Nov. 4, 1941. D. COLLINS 2,261,232

AUTOMATIC STARTING MECHANISM

Original Filed July 28, 1933 2 Sheets-Sheet 1

FIG. 1.

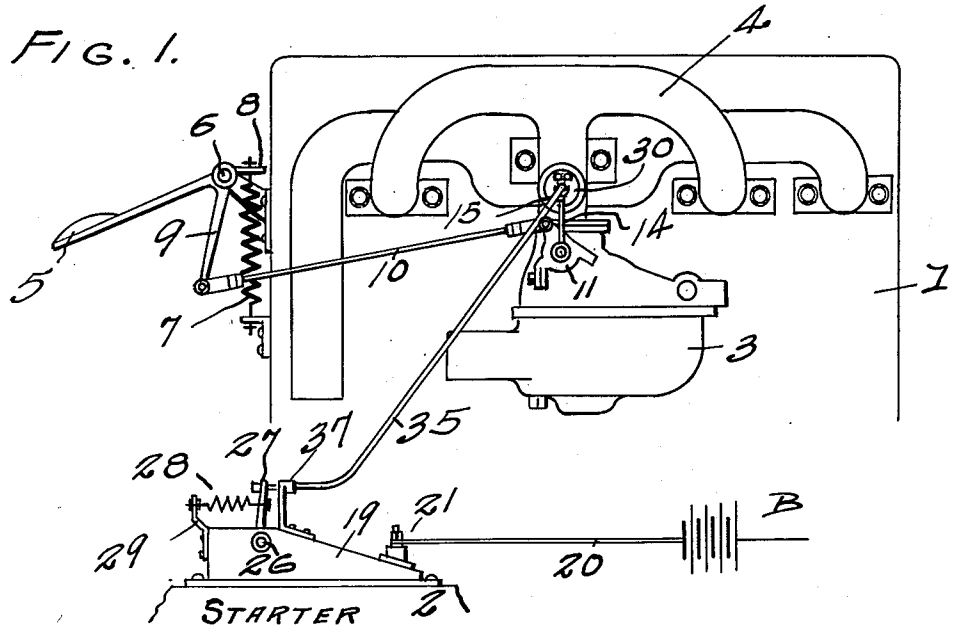


FIG. 2.

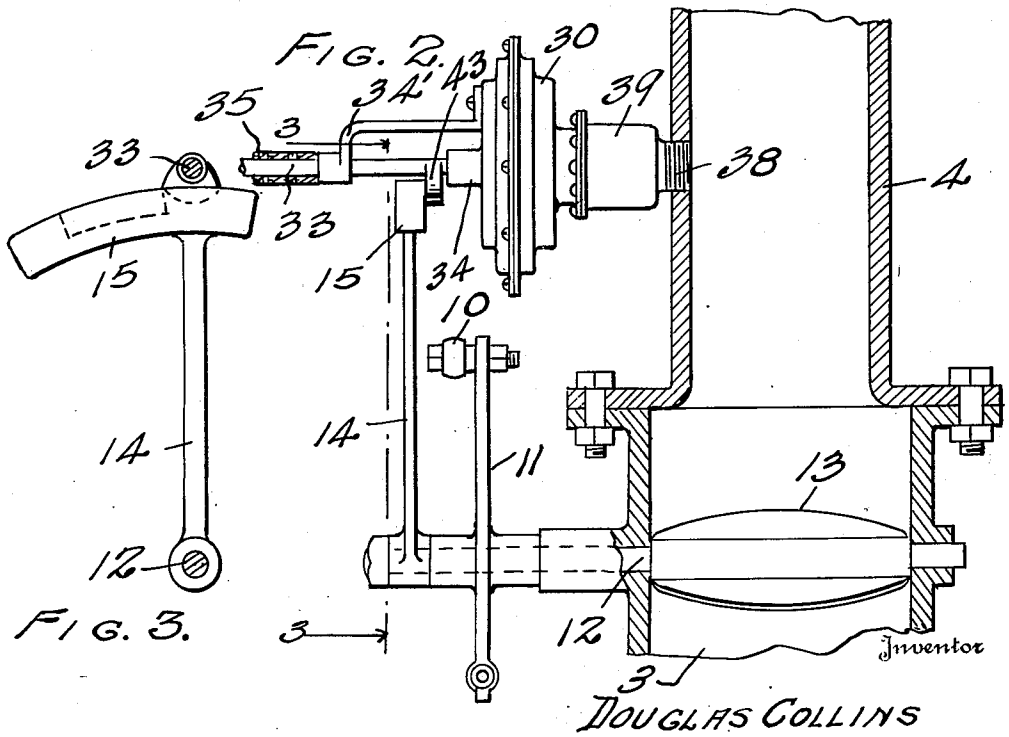


FIG. 3.

