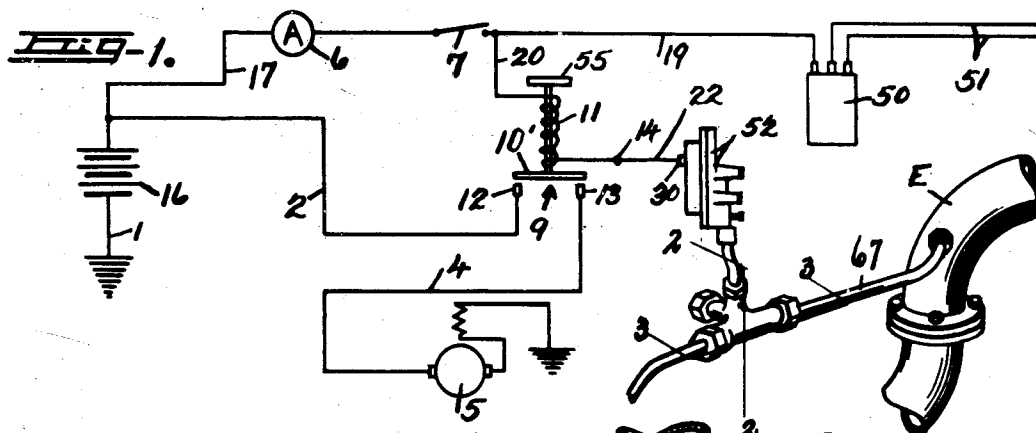
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1,981,879

AUTOMATIC CONTROLLER FOR INTERNAL COMBUSTION ENGINE STARTERS

Filed Dec. 26, 1931

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig-5.

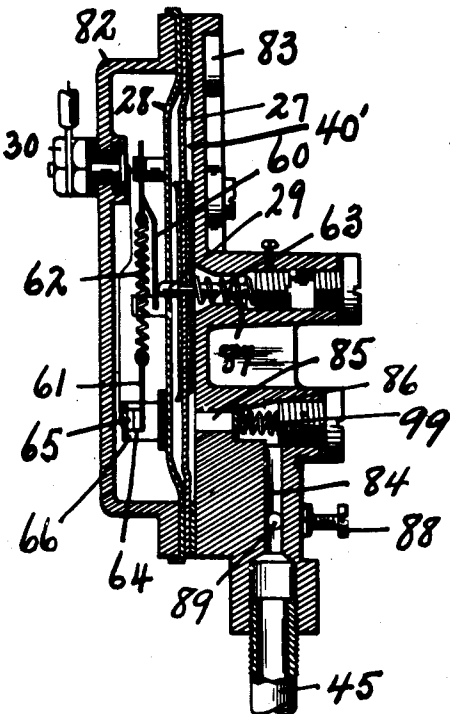


Fig-6.

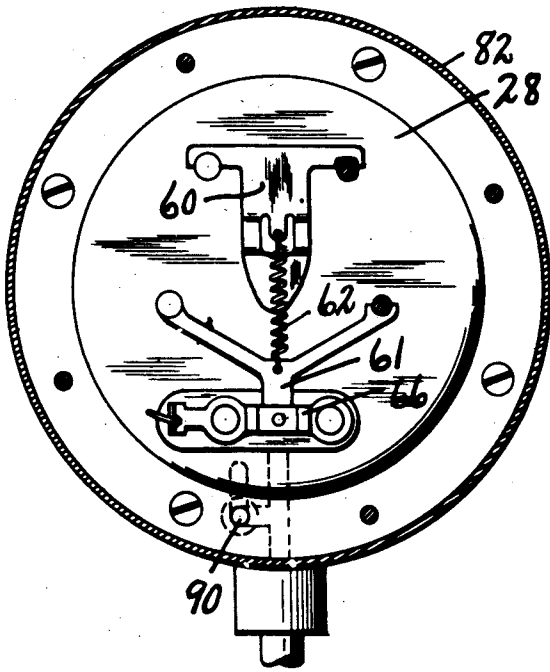


Fig-7.

