June 12, 1934. W. L. McGRATH 1,962,252

ENGINE STARTER CONTROL

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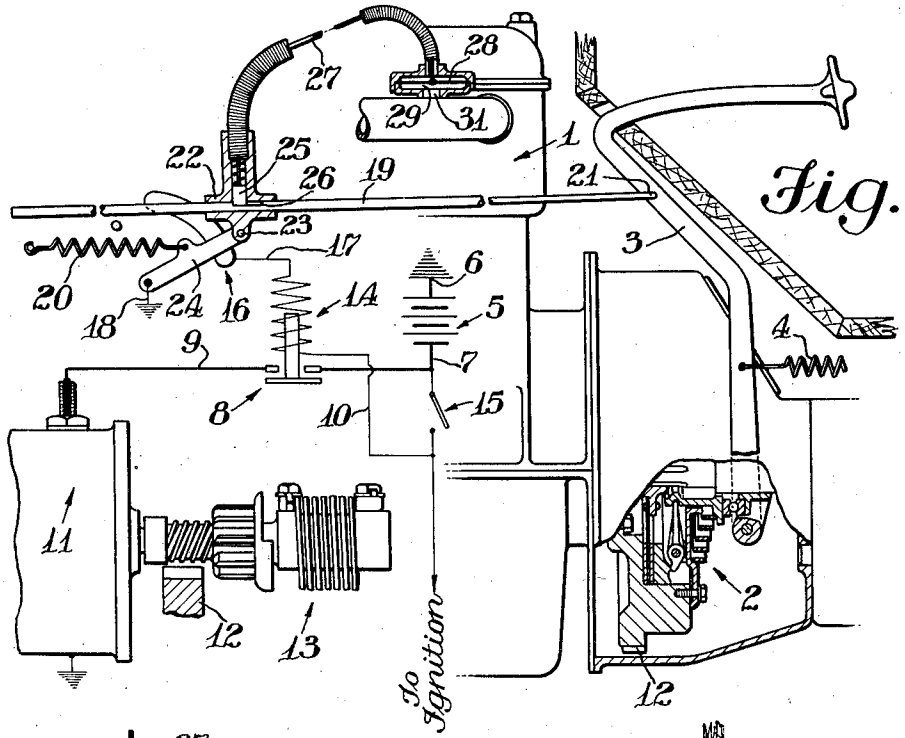