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AUTOMATIC STARTING MECHANISM

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FIG. 4.

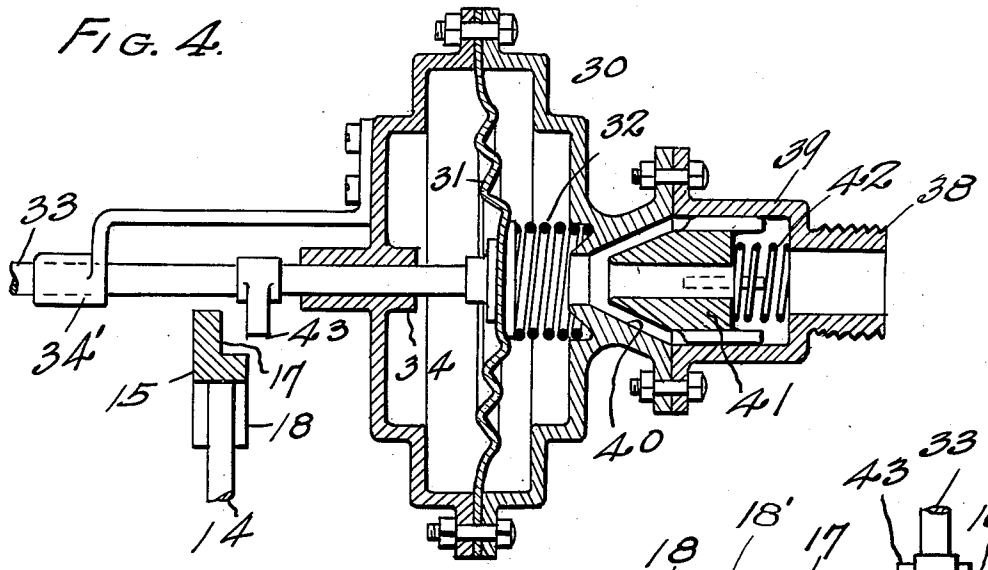


FIG. 6.

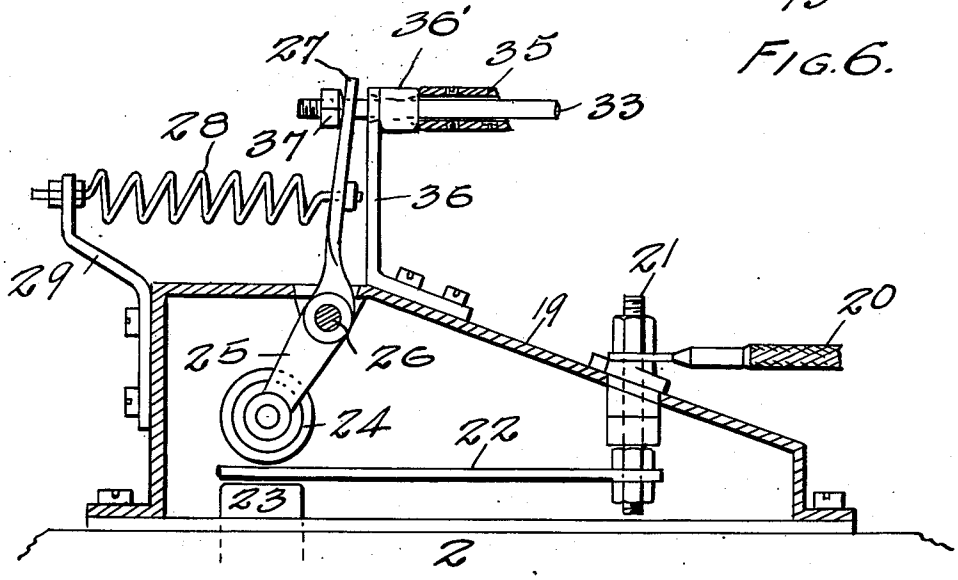


FIG. 5.

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Patented Nov. 4, 1941

2,261,232

UNITED STATES PATENT OFFICE

2,261,232

AUTOMATIC STARTING MECHANISM

Douglas Collins, Salisbury, N. C.

Application July 28, 1933, Serial No. 682,720
Renewed October 6, 1938

28 Claims. (Cl. 123—179)

My present invention relates to an improved automatic starting mechanism for internal combustion engines, and particularly to that type of mechanism involving an automatically closed starting switch or circuit maker for the electric starting motor or starter of the engine. The starter switch or circuit maker is included in the electrical system of an automotive vehicle, and the switch is closed for the purpose of cranking or re-cranking the engine. The circuit maker or starting switch is opened and retained in open position by vacuum-actuated means when the engine is running and the switch is also opened and retained in open position by direct-acting devices under control of the throttle mechanism when the engine is running, as well as when the engine is not running.

