

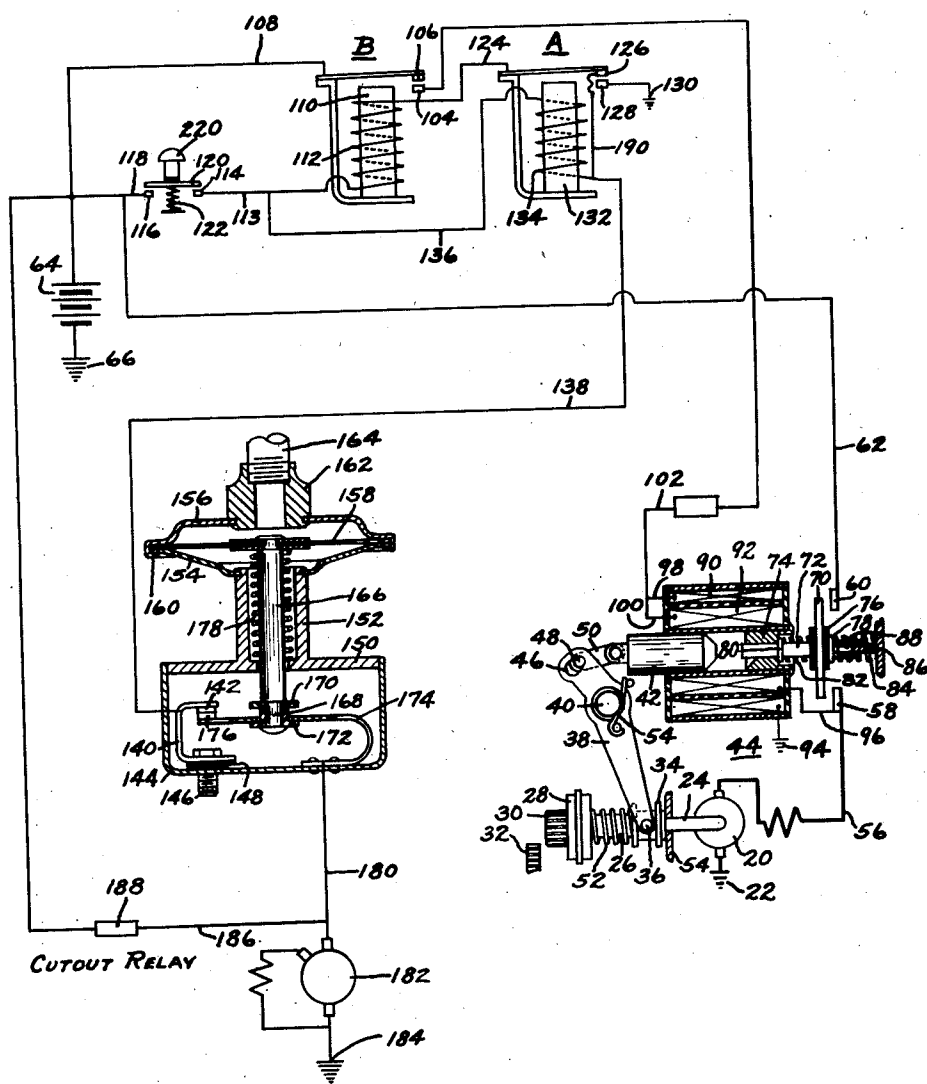
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CONTROL APPARATUS FOR ENGINE STARTERS

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CONTROL APPARATUS FOR ENGINE  
STARTERS

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This invention relates to starting apparatus for internal combustion engines, particularly to starting apparatus of the type in which the starter pinion is moved into engagement with the engine gear by an electromagnet, the energization of which is accomplished by the closing of certain manual and automatic switches in a control circuit therefor.