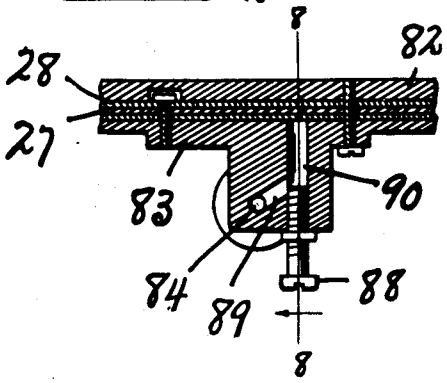
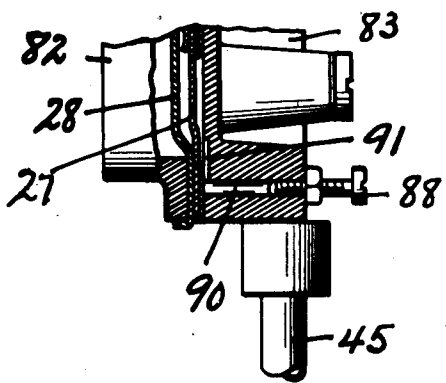


Fig-8.



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1,981,879

AUTOMATIC CONTROLLER FOR INTERNAL
COMBUSTION ENGINE STARTERSGordon B. Sayre, Syracuse, N. Y., assignor to
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Application December 26, 1931, Serial No. 583,356

9 Claims. (Cl. 290—38)

This invention relates to certain new and useful improvements in automatic controllers for internal combustion engine starters, and reference is hereby made to my copending applications, Serial No. 548,617, filed July 3rd, 1931 and Serial No. 576,319 filed November 20th, 1931 of which this application is a continuation in part.

The main object of the present invention is to provide an automatic means of going through the proper cycle for starting an internal combustion engine when the ignition switch is turned on and to provide automatic means for restarting such engine in case the engine stalls with the ignition switch on.

The invention to be described and claimed herein, contemplates the use of a new and novel apparatus and method of producing vacuum for actuating a vacuum relay which controls the making and breaking of a circuit to the electric motor which is adapted to start the engine. The use of the particular means hereinafter described, may permit substantial simplification of the circuit arrangement of the device and has many advantages, certain of which may be generally set forth as follows:

With a primary or energizing circuit including a vacuum relay operated, for instance, by connection to the intake manifold of the internal combustion engine, sufficient vacuum may be produced in the intake manifold to actuate the vacuum relay before the engine fires. With the present system, rotation of the starting motor does not produce any appreciable pressure above atmosphere in the exhaust manifold, and the engine must actually fire and exhaust before the pressure in the exhaust manifold reaches a high enough value to cause sufficient vacuum of the aspirating device to operate the vacuum relay, and, therefore, the starting motor circuit will not be broken until the engine actually fires.

Another advantage of this type of starter system is that this system is independent of the current taken by the starting motor. Consequently, should the bearings in the starting motor become gummed with oil and the starting motor require an exceptional amount of idling current, it would have no bearing on the operation of this system, but would cause a possible failure in the system where the magnetic starting switch is opened due to reduction of starting motor current. It may be possible that the starting motor current, when idling, is sufficiently high due to the aforementioned causes that a current relay will not open.

Another advantage of this system is the fact that under all conditions while the engine is pull-

ing the car, a sufficiently high pressure exists in the exhaust manifold regardless of intake manifold conditions, to cause the vacuum relay to keep its contacts open.

Another advantage of this system is that with the increased speed of the modern automobile, there seems to be a growing tendency to supercharge the engine on the intake side. Should this supercharging condition exist in an engine at high speed, a vacuum relay would not operate from the intake manifold, as the pressure would then be above atmosphere.

As soon as the exhaust pressure reaches the breaking-up valve to open the check valve in the vacuum relay, the entire time period produced by the bleed in the vacuum relay is then available. When operating from the intake manifold, the contacts in the vacuum relay may open part way due to extremely low vacuum conditions in the manifold, and should the engine hit a single explosion and not continue to run, the full time period of the vacuum relay is not available. Therefore, it starts to crank in a shorter time from a single explosion than from a running engine.