Fig. 1

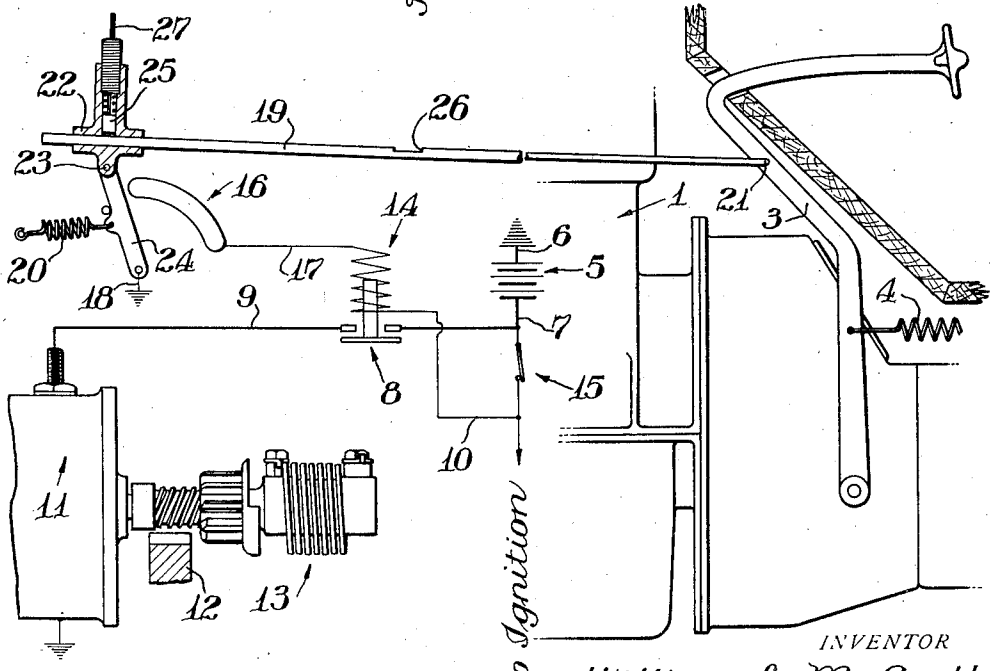


Fig. 2

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Fig. 3

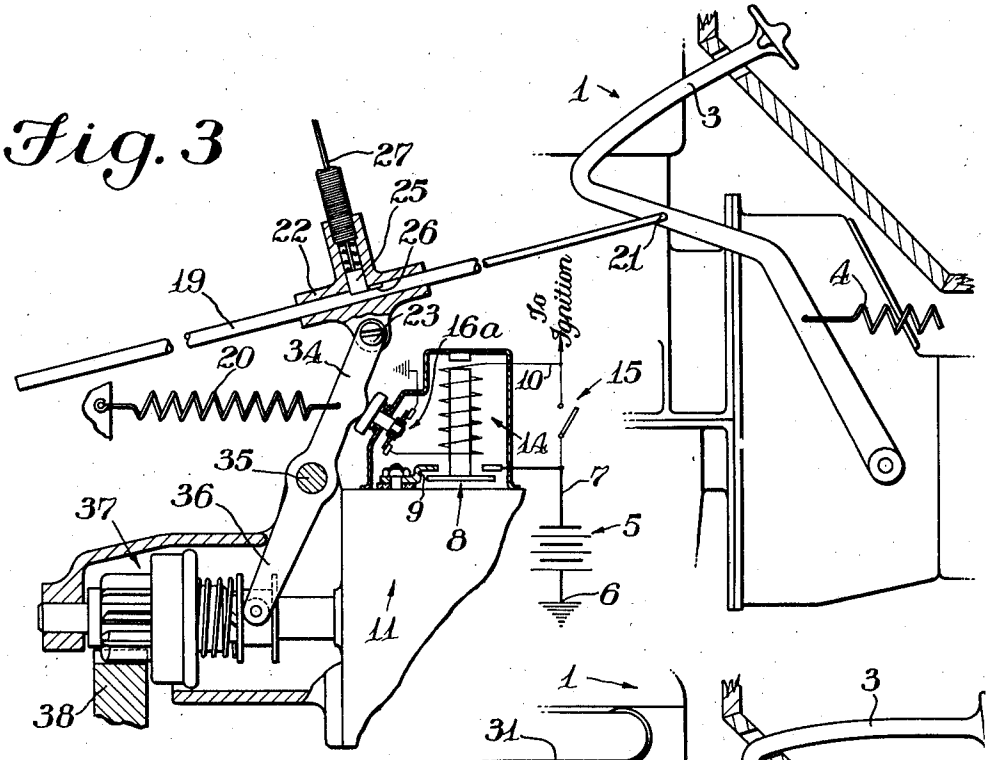
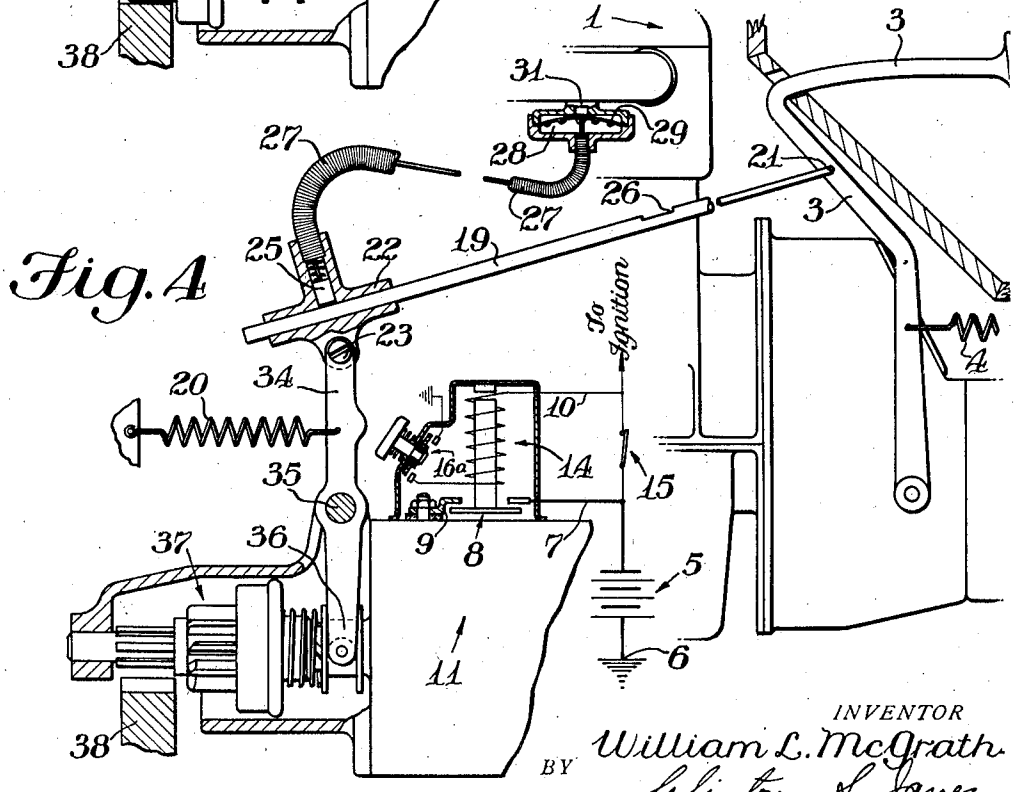