In starting apparatus of this type switches operated by fluid pressure created by the engine, either manifold vacuum or engine oil pressure, have been provided to prevent closing of the control circuit and consequent operation of the starting motor during operation of the engine under its own power. Difficulty has been encountered when such a fluid pressure operated switch is employed to provide a switch which will remain open during self-operation of the engine under all operating conditions, but will not open during "cranking" of the engine by the starting motor. This difficulty arises because the fluid pressure, whether it be manifold vacuum or engine oil pressure, is so low when the engine is operating with wide open throttle under heavy load that such fluid pressure is not greater than would be produced under some conditions when the engine is being rotated by the starting motor. Because of this condition, if the fluid pressure operated switch is so constructed that it will prevent the closing of the starter circuit when the engine is self-operative under all operating conditions the starter circuit will be opened under some circumstances when the engine is being operated by the starting motor, which is obviously undesirable.

It is, therefore, the primary object of the present invention to provide a starting apparatus of the type referred to which is so constructed that closing of the starter circuit is impossible during self-operation of the engine under any operating conditions and opening of the starter circuit during rotation of the engine by the starting motor is also impossible.

According to the present invention the object is attained by the provision of a control circuit for controlling the operation of the main starter switch which includes a fluid pressure switch that is closed when the engine is inoperative and is opened by fluid pressure both when the engine is operated by the starting motor and is self operative, and includes also a bypass circuit around the fluid pressure switch which is open when the engine is inoperative or is operating under its own power, but is closed when the starter switch is closed and the engine is being operated by the starting motor, so that the opening of the fluid

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pressure operated switch while the engine is being rotated by the starting motor, will not open the starter circuit and cause the starting motor to become inoperative.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown.

In the drawing:

The drawing is a diagrammatic view of a control mechanism for engine starters constructed in accordance with the present invention.

Referring to the drawing, the reference numeral 20 indicates the starting motor which has a ground connection 22 and an armature shaft 24 on which is splined a slidable sleeve 26, which is secured to one member of an overrunning clutch 28, the other member of which is integral with a driving pinion 30, adapted to be moved into engagement with the flywheel gear 32 of the engine, in order to rotate said gear and start the engine whenever the starting motor is operative. The sleeve 26 is moved to the left, as the device is shown in the drawing, to effect engagement of the pinion 30 with the gear 32 and the circuit between the starting motor and the battery is concurrently closed to cause the starting motor to become operative.

To this end the sleeve 26 is provided with a grooved collar 34, which is slidable on the sleeve 26 and said collar is engaged by pins 36 which project from a yoke formed at the lower end of a lever 38, suitably pivoted at 40 and connected at its upper end with the armature 42 of an electromagnet indicated generally by the reference numeral 44 and which will be more specifically described later. The lever is connected to armature 42 by a pin and slot connection, the purpose of which will be described hereinafter, and which comprises the slot 46 in the upper end of the lever and the pin 48 on a link 50 connected to the armature and which projects into said slot.

When the electromagnet is energized the armature moves to the right, the lever moves collar 34 to the left, the collar pushing against a spring 52 which surrounds the sleeve 26 between the collar and the overrunning clutch previously referred to. The collar is positioned between one end of the spring and a plate 54 secured to the right end of sleeve 26. This movement of the lever pushes the whole sleeve and clutch assembly to the left and if the teeth of the pinion do not abut those of the flywheel, the pinion will be moved immediately into engagement with the fly-

wheel gear. If there is tooth abutment between the pinion and flywheel gear, the spring 52 will be compressed as the lower end of lever 33 moves to the left until the starting motor switch is closed by movement of the armature 42, as more specifically described later. As the switch is closed, the first movement of the motor will move the pinion so that its teeth properly mesh with those of the gear 32, the spring 52 will expand and force the pinion into proper meshing engagement with said gear. This driving mechanism is the same as ordinarily used in manually operated starters of this type, the only change being the substitution of the magnetically operated lever 33 for the usual manually operated foot pedal. A spring 54 returns the lever 33 and associated parts to normal position when the magnet is de-energized.

The starting motor 20 is connected by the wire 56 with a fixed contact 58 of a starting motor switch, while a second fixed contact 60 is connected by a wire 62 with a battery indicated at 64 grounded at 66. A movable contact 70 is moved into engagement with the two fixed contacts to complete the starting motor circuit when the magnet 44 is energized, such movable contact being supported by a rod 72 which slides in a central aperture in the magnet core 74, and the left end of the rod extends beyond the core to the left so as to be engaged by the armature 42 as it moves to the right upon energization of the magnet. The armature pushes the rod to the right and moves contact 70 into engagement with contacts 58 and 60.