The cranking operation of the engine is permitted to be automatically accomplished, by the action of the starter or starting motor, when the accelerator or fuel control lever is depressed, and by the throttle mechanism in connection with a vacuum-operated unit responsive to action of the engine when the latter is running.

By the utilization of the mechanism of my invention, if the engine stalls at any time while the ignition is on in the electrical system of the vehicle, the re-cranking operation of the engine may be accomplished by action of either manual or pedal mechanism for controlling the fuel supply to the engine. Upon starting the engine, as soon as the engine fires, the high vacuum in the intake manifold is utilized in connection with a suction-diaphragm to open the circuit maker or starter switch, and as long as the engine continues running and current is supplied to the starter switch from the electrical system of the automotive vehicle, the contact points of the starter switch are held open so that no current can flow to the starter.

By means of my automatic starter mechanism in combination with the throttle control mechanism of the engine, I am enabled to control and regulate the fuel mixture supply throughout the entire operation of the engine by means of the usual accelerator pedal, and at the same time the starting mechanism is controlled and is available at all times for automatic operation when required for that purpose, i. e. for cranking the engine.

My invention consists essentially in certain novel combinations and arrangements of parts involving the throttle mechanism, the starting mechanism, and a vacuum-operated unit, as will hereinafter be more fully set forth and claimed.

In the accompanying drawings I have illustrated one complete example of the physical embodiment of my invention wherein the parts are combined and arranged according to one mode I have thus far devised for the practical application of the principles of my invention. It will be understood that various changes and alterations may be made in the exemplified structure within the scope of my claims without departing from the principles of my invention, and therefore I do not limit myself to the specific arrangement of parts shown in the accompanying drawings.

Figure 1 is a conventionalized view in elevation, showing a motor and its fuel control mechanism, the starter and starter switch, and the adaptation thereto of my automatic starting mechanism.

Figure 2 is a vertical sectional view of the carbureter and the intake manifold, showing the throttle mechanism and the switch control mechanism, together with the vacuum-controlled unit.

Figure 3 is a detail view of the cam device of the automatic control mechanism for the starter switch.

Figure 4 is a vertical sectional view of the vacuum-operated unit, showing a retarding valve for the suction-diaphragm, and also showing the cam mechanism which co-acts with the throttle mechanism.

Figure 5 is an enlarged sectional view of the housing for the starter switch or circuit maker, showing the latter in open position, and retained in that position by the suction-diaphragm of Figure 4.

Figure 6 is a detail view of the cam head which co-acts with throttle device, and disclosing three cam faces on the head, two faces for positively holding open the starter switch, and an intermediate face which operates to permit automatic closing of the starter switch.

In order that the general arrangement, assembly, and utility of parts, according to one mode I have so far devised for the practical application of the principles of my invention, may be understood I have shown in Figure 1 a conventional internal combustion engine 1 with its electric starter or motor 2, and a carbureter of suitable type is indicated at 3. These elements, and other elements of the equipment, are illustrated, for convenience, at one side of the engine, but it will be understood that the invention may readily be adapted to various makes or types of automobile engines, and the location of parts may be varied to suit different conditions.

The usual intake manifold 4 connects the car-

bureter 3 with the engine 1, and the fuel supply as here illustrated, is controlled by the usual depressible pedal-accelerator or bell crank lever 5 that is mounted on the rock shaft 6 which is journaled in suitable brackets as usual.

The accelerator pedal 5 is held uplifted by means of a spring 7 anchored at one end and connected at its other end to a lever arm 8 of the accelerator. Another arm 9 of the bell crank lever is connected as usual by the link or rod 10 to the throttle lever 11 which latter lever is mounted as usual on the pin 12, and the throttle or fuel control valve 13 is mounted on the pin and located within a portion of the carburetor to control supply of fuel mixture to the intake manifold, 4, of the engine.

In converting this well known throttle mechanism or fuel control mechanism for my own use, I employ a cam lever 14 that may be fixed on an extension of the pivot pin 12 of the throttle, and of course exterior of the carburetor and of the throttle lever 11. This auxiliary, or cam lever 14 is equipped with a cam-head 15 of arcuate shape, and is fixed on the pin 12 in adjusted position, to swing or turn with the throttle lever 11 when the accelerator 5 is depressed, and when the pedal is uplifted by tension of the spring 7 after pressure is released from the accelerator. The cam head is fashioned with three distinct cam faces, as 16, 17, and 18, the two faces 16 and 18 being adapted to cooperate with other parts to be described in the performance of the function of holding open the automatically closed starter switch, and the intermediate face 17 being adapted to permit automatic closing of the starter switch.