Fig. 4



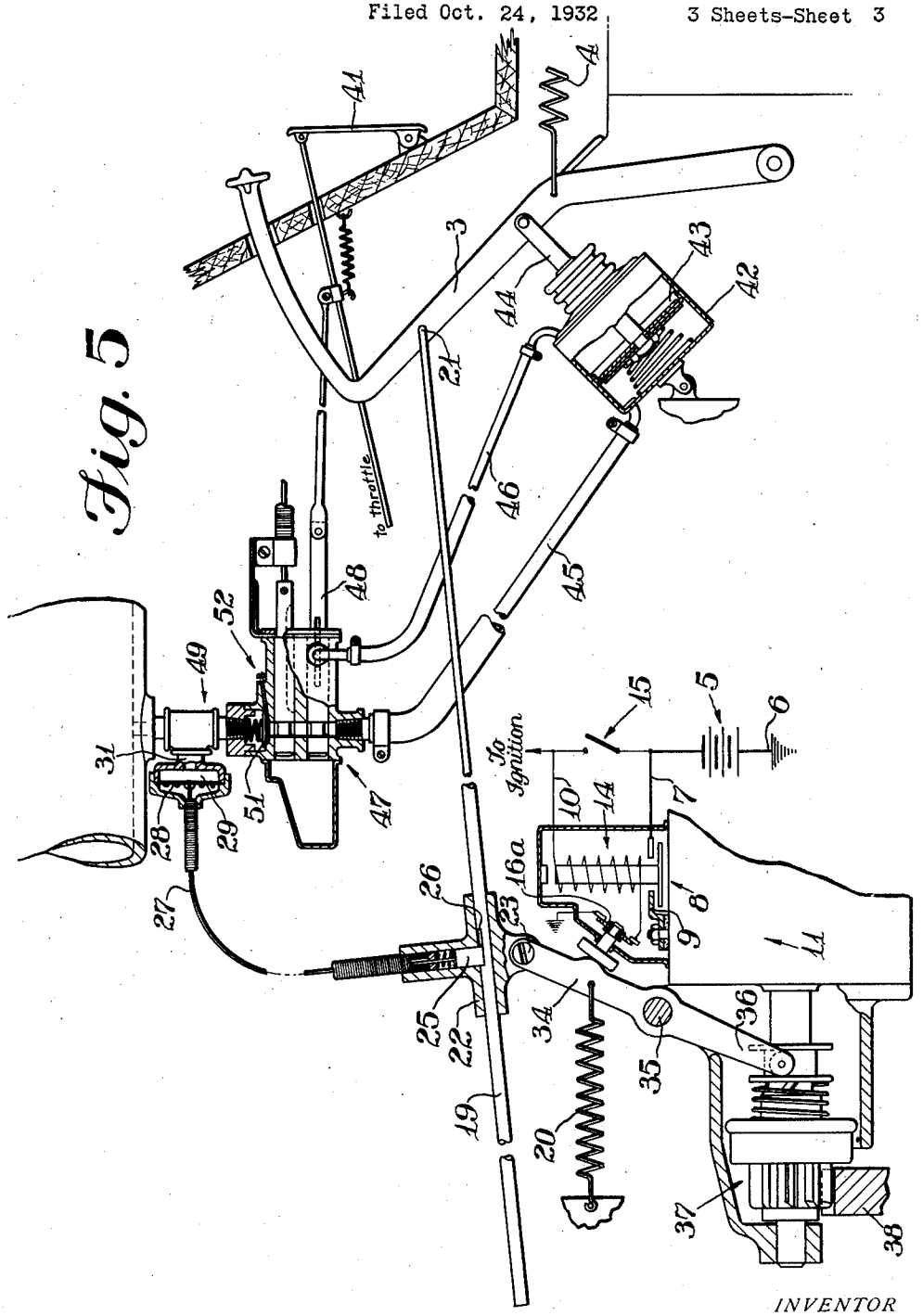
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Fig. 5