The movable contact 70 is mounted on a block of insulating material 76 which is mounted on the rod 72 between two flanges 78 and 80, which extend from the rod and a spring 82 surrounds the rod between the flange 80 and the insulating material 76, such spring tending to hold the block of insulating material against the flange 78 as shown in the drawing. The rod 72 is normally held in the position shown in the drawing with the shoulder 80 bearing against the armature core by the action of a spring 84 which bears against the flange 78 and at the other end against a stationary part which is part of a bracket secured to the magnet housing and has a projection 86 fitting telescopically within a recess or central bore 88 in the rod 72. When the magnet is energized, the movement of the armature moves the rod 72 as previously described, and through the action of the spring 82, yieldingly presses the contact 70 into engagement with the fixed contacts. Upon deenergization of the magnet, the spring 84 restores the movable contact to the position shown in the drawing.

When the starter switch has been closed in the manner indicated to complete the starting motor circuit, such motor rotates and the meshing of pinion 30 and gear 32 having been accomplished in the manner described, the motor turns the gear 32 and starts the engine. When the latter is started and is running under its own power, the magnet will be de-energized and the spring 54 returns the parts to the position shown in the drawing, opening the starter switch and disengaging the pinion 30 from the gear 32.

The magnet 44 is provided with two windings 90 and 92, the winding 90 having a ground connection 94, and the winding 92 being connected by a wire 96 with wire 56 which leads from the main starter switch to the starting motor so

that the winding 92 is grounded through the starting motor.

The two coils of the magnet are connected by wires 98 and 100 with a wire 102 which leads to a fixed contact 104 of a magnetic switch or relay B having a movable contact 106 which engages the fixed contact when the relay is energized, and is connected by a wire 108 with the battery. Whenever the contacts 104 and 106 are in engagement, current flows from the grounded battery through wire 108, contacts 104 and 106, wire 102 and wires 98 and 100 to the magnet windings and thence to ground. The magnet is thus energized resulting in operation of its armature to shift the pinion 30 and close the starter switch, both coils of the magnet being effective until the starter switch is closed. Just as soon as this takes place, the coil 92 is shunted out, so that the switch is held closed during the cranking of the engine only by the effect of the coil 90. This arrangement of the magnet with two coils, one of which is shunted out as soon as the main starter circuit is completed is substantially the same as disclosed in the patent to Dyer No. 2,302,687, November 24, 1942.

The operation of contacts 104 and 106 to effect the energization and de-energization of the magnet 44 is effected by a relay B which is controlled by a manually operable switch, a second relay A and a fluid pressure operated switch. The relay B which operates contact 106 comprises a core 110 and a winding 112 which, at one end is connected by wire 113 to a fixed contact 114 of a manually operable switch which includes a second fixed contact 116 connected by a wire 118 to the wire 62 which leads to the battery, and a movable contact 120, normally held open by spring 122, but operable manually to bridge the contacts 114 and 116. The other end of the winding 112 is connected by wire 124 to a movable contact 126, which is normally open, but is movable by a relay, to be described later, into engagement with another fixed contact 128, grounded at 130. Whenever the manually operable switch is closed and contacts 126 and 128 are closed, current flows through the winding 112 and causes the magnet 44 to be energized. The operation of the contact 126 is so controlled that when the engine is not operating and the manual switch is closed, the contact 126 will be immediately moved into engagement with the contact 128 and it will remain in engagement with the latter as long as the engine is being cranked by the starting motor and the manual switch is held closed, regardless of the effect of the fluid pressure control switch, but if the engine is operating under its own power, it will be impossible to cause engagement of the contacts 126 and 128 upon closing of the manual switch.

To this end the contact 126 is operated by a relay A comprising core 132, and winding 134, which at one end is connected by a wire 136 to the wire 113 which leads to the manual switch. The other end of the winding 134 is connected by a wire 138 to an angular supporting member 140 which carries a fixed contact 142 and is supported on a depending U-shaped bracket 144. The supporting member 140 is held in fixed position on the bracket by the screw 146 and separated from the bracket by blocks of insulating material 148.