The advantages of this system over the automatic starting system using the voltage produced by the generator as a means of locking out the starting motor, are that at extremely slow speeds, the generator voltage is so very low, that difficulty is experienced in having the lock-out function of the starting device continue to operate. With this method, no such condition exists. Also, in the generator control device, it is necessary that the generator voltage be the controlling influence that causes the starting motor to be cut off from the battery circuit. The same disadvantage exists in the generator method, as previously stated in the vacuum method, that is, due to the tight bearings, and so on.

Further, after long periods of idling with the generator type, the voltage is so extremely low, that any slight slowing down of the motor which does not really stall the motor, brings in the starting motor. In the case of this system, the slight slowing down of the motor does not bring in the starting motor as the exhaust pressure still exists as long as the engine is firing.

It has also been found that when the generator is used as a means of control, insufficient voltage in the generator caused by glazing of the commutator, or oil and dirt on the commutator, will cause a failure in the electrical system. This system being entirely independent of the generator, is not so influenced. If the muffler which muffles the exhaust of the automobile engine be-

comes sodded and plugged, it will not injure the operation of this unit, as this has a tendency to slightly increase the exhaust pressure.

Another advantage of this type of starting system is that should the engine start running backward due to suddenly opening the throttle at extremely low speeds with an advanced spark, this unit will function the same as with the engine firing properly due to the fact that the exhaust manifold is at once reduced below atmosphere pressure and air rushing from the outside through the aspirator in the opposite direction to the gas flow, still creates sufficient vacuum to keep the relay open. In the case of generator control system, the generator immediately ceases to produce voltage when it is turned in the reverse direction, which would cause the starting motor to endeavor to engage the Bendix drive with the fly wheel, with the fly wheel rotating against the rotation of the starting motor. This would result in breaking the Bendix drive or its housing, or possibly the crank case. It may also strip the teeth from the fly wheel.

Other objects and advantages will appear from the following description, taken in connection with the accompanying drawings in which:—

Figure 1 is a diagrammatic illustration of an embodiment of the invention.

Figure 2 is a section on line 2—2, Figure 1.

Figure 3 is a section on line 3—3, Figure 1.

Figure 4 illustrates a modified embodiment of the invention which, in certain cases, is preferable.

Figure 5 is a section through a vacuum relay suitable for the purpose at hand.

Figure 6 is a plan view of the relay with the case section cut away.

Figure 7 is a sectional view illustrating the adjustable bleed for the chamber at the rear of the diaphragm.

Figure 8 is a section on line 8—8, Figure 7.

The apparatus, as diagrammatically illustrated in Figure 1, comprises a battery 16 having one terminal grounded through wire 1. The opposite terminal of the battery is connected by wire 17 to an ammeter 6, ignition switch 7, wire 19 to ignition coil 50 which, in turn, is connected in the usual manner, as by wires 51 to the timer and spark plugs of an internal combustion engine, the exhaust manifold of which is illustrated at E.

The usual starting motor 5 is provided, geared or connected in any usual or well-known manner to the fly wheel or crank shaft of the engine. A starting motor circuit normally broken, is provided from battery 16 through wire 17, wire 2, terminal 12, terminal 13, wire 4 to the starting motor 5, the other terminal of the starting motor being grounded, as diagrammatically illustrated.

Terminals 12 and 13 are spaced apart so that this circuit is normally broken. Means are provided for closing the starting motor circuit in the form of an electro-magnetic starting switch, indicated generally by the arrow 9. This electro-magnetic switch comprises a coil 11 and an armature 55, the latter carrying a disk or switch member 10' adapted to bridge and electrically connect the contacts 12 and 13 for closing the starting motor circuit.

A vacuum relay circuit is provided for coil 11 as by wire 20 leading from one terminal of the coil 11 and connected through the ignition switch 7 with wire 17 to one side of battery 16. The other terminal 14 of coil 11 is connected by wire 22 with the terminal 30 of the sub-atmospheric pressure operated relay 52.