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ENGINE STARTER CONTROL

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19 Claims. (Cl. 290—38)

The present invention relates to an engine starter control, and more particularly to an arrangement for automatically controlling an engine starter incidental to the operation of a power control member for the engine such as the clutch pedal.

It is an object of the present invention to provide a novel starter control which is arranged to start an engine and restart in case of engine stall, without requiring attention or additional manipulation on the part of the operator.

It is another object to provide such a device which is simple and economical in construction and reliable and efficient in operation.

Further objects and advantages will be apparent to those skilled in this art from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a semi-diagrammatic representation of one preferred form of the invention showing the parts in idle position;

Fig. 2 is a view similar to Fig. 1 showing the parts in engine running position;

Fig. 3 is a semi-diagrammatic view of an embodiment of the invention adapted for use in connection with starter gearing of the manual shift type, showing the parts in idle position;

Fig. 4 is a similar view of the structure illustrated in Fig. 3 showing the parts in engine running position; and

Fig. 5 is a semi-diagrammatic view of an embodiment of the invention similar to that illustrated in Figs. 3 and 4 incorporating further an automatic clutch controlling system whereby a substantially fully automatic starting system is provided.

Referring first to Fig. 1, there is illustrated an internal combustion engine 1 of automotive type having a load clutch 2 arranged to be driven thereby and to connect the engine with the parts to be driven such as the transmission of a motor vehicle. Means for controlling the clutch is provided in the form of a manually operable member such as a clutch pedal 3, opening of the clutch being brought about by the pressure of the operator's foot on said pedal, the control member being urged toward clutch closing position by suitable yielding means such as a spring 4.

An electrical starting system for the engine is provided comprising a battery 5 grounded at 6 and connected by a lead 7 to a magnetic starting switch 8, which in turn is connected by a lead 9 to a starting motor 11, the motor being grounded to complete the starting circuit. Means are provided for automatically connecting the motor 11 with a member such as a flywheel gear 12 of the engine to be started, in the form of an automatic starter drive of conventional type illustrated generally at 13.

A control circuit for the magnetic starting switch 8 is provided comprising a solenoid 14, a manual switch 15 and a mechanically operated switch 16. The manual switch 15 is connected to the battery lead 7 and is preferably, as illustrated, the ignition switch of the engine. A lead 10 is provided for connecting the ignition switch with one end of the solenoid 14. The mechanical switch 16 is connected to the opposite end of the solenoid 14 by a lead 17 and when closed grounds said lead as indicated at 18 whereby the control circuit is completed and the solenoid 14 energized to close the magnetic starting switch 8.

Connecting means are provided for operating the mechanical switch 16 to cause energization of the starting system by the initial operation of the clutch controlling member 3 in a direction to close the clutch. As herein illustrated, such connecting means comprise a rod 19 pivoted at 21 to the clutch pedal and arranged to slide freely in a cross head member 22 pivoted at 23 to the arm 24 of the switch 16. Means are provided for normally connecting the cross head 22 with the rod 19 in the form of a latch member 25 slidably arranged in a cylindrical portion of the cross head 22 in position to project into a notch 26 in the rod 19 and connect the rod and cross head for movement in unison. Means are provided for disabling said connecting means and maintaining the same inoperative responsive to self-operation of the engine here illustrated in the form of a means for withdrawing the latch 25 actuated by the intake vacuum of the engine. As here shown this means comprises a flexible shaft 27 of the Bowden wire type connecting said latch to a flexible diaphragm 28 forming one wall of a closed chamber 29 communicating with the intake manifold as indicated at 31. The arrangement is such that when the engine starts, the vacuum in the intake manifold is transmitted to the chamber 29 causing the diaphragm 28 to flex and actuate the shaft 27 to withdraw the latch 25 and maintain the same in retracted position as long as the engine is self-operative.