The bracket 144 is secured by brazing, or in any other desirable way, to a flange 150 which projects from a cylinder 152. The latter is provided,

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at its upper end, with a peripheral groove in which is secured the lower part 154 of a diaphragm chamber, the upper part of which is indicated at 156. Clamped between the elements 154 and 156 is a diaphragm 158, and the upper part 156 of the diaphragm chamber is bent over at the periphery as indicated at 160, to clamp between this bent over portion and the portion 156, the lower part 154 and the diaphragm, so as to form a fluid-tight joint. A threaded nipple 162 is secured as shown at the center of the part 156, and a conduit 164 is provided and may be connected with the oil line of the engine, if oil pressure is employed, or with the manifold if suction is employed to operate the diaphragm. This conduit is screwed into such nipple, so as to convey oil under pressure to the diaphragm, or to communicate engine suction thereto. If suction is employed, the conduit should be connected below the diaphragm.

A rod 166 is connected in any suitable way to the center of the diaphragm and extends downwardly therefrom through the cylinder 152. At its lower end, the rod is reduced in size as indicated at 168 and surrounding this part of the rod is a washer 170 and a flanged collar 172 of insulating material. Received around the cylindrical part of the collar and between the washer 170 and the flange which projects from the collar is a spring 174, supporting a movable contact 176 which is adapted to engage the fixed contact 142 when the engine is not in operation. The reduced part 168 of the rod 166 is riveted over the flanged collar, as shown in the drawing, to hold the collar in position. The cylinder 152 is closed at its lower end except for an orifice in which the rod 166 fits loosely, and a spring 178 is positioned in said cylinder around the rod, between the closed lower end of the cylinder and the diaphragm 158, such spring acting to hold the diaphragm in the position with the switch contacts 142 and 176 in engagement when the engine is inoperative. The spring 174 is connected, as indicated in the drawing, by a wire 180 which extends from the spring to one of the brushes of the generator 182 which is grounded as indicated at 184. Therefore, the spring 174 is grounded through the generator and the connection 184. The generator is connected by the wire 186 to the battery to effect charging thereof and the usual cut-out relay 188 is provided in this connection. The generator and the connection therefrom to the battery is of conventional construction and need not be further described.

It will be understood that if the spring 174 is grounded through the generator, as described, the main magnet may be rendered inoperative by the generator when the latter reaches a predetermined speed and under certain operating conditions, for reasons which will be more fully set forth in the description of the operation of the device that appears hereinafter.

Attention is called to the fact that the spring 174 may have a ground connection leading directly from the spring to ground without passing through the generator. As will be apparent from the description of the operation which follows later on, if the device is constructed in this way, the starting motor will always continue to operate until the manually operable push button 220 is released, whereas if grounded through the generator, as illustrated in the drawing, the starting motor, under certain circumstances, may be rendered inoperative by the generator as soon as the engine begins to run under its own power and

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operates rapidly enough to bring the speed of the generator up to the point required to cause the de-energization of the main magnet. Likewise, if the generator ground connection is used as shown, the generator will prevent any possibility of accidental operation of the starting motor during self-operation of the engine, even in the event of failure of the fluid pressure switch.

For a purpose to be more fully explained, there is a second ground connection for the winding 134, when the contacts 126 and 128 are closed. To this end a wire 190 is connected to the winding 134 and is also connected to the switch contact 126.

It will be understood that instead of connecting the upper half of the diaphragm with a source of oil under pressure to effect opening of the contacts 142 and 176, when the engine is in operation, the upper part of the diaphragm chamber could be made solid except for a vent and a suction conduit could be connected to the lower part of the diaphragm chamber and the intake manifold so as to communicate the engine suction to the lower side of the diaphragm to pull the diaphragm down when the engine is running.