The electric switch or circuit maker for the starter or electrical motor 2 is enclosed within a housing 19 that may conveniently be attached, as shown, on the top of the starter 2, and a wire 20 and battery B of the electrical system of an automotive vehicle, which includes the ignition system, are indicated in Figure 1. The wire 20 is connected to a terminal post 21, and within the housing a spring blade 22 is mounted on the post for co-action with a stationary contact point or button 23. These parts, the spring blade and the button form the two contact points of the automatically closed circuit maker or switch for the starter or starting motor 2.

The circuit maker is closed by pressure on the spring blade from a roller 24, of non-conducting material, which roller is journaled in the free end of an arm 25 of the spring lever or switch lever, and the lever is pivoted at 26 in the walls of the housing 19.

The upper or outer arm 27 of the switch lever has secured thereto a spring 28, and the latter is anchored to a bracket 29 attached to the exterior of the housing 19. The spring 28, it will be seen, is adapted, through its tension, to pull the lever arm 27 to the left in Figure 5, and swing the arm 25 to the right, thus causing the roller 24 to ride down the free end of the spring blade into contact with the button 23, to close the starter switch, and thus energize the starter 2 for cranking the engine.

The spring is thus adapted to automatically close the switch at all times, in the absence of a greater force that may be applied to the arm 27 of the switch lever to open the switch or hold it open.

Through the movement of the switch lever 25—27 and a vacuum-operated unit responsive to suction in the intake manifold of the engine while the latter is running, the starter switch is opened and may be held open; and in addition, positive means in connection with the cam faces 16 and 18 are employed for opening the starter switch and for holding it open; and the intermediate cam face 17 is adapted under certain conditions, to allow the spring 28 to automatically close the starter switch.

The vacuum operated unit includes a casing 30 which forms a chamber in which the flexible diaphragm 31 is mounted, and a spring 32 at the engine or vacuum side of the diaphragm, is interposed between the diaphragm and one of the walls of the casing. This spring, under tension tends to resist suction at the vacuum side of the diaphragm, and is compressed by the diaphragm when the latter is moved to the right, as in Figure 4, under suction from the engine. In the absence of suction at the vacuum side of the diaphragm, the spring 32 tends to move the flexible diaphragm away from the vacuum side of the enclosing casing, and toward the starter switch, i. e. toward the left in Figure 4. When the engine is running and a vacuum condition exists in the engine, the flexible diaphragm is pulled by suction to the right as in Figure 4.

A suitable pull-wire or flexible connection 33 is attached at the pressure side of the diaphragm, at the center thereof and axially alined with the spring 32 at the vacuum side of the diaphragm, and adjacent to the diaphragm, the wire is supported to slide in bearings as 34 and 34' under movement in either direction of the flexible diaphragm. The pull wire or connection 33 is supported throughout its length in operative position, within a sheathing or tubular cover 35, which possesses sufficient rigidity to permit proper disposition of the pull wire in its extension toward the starter switch. The supporting sheathing or cover 35 for the wire may be adjusted as to its position and shape or form in accord with the location of the starter switch in respect to the vacuum-operated unit and the sheathing provides a support in which the necessary longitudinal movement or sliding of the wire is freely accomplished.

The tubular sheathing is supported at the bracket bearing 34' of the vacuum operated unit, and also by bracket 36a attached to the housing of the starter switch, and the pull wire passes through a guide sleeve 36' of this bracket, and also through a hole in the upper free end of the arm 27 of the switch lever. After passing through the hole in the lever arm, the end of the wire is provided with an anchor, stop, or abutment 37 of suitable character, here shown as a nut on the threaded end of the wire. In Figure 5 the end portion of the wire has free play in the sleeve 36', the perforated end of the lever arm 27 and the tubular sheathing 35, but the spring 28 and the stop 27 are so adjusted that a pull on the wire to the right to the position of Figure 5, causes the arm 27 of the switch lever to swing to the right, and arm 25 to swing to the left, freeing the roller 24 from contact with the spring blade 22, and thus opening the starter switch or circuit maker. In Figure 5, the diaphragm in the position of Figure 4 has, under action of suction, pulled the wire to bring the stop or abutment 37 into contact with the lever arm 27, and the abutment is holding the lever in open position against the tension of the expanded spring 28 of the switch. In the absence of a vacuum at the engine side of the diaphragm, the compressed spring 32 forces or pushes the diaphragm to the

left in Figure 4, thus sliding the wire in its supporting sheath and moving the abutment 37 to the left in Figure 5, thus freeing the arm 27 of the lever from the pull of the diaphragm. When thus freed, the arm 27 is pulled by the extended spring 28, the arm 25 is swung to the right, and the roller 24 rides down the free end of the spring blade into contact with the button 23, thus closing the starter switch.