In the operation of this embodiment of the invention, starting with the parts in idle position as illustrated, closure of the ignition switch 15 completes the control circuit through solenoid 14 and mechanically operated switch 16 to the ground at 18 whereby solenoid 14 is energized to close the starting switch 8 causing the auto-

matic gearing 13 to engage and crank the engine member 12. When the engine starts, the gearing 13 is automatically disengaged in the usual manner.

At this time, the operator incidental to engaging the transmission gears of the vehicle, depresses the clutch pedal 3 whereupon the switch 16 is opened and the intake vacuum operates to withdraw the latch 25 from its engagement with the rod 19. When the operator has engaged the transmission gears and allows the clutch pedal 3 to return to its closed position under the influence of the spring 4, the control switch 13 remains in open position under the influence of its spring 20 as illustrated in Fig. 2 since the connection between said switch and the clutch pedal 3 is maintained inoperative so long as the engine is running.

It will be understood that the engagement of the latch 25 in the notch 26 may be such as to prevent the withdrawal of the latch 25 until the force exerted by the rod 19 is entirely released, for which purpose the engaging edges of the notch and latch may be undercut if so desired. On the other hand, if it is deemed preferable to allow immediate release of the switch 16 upon self-actuation of the engine irrespective of whether the pressure of the clutch pedal is relieved by the operator, this may readily be done by proper proportioning of the operating parts.

In case of engine stall, the latch 25 is released and allowed to bear against the rod 19 whereupon the subsequent motion of the clutch pedal 3 in a direction to engage the clutch causes reactuation of the starting mechanism. It will be understood that in the operation of motor vehicles, engine stalling usually occurs when the engine throttle is closed and the engine is disengaged from the vehicle by opening the load clutch either manually or automatically in case the vehicle is provided with an automatic clutch controlling device. If the vehicle is stopped, the normal operation of getting under way comprises engaging the proper transmission gears and then letting in the clutch in the usual manner. It will be readily understood that since the stalling of the engine allows the latch 25 to engage the rod 19, this operation of the clutch pedal after an engine stall causes restarting of the engine in the manner above described. The operator therefore whether aware of the engine stall or not, is required to do nothing more than he would have done had the engine not stalled.

If the vehicle is in motion when stalling occurs, the engine might of course be cranked merely by the engagement of the clutch, but this is undesirable since it throws a heavy strain upon the transmission parts and, in case of high speeds, might cause skidding of the rear wheels of the vehicle. The automatic starting of the engine by the initial return movement of the clutch pedal is therefore very desirable in this case also and of course requires no extra manipulation upon the part of the operator.

The switch 16 may be arranged as illustrated to permit closure of the clutch if so desired. Such an arrangement permits the vehicle to be moved by the starting mechanism if the operator so desires merely by allowing the clutch to engage. This insures motion of the vehicle in case of an emergency such as a stall at a railroad crossing whether or not the engine becomes self-operative. In some installations however it may be deemed preferable for the switch 16 to provide a positive stop for the clutch pedal 3 after merely sufficient movement thereof to close said switch, thus preventing closure of the clutch, as illustrated for example in Figs. 3 and 4. The operator is thereby apprised of the actuation of the starting device by the failure of the clutch pedal to return to closed position when the pressure thereon is relieved.

In Figs. 3 and 4 of the drawings there is illustrated a second embodiment of the invention in which the actuation of the clutch pedal is arranged not only to close the starting switch but also to effect the engagement of a starting mechanism of the manual shift type. As here illustrated, the clutch pedal 3 is arranged to actuate a lever 34 corresponding to the switch lever 24 by means of a connection formed by a rod 19, cross head 22, and latch 25 arranged to engage in a notch 26 in the rod 19 all as previously described in connection with the first embodiment of the invention. The lever 34 is pivoted at 35 to the housing of the starting motor 11 and is provided with a shifting fork 36 at its lower end arranged to engage and move a starting pinion assembly of conventional type indicated generally at 37 into and out of engagement with an engine member 38. It will be understood that the starting pinion is splined to the motor shaft through an overrunning connection in the usual manner for this form of starting device.

The electrical system for the starting motor 11 is similar to that previously described, including the battery 5 and starting switch 8 controlled by a solenoid 14. The solenoid is arranged to be energized from the battery 5 by means of a manual switch 15 and a mechanical switch 16*a* corresponding to the switch 16 in the first embodiment of this invention and arranged to be closed by the movement of the lever 34 after said lever has shifted the starting pinion into engagement with the engine member 38.