From the foregoing description, it will be apparent that the normal position of the parts, that is, the position of such parts when the engine is inoperative is as shown in the drawing, with the pressure operated switch closed. If the manually operated switch button 220 is then operated to close the switch operated thereby, current will first flow from the battery through such switch, the wire 113, wire 135, winding 134, wire 133, contacts 142, 176, spring 174 and connection 180 through the generator to ground. This will energize relay A and effect closing of contacts 126 and 128. Closing of these contacts will immediately cause the energization of relay B because current flows from the battery, through the manual switch, winding 142, wire 124 and contacts 126, 128 to ground. As soon as relay B is energized, the main magnet 44 is energized, the main starter circuit is closed and the pinion 30 is moved into mesh with the gear 32 as previously described. The engine will then be cranked and ultimately will be started.

During the cranking of the engine, fluid pressure, either the oil pressure or manifold vacuum, whichever is used, may be effective to move the diaphragm down against the force of springs 174 and 178. Under some conditions, the force exerted by this fluid pressure is great enough, even during the cranking period and before the engine begins to operate under its own power, to cause separation of contacts 142 and 176, but with the device disclosed, this cannot cause the de-energization of the main magnet 44, nor cause the starting motor to become inoperative, unless the operator, himself, opens the manually operated switch. Operation of the generator may cause the de-energization of the main magnet under certain circumstances, but never during cranking, as the generator speed is insufficient.

Because of the second ground connection for the relay A, comprising wire 190, contacts 126, 128 and ground connection 130, which is established when relay A is energized, the opening of the ground connection for such relay which includes the fluid pressure switch, does not have any de-energizing effect on the relay. In other words, after initial energization of relay A, to cause operation of the starting motor, the relay cannot generally be de-energized except by de-

liberate action of the operator, in opening the manual switch.

On the other hand, if the engine is operating under its own power, neither the relay A nor the main magnet will be energized, even if the fluid pressure falls so low that the fluid pressure switch is closed, so that the starting motor cannot be caused to become operative. Even if the fluid pressure became so low that the switch operated thereby were closed, the generator would be operating rapidly enough to de-energize the winding 134 and the closing of the manually operated switch would have no effect.

Ordinarily the generator has no effect in causing de-energization of the main magnet, but is effective in the event of failure of the fluid pressure switch or great delay in the operation of such switch, to bring about the de-energization of the main magnet when the engine operates under its own power and fast enough to drive the generator at more than a predetermined speed.

If at any time when the generator is operating at a speed above the predetermined speed referred to and the fluid pressure switch is closed, current will flow from the generator through wire 180, the fluid pressure switch and wire 133 to the winding 134 through which it flows in a direction opposite to the current flowing from the battery. This nullifies the action of the battery current on said winding and causes contacts 126 and 128 to separate, which results in the de-energizing of the magnet for reasons that will be apparent. Whenever the fluid pressure switch is open, current from the generator can not flow to the winding 134, so that the generator has no de-energizing function at any time that said fluid pressure switch is open. Since the fluid pressure switch is opened under normal circumstances during engine cranking and before the generator is operated at sufficient speed to have any effect, the main magnet is de-energized, under normal conditions only by opening of the manual switch.

However, if there should be any failure of the fluid pressure switch due to a broken diaphragm, or for any other reason, or if there is sufficient delay in the operation of the fluid pressure switch, due to oil viscosity or any other cause, which is sufficient to enable the generator to attain the necessary speed of operation before the opening of the fluid pressure switch, the action of the generator will de-energize the main magnet.

Likewise the generator will prevent any energization of the main magnet during self-operation of the engine if the manual switch be accidentally closed. In the event of failure of the fluid pressure switch, or if the speed of the engine would be reduced sufficiently to enable the closing of the fluid pressure switch, operation of the manual switch would not cause the main magnet to be energized because as soon as the fluid pressure switch closed, the generator would de-energize winding 134 and closing of the manual switch would not effect closing of contacts 126 and 128.

Normally, when the engine starts to operate under its own power, the fluid pressure separates the contacts 142 and 176 and the operator releases the manual switch. The opening of the fluid pressure switch breaks one ground connection of the relay A and the opening of the manual switch breaks the other ground connection of such relay, comprising contacts 126 and 128.