For the present, it is sufficient to state that the contacts of relay 52 are normally closed when the engine E is not operating. The instant the circuit of coil 11 closes, disk or switch 10' is actuated to close the starting motor circuit through contacts 12 and 13 whereupon the starting motor 5 acts to rotate the fly wheel of the engine E in the usual and well-known manner.

The sub-atmospheric pressure relay 52 may take various forms, but the one illustrated is suitable for the purpose and comprises a cup-shaped body 82 with a head 83 secured thereto as by screws or the like, to provide an internal chamber. The edge of flexible diaphragm 27 and preferably the edge of a partition wall 28 formed of metal or the like, are clamped between the body 82 and head 83.

Diaphragm 27 carries a stud 29 fixed to the center thereof which extends through an opening in the partition 28 and normally engages the actuating arm 60 for the snap switch mechanism which includes a contact-carrying arm 61 and a spring 62 connecting the contact-carrying arm 61 with the actuating arm 60. Spring 87 normally urges the diaphragm in a direction to cause stud 29 to engage the actuating arm 60 and move it in a direction which will cause spring 62 to move the contact-carrying arm 61 in a direction to bring contact 64 carried thereby into contact with the cooperating contact 65 secured to the U-shaped member 66 which is mounted upon but insulated from the partition 28.

Contact 65 is electrically connected to terminal 30, while contact 64 is grounded as through the engine E. The detailed construction of a relay of this type is disclosed in my copending application Serial No. 583,355, and it should be sufficient herein to describe its general operation, as the operation of this relay is not the subject-matter of the claims of this application.

It will be apparent that under normal conditions, spring 63 holds diaphragm 27 in a position so that stud 29 engages actuating arm 60 so that the contacts are normally closed.

When sub-atmospheric pressure is produced in chamber 40' at the rear of diaphragm 27, the diaphragm will be retracted carrying stud 29 away from actuating arm 60 and permitting spring 62 to move contact 64 away from contact 65, thereby breaking the circuit for energizing the coil 11, whereupon switch 9 opens to break the starting motor circuit.

This invention provides a peculiarly advantageous apparatus and method for producing vacuum of the required degree and at the desired time to separate the contacts of the vacuum relay to break the energizing circuit for coil 11. This vacuum-producing apparatus takes advantage of the fact that the gases exist in and pass through the exhaust manifold E of the engine under pressure and that this pressure exists immediately upon firing of the engine.

The apparatus herein disclosed for utilizing this pressure existing in the exhaust manifold, comprises a body 10 connected to a pipe 67 which penetrates the exhaust manifold E. The connection of tube or pipe 67 to body 10 may be made in any usual manner as, for instance, by tubing sleeve 68 and tubing nut 69. The apparatus utilized for producing the required vacuum, as herein illustrated, may be generally defined as an aspirator, and the body 10 of the aspirator is provided with a conduit therethrough which at the section 70, is tapered or substantially conical and leads to a restricted passage 71, in this instance

arranged at substantially the center portion of the body 10.

On the side of the restricted passage 71 opposite the tapered section 70 is a second section 72 flaring outwardly or widening as it extends from the passage 71, and is preferably a counterpart of the section 70. An exhaust or discharge tube 73 may be connected to the end of the body 10 at a point beyond the cone section 72 as by means of tubing sleeve 74 and tubing nut 75.

I have discovered that where tube 73 is permitted to discharge into the atmosphere, this tube is somewhat larger than the tube 67 which normally constitutes the inlet to the body 10, and as an illustration, tube 67 may be one-fourth of an inch in interior diameter, tube 73 may be three-eighths of an inch in interior diameter, and the restricted passage 71 may be one-eighth of an inch in diameter. However, these sizes are variable and these particular specifications are not by way of limitation.

The restricted passage 71 constitutes a choke between the contracting passage 70 and the expanding passage 72, and acts to produce high velocity of gases through passage 71. Gas enters normally through tube 67, is caused to be reduced in volume by the choke 70, passes through 71 at high velocity and is again relieved at 72 to pass out through the exhaust passage 73.