In the operation of this embodiment of the invention, starting with the parts in idle position as illustrated in Fig. 3, closure of the ignition switch 15 energizes solenoid 14 to close the starting switch 8 and cause motor 11 to crank the engine. When the engine starts, latch 25 is withdrawn by the intake vacuum, allowing the starter pinion assembly 37 to be disengaged from engine gear 38 by spring 20, and permitting the clutch pedal 3 to be moved to closed position by spring 4 under the control of the operator, as illustrated in Fig. 4.

It will be understood, as pointed out in connection with the first embodiment of the invention, that the latch may be arranged to be withdrawn by the intake vacuum as soon as the engine starts, but usually it is preferable to so form the latching parts that disconnection thereof does not take place till the clutch pedal 3 has been depressed by the operator to relieve the pressure thereon.

Should the engine stall, this occurs, as above pointed out, while the clutch is out. The latch 25 is thereby allowed to engage the notch 26, and subsequent release of the clutch pedal to engage the clutch causes shifting of the starter gearing into engagement and closure of the control switch 16*a* thus restarting the engine. If the engine is stopped by opening the ignition switch 15, the subsequent release of the clutch pedal by the operator causes the engagement of the starter gearing, but the motor is not ener-

gized since the control circuit therefor is open, as illustrated in Fig. 3.

If the operator should disengage the transmission gears and let in the clutch prior to turning off the ignition key, the subsequent closure of the ignition switch does not immediately cause restarting. However, when the operator throws out the clutch, engages the transmission gears, and begins to let the clutch back in, precisely as he would do to start the car if the engine were already running, the starting gears are engaged and the engine started as above described. It will thus be seen that in all cases the starting operation is taken care of without requiring thought or effort on the part of the operator.

In Fig. 5 the form of the invention illustrated in Figs. 3 and 4 of the drawings is shown in conjunction with an automatic clutch control of known type to form therewith a completely automatic starting system. The parts of the starting system including the starting gearing, the shifting mechanism and the motor and control circuits are the same as illustrated in Figs. 3 and 4 and are similarly numbered. The clutch controlling element 3, however, is arranged to be operated by energy supplied by the self operation of the engine, as by means of the intake vacuum thereof, under the control of a manually operable element 41 such as the accelerator pedal of the motor vehicle.

As here illustrated the operating motor for the clutch pedal 3 comprises a cylinder 42 having a piston 43 therein connected to the clutch pedal by means of a piston rod 44. The cylinder 42 is connected by means of conduits 45 and 46 at opposite ends to a control valve mechanism indicated in general at 47 and comprising a slide valve 48 movable to connect conduit 45 to the engine intake through a suitable conduit 49 while venting the connection 46, or to cut off the vacuum connection and control the return movement of the piston 43 to secure reengagement of the clutch in suitable manner. Since the clutch control device is not a part of the present invention and is well known in the art, it is believed that a further description of the operation thereof is unnecessary, it being merely understood that the release of the accelerator pedal 41 to cause idling of the engine causes the actuation of the clutch pedal 3 to its open position, while operation of the accelerator pedal 41 to increase the power of the engine causes the clutch pedal 3 to be returned to closed position.

In the operation of this embodiment of the invention, and starting with the parts in idle position as illustrated, closure of the ignition switch 15 causes energization of solenoid 14 to close the starting switch 8 and cause the motor 11 to be energized to crank the engine. During the cranking operation, the accelerator pedal 41 will be depressed to a position suitable for starting purposes, thus rendering the automatic clutch control inoperative. However, should the accelerator pedal 41 be released to its idling position the intake vacuum during cranking is ordinarily not sufficient to actuate the clutch pedal.

As soon as the engine becomes self-operative, the accelerator pedal 41 is released to its idling position in order to prevent the engine from racing, and the automatic clutch control thereby moves the clutch pedal 3 to the end of its clutch releasing travel. At the same time the latch 25 is withdrawn by the intake vacuum, thus disconnecting the clutch pedal 3 from the operating lever 34. As a result of either of these incidents the manually operated switch 16*a* is opened and the starting pinion assembly 37 is allowed to move to its disengaged position under the action of spring 20. Thereafter the clutch pedal 3 is operated in the usual manner by the automatic clutch control under the control of the accelerator pedal 41.