Under normal conditions, the fluid pressure switch remains open as long as the engine is self-operative and accidental closing of the manual switch will have no effect. Under abnormal con-

ditions such as previously referred to, the action of the generator will effect opening of the contacts 126 and 128 when the fluid pressure switch fails to remain open, whenever the engine is self-operative, so that accidental operation of the manual switch cannot cause the main magnet to operate as long as the engine is self-operative, regardless of what may happen to the fluid pressure switch, or how long a delay there may be in the action of the fluid pressure switch.

As already stated in the foregoing description, the fluid pressure switch which is operable by the engine may be operated by either oil pressure or by the engine suction or manifold vacuum. The oil pressure operated switch has one advantage which may be mentioned. Sometimes in starting an engine the engine will make two or three rotations and then stop. Due to the inertia of the parts, they will remain in motion for a brief period of time and if the pressure operated switch could close during such period of time, it might result in the starting motor being rendered effective because the manually operated switch would be still closed by the operator. This would result in damage to the starter pinion and flywheel gear so that it is desirable to prevent any possible reclosing of the pressure operated switch under such conditions. When oil pressure is employed there is a definite lag in the operation of the switch due to the viscosity of the oil, particularly in cold weather. This delay will cover a period of several seconds and is sufficient to assure that the engine parts are fully stopped before the reclosing of the switch can take place.

This application is a continuation of application Serial No. 542,475, filed June 28, 1944, which application has now become abandoned.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Starting apparatus for internal combustion engines comprising, in combination, a current source, a starting motor operable by current from said source, a main switch for connecting the starting motor and current source, a magnet for operating said main switch, a control circuit for controlling the action of said magnet and including a control switch operated by fluid pressure created by the engine and operable to prevent energization of said magnet during self operation of the engine, said switch being opened by said pressure both when the engine is self-operative and when rotated by the starting motor and the control circuit being so arranged that the fluid pressure switch must be closed to effect initial closing of the main switch, a second switch in circuit with the fluid pressure switch and effective upon closing to bring about a closing of the main switch if the fluid pressure switch is also closed, a third control switch the closing of which is effected upon closing of the control circuit and which is effective when closed to establish a second control circuit for said magnet by-passing said fluid pressure switch so that when said fluid pressure switch is opened as the engine is rotated by the starting motor, the magnet will not be deenergized to render the starting motor inoperative as long as said third switch remains closed.

2. Starting apparatus for internal combustion engines comprising, in combination, a current

source, a starting motor operable by current from said source, a main switch for connecting the starting motor and current source, a control circuit for the main switch including in series a manually operable switch and a switch operated by fluid pressure created by the engine and opened by said pressure both when the engine is self-operative and during cranking, said control circuit being so arranged that both the manual and pressure operated switches must be closed to effect closing of the main switch, means rendered effective by closing of said control circuit to establish a second control circuit bypassing the fluid pressure switch, whereby when the latter is opened during engine cranking the main switch remains closed, means whereby the opening of the manual switch when the engine becomes self operative will cause the opening of the second control circuit, a generator, and means operable by the generator to prevent closing of the second control circuit during self-operation of the engine if the fluid pressure switch fails to open.

3. Engine starting apparatus for internal combustion engines comprising, in combination, a current source, a starting motor operable by current from said source, a main magnetic switch for connecting the starting motor with the current source, a control circuit for controlling the operation of said magnetic switch which includes a first control switch, operable by fluid pressure created by the engine and opened by such pressure when the engine is self-operative to prevent closing of the main switch, or when operated by the starting motor, said control circuit also including a second control switch in series with the fluid pressure switch and so arranged that both said switches must be closed to effect the initial closing of the main switch, a third control switch which is closed by the closing of said control circuit and when closed is effective to maintain the main switch closed irrespective of the condition of the fluid pressure switch whereby when the fluid pressure switch is opened during operation of the engine by the starting motor, the main switch will remain closed.

4. Engine starting apparatus for internal combustion engines comprising, in combination, a current source, a starting motor operable by current from said source, a main magnetic switch for connecting the starting motor with the current source, a control circuit for controlling the operation of said magnetic switch which includes a first control switch, operable by fluid pressure created by the engine and opened by such pressure when the engine is self-operative to prevent closing of the main switch or when operated by the starting motor, said control circuit also including a second control switch in series with the fluid pressure switch and so arranged that both said switches must be closed to effect the initial closing of the main switch, a third control switch which is closed by the closing of said control circuit and when closed is effective to maintain the main switch closed irrespective of the condition of the fluid pressure switch whereby when the fluid pressure switch is opened during operation of the engine by the starting motor, the main switch will remain closed, a generator and means operable by the generator to prevent closing of the main switch during self-operation of the engine if the fluid pressure switch fails to open.