Entering passage 71, as by penetrating the wall of body 10, is a jet 31 which has preferably a conical end 47 entering in and disposed within the passage 71. The jet 31 is preferably in the form of a tube for a considerable portion of its length, and at the end, which extends within the passageway 71 the interior diameter of the jet, as illustrated at 30, is quite small and leads to a passageway 40 of enlarged diameter, the wall of which is provided with diametrical passageways or holes 37 leading to chamber 41 formed within an extension of the body 10 and surrounding the adjacent portion of the jet 31.

The wall of the chamber 41 is provided with a hole or passageway 43 leading to and in communication with tube 45, which tube is connected to the body 10 as by tubing sleeve 80 and tubing nut 81. The tube 45 leads to and is connected to the head 83 in any suitable manner and communicates through passageway 84 and passageway 85 with the chamber 40' at the rear of diaphragm 27.

Valve 86 is provided in passage 85 which opens when suction exists in line 45 but is closed by a spring 99 when the engine is not operating so as to maintain subatmospheric pressure in chamber 40' for a short time period which may be adjusted by moving screw 88 which controls communication of passageway 89 leading from passageway 84 to the passageway 90 which is in communication with chamber 40' as through recess 91 formed in the head 83.

The period of time required for producing atmospheric pressure in chamber 40' after valve 86 closes, can be adjusted by the regulating screw 88 adapted to obstruct more or less the passage of air through conduit 89. This time period assures stopping of the engine before contacts 64 and 65 close.

It will be apparent that when the velocity of gas or fluid in passage 71 is sufficiently rapid, air is drawn from chamber 40' through tube 45, passageway 43, chamber 41, passageways 37 and jet 30. This air joins the main stream of gas flowing through passageways 70, 71 and 72 and escapes. The jet 31 is disposed and projects into passageway 71 at substantially right angles to

the direction of movement of fluid through body 10 and the projection 94 which surrounds the jet member may be closed air-tight as by a screw cap 95 and gasket interposed head 96 upon the jet and the outer end of the extension 94.

It is important that the end of the jet which projects into the passage 71 shall extend into the passage a substantially exact distance. Therefore, calibrating washers 97 may be applied under the head of jet 31 to cause the jet end to extend to the exact distance within passageway 71, which produces the most effective operation. As suggested of particular relations between certain of the elements of the structure, the tube 67 which connects with the exhaust manifold of the engine is of sufficient diameter to carry approximately four times the volume of gas that would pass through restricted conduit 71.

The tube 73 which may be open to atmosphere is of approximately eight times the volume of gas passing through 71. This gives a free passage of the gas to atmosphere eliminating any back pressure.

It will be apparent that with this construction and arrangement of vacuum-producing apparatus, it is of no importance in which direction through body 10 that the gas or fluid moves in order to produce suction or vacuum in chamber 40. Therefore, this apparatus operates with equal efficiency whether pressure or vacuum exists in the exhaust manifold, and the latter condition is some times present due to backfiring or reverse rotation of the engine. Under either condition, with this apparatus, the sub-atmospheric relay contacts are maintained open so that the electric starter will not operate to engage engine parts until substantial atmospheric pressure exists in the exhaust manifold.

The structure diagrammatically illustrated in Figure 4, differs from that illustrated in Figure 1, solely in the provision of a secondary relay of the current operated type. The use of this secondary relay is, in many cases, advantageous in that the opening of the contacts of relay 52 and the breaking of the primary circuit of coil 11 will not cause switch 9 to open since a secondary circuit is provided for coil 11 from battery 16 through wires 17 and 20, coil 11, terminal 14, wire 23, contact 29, armature 26 carrying contact 28 adapted for electrical connection with contact 29, the former contact being grounded through wire 53.

The armature 26, the contacts 28 and 29 and wire 53 taken in conjunction with core 24 and coil 25 which is positioned in the starting motor circuit, constitutes a current controlled relay. Spring 27 is provided for normally holding the armature 26 in such a position, that contacts 28 and 29 are electrically disconnected.