Should the engine stall at any time, this stalling will occur when the accelerator pedal is released and the clutch pedal 3 is therefore also in its open position by virtue of the automatic clutch control. The failure of the intake vacuum due to the stalling of the engine allows the reengagement of latch 25 in notch 26, and thereafter allows initial closing movement of the clutch pedal 3 to take place. However, since the clutch pedal is at this time connected to the control lever 34, this initial movement causes pinion assembly 37 to be shifted into engagement with the engine member 38 and the starting operation to be repeated as previously described.

It will be noted that at this time the engaging movement of the clutch pedal 3 is limited to merely sufficient movement to cause the starting operation, and the engagement of the clutch is effectively prevented by said starting mechanism until the engine has picked up sufficiently to actuate the clutch control and thereby hold open the clutch.

In certain cases it may be desirable to employ means for insuring the reestablishment of the starter control connection prior to the release of the clutch pedal 3 by the automatic clutch control. Such means are here illustrated in the form of a check valve 51 arranged between the valve 47 and the connection 49 to the intake manifold, whereby the dissipation of the vacuum in the intake manifold due to engine stall is prevented from immediately establishing atmospheric pressure in the cylinder 42. A bleeder connection to allow the gradual admission of atmospheric pressure to the cylinder 42 around the check valve 51 is preferably provided and may take the form as indicated of a means for introducing a measured leakage around the check valve such as a wedging needle member 52 adapted to slightly raise said valve. It will be understood that the needle 52 is adjusted so as to permit atmospheric pressure to be restored in the cylinder 42 a predetermined time after the engine has stopped, suitably determined to insure the engagement of the starting connection and the complete immobility of the engine prior to the release of the clutch pedal to cause restarting of the engine.

It will be seen that there is here provided a device whereby the entire control of the starting mechanism is automatic after initial closure of the ignition switch 15, and the entire control of the power plant involves the manipulation of the accelerator pedal and gear shift only.

It will be understood that if the engine should be stopped while the accelerator pedal is depressed and the clutch engaged, as might occur if the ignition switch were open while the accelerator pedal was depressed, all that is necessary for the operator to do is to depress the clutch manually sufficiently to allow the latch 25 to drop into engagement, whereupon the automatic control of the power plant is reestablished.

It will be readily appreciated that this embodiment of the invention is equally adaptable to the automatic type of starter gearing as illustrated

in Figs. 1 and 2, in which case the shifting mechanism for the starter gearing would be omitted without affecting the structure or operation of the remaining elements of the combination.

Although certain embodiments of the invention have been shown and described in detail it will be understood that other embodiments are possible and that various changes may be made in the details and arrangements of the parts without departing from the spirit of the invention as defined in the claims appended hereto.

What is claimed is:—

1. In combination with an internal combustion engine, a load clutch therefor, and means for controlling said clutch, a starting system for said engine and means for energizing said starting system responsive to movement of said clutch controlling means in a direction to close the clutch.

2. In combination with an internal combustion engine, a load clutch therefor and means for controlling said clutch, a starting system for said engine including a starting switch and means for closing said switch responsive to initial movement of said clutch controlling means in a direction to close the clutch.

3. In combination with an internal combustion engine, a load clutch therefor and means for controlling said clutch, a starting system for said engine including a starting switch, means for closing said switch responsive to movement of said clutch controlling means in a direction to close the clutch, and means for disabling said closing means responsive to self-operation of the engine.

4. In combination with an internal combustion engine, a load clutch therefor and a member for controlling said clutch, a starting system for said engine including a starting switch, means for controlling said switch, and a connection between said clutch controlling member and said switch controlling means whereby initial movement of the clutch controlling member in a direction to close the clutch causes closure of said switch.

5. In combination with an internal combustion engine, a load clutch therefor and a member for controlling said clutch, a starting system for said engine including a starting switch, means for controlling said switch, and a connection between said clutch controlling member and said switch controlling means whereby initial movement of the clutch controlling member in a direction to close the clutch causes closure of said switch, said connection being operative to prevent closure of the clutch, and means for rendering said connection inoperative responsive to self-operation of the engine.

6. In combination with an internal combustion engine, a load clutch therefor and means for controlling said clutch, a starting system for said engine including a magnetic starting switch, a control circuit for said magnetic switch including a manual switch and a mechanically operated switch and means for closing said mechanically operated switch by movement of the clutch controlling means in a direction to close the clutch.