This described automatic closing of the switch is permitted only when the intermediate, depressed cam face 17 of the cam head 15 is alongside of a lug 43 rigidly secured in adjusted position on the wire between the two guides or supports 34 and 34' supported on and from the casing of the diaphragm.

The diaphragm casing is attached by means of a threaded nipple 38 to the intake manifold 4, above the throttle 13, and between this connection with the manifold and the diaphragm, a valve casing 39 is interposed adjacent the valve seat 40 in one wall of the casing, which seat has a port opening into the casing at the vacuum side of the diaphragm. A tapered slide valve 41 having a central inner bore or passage alined with the diaphragm port and the nipple 38 is located in the chamber formed by the casing 39, and a spring 42 tends to urge this tapered valve to the left in Figure 4 to occupy the seat 40, for the purpose of reducing the capacity for suction at the vacuum side of the diaphragm, and, under other conditions, as when re-cranking the engine after the latter is stalled, for increasing the capacity or volume of suction. Thus, when the tapered plug valve occupies its seat, under tension of the spring 42, the suction area is reduced to the capacity or area of the bore of the plug valve, while with the valve in the open position of Figure 4 the suction area is increased by the added space surrounding the valve and within the seat and the valve chamber 39.

As indicated in the drawings, when the engine is at rest, the accelerator 5 is uplifted, and the throttle valve is in substantially closed position of Figure 2, the cam lever, under control of the throttle pin 12 is in position of Figure 3 with its cam face 16 in frictional contact with the lug 43, thereby holding the wire 33 taut and the lever arm 27 over to the right in Figure 5 with the starter switch open.

By depressing the pedal 5, after the ignition switch has been turned on or closed, the engine is cranked without necessity for attention on the part of the vehicle driver to any other device, and the pedal is depressed in usual manner for controlling the supply of fuel mixture to the intake manifold and cylinders of the engine. As the throttle is advanced or opened, the turning movement of the throttle pin 12 swings the cam lever 14 synchronously with the throttle lever 11, and the cam face 16 of the cam head 15 rides across the adjoining face of the lug 43. As the cam head advances in its swinging movement the depressed cam face 17 moves into position opposite the lug, and because of the absence of suction at this early stage of the starting operation, the spring 32 and the switch spring 28 are free to push and pull the connecting wire 33, thus locating the lug 43 in the depressed cam face 17. This action of the expanded spring 28, in its contracting movement, swings the switch lever and thereby closes the starter switch and the electric starter is energized.

As soon as the engine is firing, the suction created in the cylinders and manifold 4 pulls the diaphragm toward the vacuum side thereof against tension of the spring 32, thereby pulling the wire or stem 33, and withdrawing the lug 43 from the depressed cam face to the position of Figure 4. By the same movement of the wire or stem 33 the switch lever 25—27 is pulled to position of Figure 5 to open the switch against the tension of spring 28, and the starting motor is thereby cut out.

To prevent the throttle being opened too wide at the time of cranking the engine, the shoulder 18' between the cam face 17 and the cam face 18, limits the movement of the arcuate cam head by forming an abutment for the lug 43.

It will be understood that under some conditions, as for instance, when the automobile is ascending a steep hill, and with the throttle wide open, there is practically no vacuum condition existing beyond the suction which draws the fuel through the intake manifold, even though the engine is running. Under this, and similar conditions, the cam face 18 co-acts with the lug 43 to hold the diaphragm to the right, or vacuum side, of the housing. Thus, the cam section 18 performs the same function of holding open the starter switch when the engine is running and there is no vacuum to move the diaphragm, in the same manner that cam section 16 holds open the starter switch when the engine is not running and there is no vacuum.

During the cranking operation, to prevent the diaphragm from being moved to the right or vacuum side by engine suction as the cranking speeds, one or both of the springs 28 and 32 are of sufficient strength or tension for this purpose. Under abnormal cranking conditions, as when the engine has been stalled and is being re-cranked, these springs may have a tendency to energize the starting motor before the engine has come to rest, should the attempt be made to re-crank the engine before it ceases movement. Under these conditions it is necessary that the closing of the starter switch be slightly delayed.