The tension of spring 27 is so determined or adjusted that the necessary current to crank the automobile engine, when flowing through coil 25, will magnetize core 24 sufficiently to keep contacts 28 and 29 closed. However, when the starting motor 5 is relieved of the load of cranking the engine, there is a decided reduction of current flowing through coil 25, and under this condition, spring 27 is sufficiently strong to separate contacts 28 and 29 thereby breaking the secondary circuit of the relay 9, releasing armature 55 and permitting movement of switch 10' to break the starting motor circuit. This secondary circuit for the coil 11 assures starting of the engine before the starting motor circuit is broken, as might result in cases where the vacuum relay alone is

used in connection with a primary circuit for coil 11.

Although I have shown and described specific embodiments of the invention as constituting perhaps preferred forms thereof, I do not desire to restrict myself to the details of form, construction or arrangement, as various changes and modifications may be made without departing from the invention, as set forth in the appended claims.

I claim:

1. In an automatic controller for internal combustion engine starters, the combination of a starting motor, a normally broken starting motor circuit, an electro-magnetic switch for closing the starting motor circuit and including a coil, a circuit for said coil and including a pressure-operated relay, an aspirating device associated with the exhaust manifold of the engine, and means connecting the aspirating device with the said pressure operated relay.

2. In an automatic controller for internal combustion engine starters, the combination of a starting motor, a normally broken starting motor circuit, an electro-magnetic switch for closing the starting motor circuit and including a coil, a coil energizing circuit including a pressure-operated relay having contacts normally closed at atmospheric pressure, and an aspirating device associated with the exhaust manifold of the engine and connected to said pressure-operated relay for opening said contacts when pressure above atmosphere exists in the engine manifold.

3. In an automatic controller for internal combustion engine starters, the combination of a starting motor, a normally broken starting motor circuit, an electro-magnetic switch for closing the starting motor circuit and including a coil, a coil energizing circuit including a pressure-operated relay having contacts normally closed at atmospheric pressure, a conduit connected to the exhaust manifold of the engine and including a restricted section, a jet communicating with said restricted section, and means connecting the jet with the pressure-operated relay device.

4. An automatic controller for internal combustion engine starters comprising an internal combustion engine, an ignition circuit therefor comprising a switch, a starting motor, means including an electro-magnetic switch having an actuating coil in circuit with the first switch for controlling the operation of the motor, a sub-atmospheric pressure relay in said coil circuit and including contacts normally closed at atmospheric

pressure, and means actuated in accordance with the pressure existing in the exhaust manifold of the engine for separating said contacts.

5. An automatic controller for internal combustion engine starters comprising an internal combustion engine, an ignition circuit therefor comprising a switch, a starting motor, means including an electro-magnetic switch having an actuating coil in circuit with the first switch for controlling the operation of the motor, a sub-atmospheric pressure relay in said coil circuit and including contacts normally closed at atmospheric pressure, an aspirating device associated with the exhaust manifold of the engine, and means connecting the aspirating device with the sub-atmospheric pressure relay.

6. An automatic controller for internal combustion engine starters comprising an internal combustion engine, an ignition circuit therefor comprising a switch, a starting motor, means including an electro-magnetic switch having an actuating coil in circuit with the first switch for controlling the operation of the motor, a sub-atmospheric pressure relay in said coil circuit and including contacts normally closed at atmospheric pressure, a conduit connected to the exhaust manifold of the engine and including a section of restricted cross-sectional area, a jet penetrating the conduit at said restricted section, and means connecting the jet with the sub-atmospheric pressure relay.

7. In an automatic controller for internal combustion engine starters, a normally broken starting motor circuit, means for closing said starting motor circuit comprising a second circuit, and means comprising a vacuum-operated device for controlling said second circuit, said vacuum operated device being operable by the flow of gases through the exhaust manifold of the engine.

8. In an automatic controller for internal combustion engine starters, a normally broken starting motor circuit, means for closing said starting motor circuit comprising a vacuum-operated device, said vacuum-operated device being operable by the flow of gases through the exhaust manifold of the engine.

9. In an automatic controller for internal combustion engine starters, a normally broken starting motor circuit, means for closing said starting motor circuit comprising a pressure operated device and a venturi operable by the flow of gases through the exhaust manifold of the engine for actuating said pressure operated device.

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