7. In combination with an internal combustion engine, a load clutch therefor and means for controlling said clutch, a starting system for said engine including a magnetic starting switch, a control circuit for said magnetic switch including a manual switch and a mechanically operated switch, means for closing said mechanically operated switch by movement of the clutch controlling means in a direction to close the clutch and means for rendering said closing means inoperative responsive to self-operation of the engine.

8. In combination with an internal combustion engine, a load clutch and a clutch controlling member therefor, starting gearing therefor including a shiftable element and connecting means for shifting said element by operation of the clutch controlling member in a direction to close the clutch.

9. In combination with an internal combustion engine, a load clutch and a clutch controlling member therefor, starting gearing therefor including a shiftable element, connecting means for shifting said element by operation of the clutch controlling member in a direction to close the clutch, and means responsive to self-operation of the engine for disabling said connecting means.

10. In combination with an internal combustion engine, a load clutch and a power controlling member therefor, a starting system therefor including a motor, a starting switch, means including a shiftable pinion for connecting the motor to the engine; and connecting means for shifting the pinion into driving position and causing closure of the starting switch by operation of the clutch controlling member in a direction to close the clutch.

11. In combination with an internal combustion engine, a load clutch and a power controlling member therefor, a starting system therefor including a motor, a starting switch and means including a shiftable pinion for connecting the motor to the engine; connecting means for shifting the pinion into driving position and causing closure of the starting switch by operation of the clutch controlling member in a direction to close the clutch, and means responsive to self operation of the engine for maintaining said connecting means inoperative.

12. In combination with an internal combustion engine, a load clutch and a clutch controlling member therefor, starting gearing therefor including a shiftable element and connecting means for shifting said element by operation of the clutch controlling member in a direction to close the clutch, said connecting means being operative to prevent closure of the clutch.

13. In combination with an internal combustion engine, a load clutch and a clutch controlling member therefor, starting gearing therefor including a shiftable element and connecting means for shifting said element by operation of the clutch controlling member in a direction to close the clutch, said connecting means being operative to prevent closure of the clutch and means responsive to self-operation of the engine for disabling said connecting means, thereby allowing the clutch to be closed and the shiftable element to return to normal position.

14. In combination with an internal combustion engine, a load clutch, a clutch controlling element, a starting system including a starting switch, means normally urging said clutch controlling member in the direction to close the clutch, means causing closure of the starting switch responsive to movement of the clutch controlling element in the clutch closing direction, means responsive to self-operation of the engine for moving said clutch controlling element in the direction to open the clutch, and means responsive to self-operation of the engine for disabling said means for causing closure of the starting switch.

15. In combination with an internal combus-

tion engine, a load clutch, a clutch controlling element, a starting system including a starting switch, means normally urging said clutch controlling member in the direction to close the clutch, means causing closure of the starting switch responsive to movement of the clutch controlling element in the clutch closing direction, means responsive to self-operation of the engine for moving said clutch controlling element in the direction to open the clutch, means responsive to self operation of the engine for disabling said means for causing closure of the starting switch and means operative in case of engine stall to insure the re-establishment of the switch closing means prior to the release of the clutch controlling member by the clutch opening means.

16. In combination with an internal combustion engine, a load clutch, a clutch controlling element, a starting system including a starting switch, means normally urging said clutch controlling member in the direction to close the clutch, means causing closure of the starting switch responsive to movement of the clutch controlling element in the clutch closing direction, said last means being operative to prevent closure of said clutch, means under the control of the operator responsive to self-operation of the engine for moving said clutch controlling element in the direction to open the clutch, means responsive to self-operation of the engine for disabling said means for causing closure of the starting switch, thereby allowing closure of the clutch under the control of the operator.

17. In combination with an internal combustion engine, a power controlling member therefor, a starting system for said engine, means whereby actuation of the power controlling member causes energization of the starting system and means for maintaining such energization of the starting system irrespective of the release of the power controlling member.

18. In combination with an internal combustion engine, a clutch operating member therefor, a starting system for said engine, means whereby actuation of the clutch operating member causes energization of the starting system and means for maintaining such energization of the starting system irrespective of the release of the clutch operating member.

19. In combination with an internal combustion engine, a power clutch therefor, a pedal for controlling said clutch, a starting system for said engine, means whereby actuation of the clutch pedal causes energization of the starting system, means for maintaining such energization of the starting system irrespective of the release of said clutch pedal and means responsive to self-operation of the engine for causing deenergization of the starting system.

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