For this delayed closing of the starter switch and the energizing of the starting motor to re-crank the stalled engine, I provide the bleeder valve 41, which while under these conditions is occupying its seat, and, therefore permits air to enter the vacuum side of the housing slowly. The slow movement of air to the vacuum side of the diaphragm delays the movement to the left of the diaphragm, and during this delayed movement the engine comes to rest, after which the starter switch is closed for re-cranking of the engine.

This retarding of the closing action of the starter switch, when the engine is being re-started or re-cranked, permits the engine to come to a complete rest before the engine is cranked or re-started, and before the starting motor gears engage the fly wheel of the engine, thus removing the possibility of a clash of the starting gears.

When the engine is running, the diaphragm is pulled to the right in Figure 4 by suction through the intake 4, and the diaphragm spring 32 is thus compressed. The valve 41 is pulled away from its seat 40, compressing the valve spring 42, and in this position of the valve the vacuum is permitted to pull through the center bore of the valve, as well as through the valve chamber exterior of the valve.

In the event of a failing vacuum, the spring 42 will close the valve 41 to its seat 40, thus reducing the area of the suction pull at the vacuum side of the diaphragm, and permit air to leak

slowly back into the diaphragm housing, as the switch spring 28 and the diaphragm spring 32 force the diaphragm and its stem to the left in Figures 4 and 5, to permit closing of the starting switch.

In applicant's copending application Serial No. 500,947 there is disclosed a mechanism through the medium of which the closing of the starting motor circuit is effected by operation of the accelerator pedal and such mechanism is claimed broadly therein. The claims in this application are directed only to the specific mechanism which is disclosed herein.

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

1. In a starting mechanism for internal combustion engines, the combination with a fuel control mechanism, a starting switch, and a spring-operated lever tending to automatically close the switch, of means operable with the control mechanism for holding said lever, and co-acting elements of said fuel control mechanism and the last mentioned means for releasing said lever.

2. In an automatic starting mechanism for internal combustion engines, the combination with a fuel control mechanism, a starting switch, and a spring-operated lever tending to close said switch, of means for releasing said lever, and vacuum-operated means for opening the switch in connection with said lever and for holding said lever when the engine is running.

3. In a starting mechanism for internal combustion engines, the combination with a fuel control mechanism, a starting switch, and a spring-pressed lever tending to close said switch, of means for releasing said lever, vacuum operated means for opening said switch in connection with said lever, and means operable under suction from the engine for delaying the release of said lever.

4. In an automatic starting mechanism for internal combustion engines, the combination with a fuel control mechanism, a starting switch, and a spring-operated lever for closing said switch, of a vacuum operated unit having a stem connected to said lever and a lug on said stem, a cam-lever operable with the fuel control mechanism, and a cam-device on said lever for co-action with said lug to permit closing of the switch.

5. The combination in an automatic starting mechanism for internal combustion engines with the fuel control mechanism, a cam lever operable with said mechanism and a plurality of cam faces mounted on said lever, of a vacuum-operated unit including a stem, a lug on said stem for co-action with said cam faces, a starting switch and independent means for automatically closing said switch, and an operative connection between said stem and said independent means.

6. In a starting mechanism for internal combustion engines, the combination with a fuel control mechanism, a starting switch, and a spring-pressed lever tending to close said switch, of means for releasing said lever, vacuum operated means for opening said switch in connection with said lever, said vacuum operated means including a housing communicating with the intake manifold of the engine, a diaphragm in the housing, a spring-closed suction-opened valve between the housing and manifold, and said valve having an interior bore whereby a delay is caused in the release of said lever and automatic closing of said switch.

7. In a starting mechanism for internal combustion engines, the combination with a fuel control mechanism, a starting switch, and a spring-pressed lever tending to close said switch, of means for releasing said lever, vacuum operated means for opening said switch in connection with said lever, said vacuum operated means including a housing communicating with the intake manifold of the engine, a diaphragm in said housing and a spring in the housing bearing against the suction-side of the diaphragm, a valve casing having a seat between the housing and manifold, a suction-opened valve in the casing and a spring adapted to close said valve, and said valve having an interior bore whereby a delay is caused in the release of said lever and automatic closing of said switch.

8. In an automatic starting mechanism for an internal combustion engine having an intake manifold, the combination with a housing in communication with the manifold and a diaphragm in the housing, of a fuel control mechanism, a starting switch, a spring-operated lever tending to close said switch, a movable stem connecting said diaphragm and lever, control means on said stem, and means in connection with the fuel-control mechanism for co-action with said control-means for releasing said lever.