5. Engine starting apparatus for internal combustion engines comprising, in combination, a

current source, a starting motor operable by current from said source, a main magnetic switch for connecting the starting motor with the current source, a control circuit for controlling the operation of said magnetic switch which includes a normally closed control switch operable by fluid pressure created by the engine and opened thereby when the engine is self-operative to prevent closing of the main switch and also opened when the engine is being operated by the starting motor, said control circuit being so arranged that said fluid pressure switch must be closed to effect initial closing of the main switch, a second normally open switch in said control circuit in series with said fluid pressure switch and effective upon closing to cause the closing of the main switch, and a third normally open control switch the closing of which is effected by said second control switch and which is effective when closed to maintain the main switch closed irrespective of the condition of the fluid pressure switch, whereby when the latter is opened during operation of the engine by the starting motor, it does not effect opening of the main switch.

6. Engine starting apparatus for internal combustion engines comprising, in combination, a current source, a starting motor adapted to be operated by current from said source, a main switch for controlling the circuit between the current source and starting motor, a control circuit for controlling the operation of the main switch which includes a control switch operated by fluid pressure and so constructed that the pressure created by the engine, either when operated by the starting motor or when self-operative, may be effective to open the switch, a second control switch that when closed maintains the main switch in closed condition and is closed at the same time the main switch is closed and independently of the operation of the starting motor, whereby the main switch is held closed during operation of the engine by the starting motor regardless of the condition of the pressure operated switch, a generator and means whereby under certain operating conditions, the generator is effective when the engine becomes self-operative to effect opening of said second control switch.

7. Starting apparatus for internal combustion engines comprising, in combination, a current source, a starting motor operable by current from said source, a main starter switch adapted to close the circuit between said current source and the starting motor, a magnetic switch between the current source and the main switch operable to effect closing of the main switch when it is closed, a control circuit for the magnetic switch which includes a control switch operable by fluid pressure created by the engine and in circuit with the winding of said magnetic switch, said control switch being normally closed and so constructed that it may be opened during self-operation of the engine or when said engine is being operated by the starting motor, a second magnetic switch in circuit with the winding of the first magnetic switch and having a winding in circuit with the fluid pressure operated switch, said second magnetic switch being so constructed that when closed it establishes a ground connection for its own winding and for that of the first magnetic switch, and means for causing the closing of the second magnetic switch when the first magnetic switch is closed to cause operation of the starting motor and for maintaining said second magnetic switch closed while the engine

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is being operated by said starting motor, whereby the fluid pressure switch may open without causing the starting motor to become inoperative.

8. Starting apparatus for internal combustion engines comprising, in combination, a current source, a starting motor operable by current from said source, a main starter switch adapted to close the circuit between said current source and the starting motor, a magnetic switch between the current source and the main switch operable to effect closing of the main switch when it is closed, a control circuit for the magnetic switch which includes a control switch operable by fluid pressure created by the engine and in circuit with the winding of said magnetic switch, said control switch being normally closed and so constructed that it may be opened during self-operation of the engine or when said engine is being operated by the starting motor, a second magnetic switch in circuit with the winding of the first magnetic switch and having a winding in circuit with the fluid pressure operated switch, said second magnetic switch being so constructed that when closed it establishes a ground connection for it sown winding and for that of the first magnetic switch, means for causing the closing of

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the second magnetic switch when the first magnetic switch is closed to cause operation of the starting motor and for maintaining said second magnetic switch closed while the engine is being operated by said starting motor, whereby the fluid pressure switch may open without causing the starting motor to become inoperative, a generator and a connection from said generator to the winding of the second magnetic switch so that under certain operating conditions the generator is effective to prevent closing of said second magnetic switch when the engine is operating under its own power.

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