9. In an automatic starting mechanism for an internal combustion engine having an intake manifold, the combination with a housing communicating with the manifold, a suction diaphragm in the housing, a fuel control mechanism, a starting switch, and a spring-actuated lever tending to close said switch, of a movable stem connecting the lever and diaphragm and a lug on the stem, a lever operative with the fuel control mechanism, a cam face on the lever for co-action with said lug to hold the switch open, and another face on the lever for co-action with the lug to permit closing of the switch.

10. Automatic starting mechanism for internal combustion engines comprising a battery, a starting motor adapted to receive current from said battery, a control switch for controlling the effectiveness of the starting motor, automatic means for closing said switch, a movable member cooperating with said switch closing means for controlling the operation of said switch, said member being so constructed that when it occupies a position at one extreme of its movement the switch closing means is prevented from closing the switch, when said member occupies an intermediate position the switch closing means is permitted to operate to close said switch and when said member is moved to the other extreme of its movement the switch closing means is again prevented from operating, and means for moving said member to its several positions.

11. Automatic starting mechanism for internal combustion engines comprising a battery, a starting motor adapted to receive current from said battery, a control switch for controlling the effectiveness of the starting motor, automatic means for closing said switch, a movable member cooperating with said switch closing means for controlling the operation of said switch, said member being so constructed that when it occupies a position at one extreme of its movement the switch closing means is prevented from closing the switch, when said member occupies an intermediate position the switch closing means is permitted to operate to close said switch and when said member is moved to the other extreme of its movement the switch closing means is

again prevented from operating and manually operable means for moving said member to its several positions.

12. Automatic starting mechanism for internal combustion engines comprising a battery, a starting motor adapted to receive current from said battery, a control switch for controlling the effectiveness of the starting motor, resilient means normally tending to close said switch, a movable member cooperating with the switch closing means to control its operation as said member is moved to different positions normally preventing the closing of the switch when the engine is not running, and means for moving said member to a position to permit closing of the switch in order to enable the engine to be started, said member being also movable by said moving means to another position to prevent closing of said switch by said resilient means when the engine is operating under its own power.

13. Automatic starting mechanism for internal combustion engines comprising a battery, a starting motor adapted to receive current from said battery, a control switch for controlling the effectiveness of the starting motor, resilient means normally tending to close said switch, a movable member cooperating with the switch closing means to control its operation as said member is moved to different positions normally preventing the closing of the switch when the engine is not running, means for moving said member to a position to permit closing of the switch in order to enable the engine to be started, and means operable by the engine for opening said switch when the engine begins to run, said member being also movable by said moving means to another position to prevent closing of said switch by said resilient means when the engine is operating under its own power.

14. Automatic starting mechanism for internal combustion engines comprising a battery, a starting motor adapted to receive current from said battery, a control switch for controlling the effectiveness of the starting motor, resilient means normally tending to close said switch, a movable member cooperating with the switch closing means to control its operation as said member is moved to different positions normally preventing the closing of the switch when the engine is not running, means for moving said member to a position to permit closing of the switch in order to enable the engine to be started and means operable by engine suction for opening said switch when the engine begins to run, said member being also movable by its said moving means to another position to prevent closing of said switch by said resilient means when the engine is operating under its own power.

15. Automatic starting mechanism for internal combustion engines comprising a battery, a starting motor adapted to receive current from said battery, a control switch for controlling the effectiveness of the starting motor, automatic means for closing said switch to cause the operation of the starting motor, a movable member cooperating with the switch closing means to control its operation as said member is moved to different positions normally preventing the closing of the switch, means for variably controlling the amount of combustible mixture supplied to the engine, means connecting said movable member to said last named means so as to be operated thereby, said member being movable by said mixture controlling means to permit closing of the switch, and also movable by said mixture controlling means to a position to positively prevent closing of said switch when the mixture controlling means is in a certain operative position.

16. Automatic starting mechanism for internal combustion engines comprising a battery, a starting motor adapted to receive current from said battery, a control switch for controlling the effectiveness of the starting motor, automatic means for closing said switch to cause the operation of the starting motor, a movable member cooperating with the switch closing means to control its operation as said member is moved to different positions normally preventing the closing of the switch, means for variably controlling the amount of combustible mixture supplied to the engine, means connecting said movable member to said last named means so as to be operated thereby, said member being movable by said mixture controlling means to permit closing of the switch as the mixture controlling means is moved to increase the quantity of mixture supplied to the engine, and also adapted to be moved to a position to positively prevent closing of the switch as said mixture controlling means is moved to a position to supply a maximum quantity of fuel mixture to the engine.

17. Automatic starting mechanism for internal combustion engines comprising a battery, a starting motor adapted to receive current from said battery, a control switch for controlling the effectiveness of the starting motor, automatic means for closing said switch to cause the operation of the starting motor, a movable member normally preventing closing of the switch, means for variably controlling the amount of combustible mixture supplied to the engine, means connecting said movable member to said last named means so as to be operated thereby, said member being movable by said mixture controlling means to permit closing of the switch as the mixture controlling means is moved to increase the quantity of mixture supplied to the engine, and means operable by engine suction to open said switch, said member being also movable by said mixture controlling means, as the latter is moved to a position to supply a maximum quantity of fuel mixture to the engine, to a position where it prevents closing of the starter switch in the event of reduction in engine suction.

18. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, means normally tending to close said switch, means operable by the mixture controlling means and cooperating with said switch closing means to prevent the closing of said switch when the mixture controlling means is in normal inoperative position and movable by said mixture controlling means to a position to permit the switch to be closed so as to cause the starting motor to become operative.

19. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, means normally tend-

ing to close said switch, means operable by the mixture controlling means and cooperating with said switch closing means to prevent the closing of said switch when the mixture controlling means is in normal inoperative position and movable by said mixture controlling means, as the latter is operated to increase the mixture supply, to a position to permit the switch to be closed so as to cause the starting motor to become operative.

20. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, means normally tending to close said switch, means operable by the mixture controlling means and cooperating with said switch closing means to prevent the closing of said switch when the mixture controlling means is in normal inoperative position, said means being movable to different positions by said mixture controlling means as the latter is operated to vary the mixture supply, in one of which positions it permits the closing of said switch, while in another of such positions it prevents any closing of said switch.

21. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, means normally tending to close said switch, means operable by the mixture controlling means and cooperating with said switch closing means to prevent the closing of said switch when the mixture controlling means is in normal inoperative position, said means being movable to different positions by the mixture controlling means as the latter is operated to progressively increase the mixture supply and adapted to be moved to a position to permit closing of the switch as the mixture supply is partially increased and to a position to prevent closing of the switch as the mixture supply is further increased.

22. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, means normally tending to close said switch, means operable by the mixture controlling means and cooperating with said switch closing means to prevent the closing of said switch when the mixture controlling means is in normal inoperative position, said means being movable by said mixture controlling means to a position to permit the switch to be closed, so as to cause the starting motor to become operative and means operable by engine suction to effect opening of said switch.

23. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, means normally tending to close said switch, means operable by the mixture controlling means and cooperating with said switch closing means to prevent the closing of said switch when the mixture controlling means is in normal inoperative position, said means being movable by the mixture controlling means as the latter is operated to increase the mixture supply to a position to permit closing of the switch, and to a position to hold the switch open as the mixture supply is increased further, and means operated by engine suction for also holding the switch open.

24. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, a spring operated member tending to close the switch, a member operable by the mixture controlling means for preventing operation of the switch closing member and movable to a position to permit the spring to operate said switch closing member as the mixture controlling means is moved to increase the amount of mixture supplied to the engine.

25. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, a spring operated member tending to close the switch, a member normally preventing operation of the switch closing member and movable by the mixture controlling means to a position to permit said spring to operate said switch closing member as the mixture controlling means is moved to increase the amount of mixture supplied to the engine and means operated by engine suction to move said switch closing member against the force of its spring to effect opening of the switch.

26. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, a spring operated member tending to close the switch, a cam operable by the mixture controlling means and having different surfaces thereon cooperating with said switch closing member, said cam normally being in such position that a surface thereon prevents operation of the switch closing member, and being movable to a different position to bring another surface thereon into cooperative relation with the switch closing member to permit closing of the switch by said last named member.

27. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, a spring operated member tending to close the switch, a cam operable by the mixture controlling means and having different surfaces thereon cooperating with said

switch closing member, said cam normally being in such position that a surface thereon prevents operation of the switch closing member, and being movable first to a position to bring a surface thereon into cooperative relation with the switch closing member which is of such form as to permit closing of the switch and then upon further movement of the cam to bring another surface into cooperative relation with the switch closing member which is of such form as to prevent closing of the switch.

28. In a starting apparatus for internal combustion engines having a starting motor, a current source for operating said starting motor and a circuit between said starting motor and the current source, a switch for controlling the connection of said current source with the starting motor, means for controlling the supply of fuel mixture to the engine, a spring operated member tending to close the switch, a cam operable by the mixture controlling means and having different surfaces thereon cooperating with said switch closing member, said cam normally being in such position that a surface thereon prevents operation of the switch closing member, and being movable first to a position to bring a surface thereon into cooperative relation with the switch closing member which is of such form as to permit closing of the switch and then upon further movement of the cam to bring another surface into cooperative relation with the switch closing member which is of such form as to prevent closing of the switch, and other means operated by engine suction for preventing closing of the switch.

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