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Wenrich et al.

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[54] **AIR STARTER**

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[52] **U.S. Cl.** ..... **123/179 F**

[51] **Int. Cl.** **F02n 7/08**

[58] **Field of Search** ..... 123/179 F

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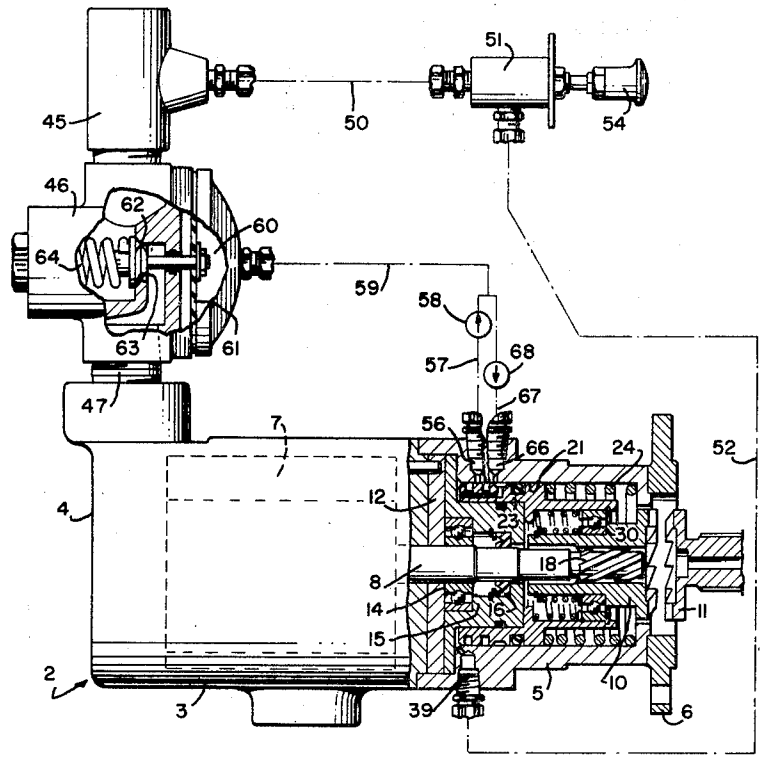
[57] **ABSTRACT**

A fluid-operated starter containing a fluid-operated piston that moves the starter clutch into an engagement position, a valve for opening and closing the supply line to the starter motor and the piston cooperating with a means that opens the valve upon the arrival of the piston at its extended position and closes the valve upon the arrival of the piston at its retracted position.

6 Claims, 4 Drawing Figures



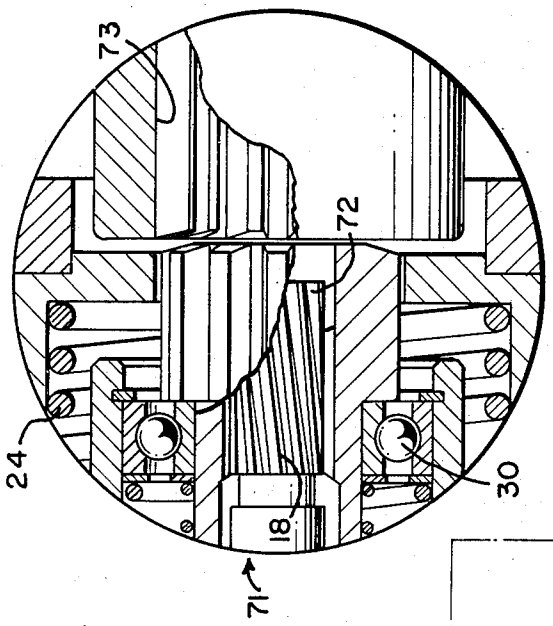

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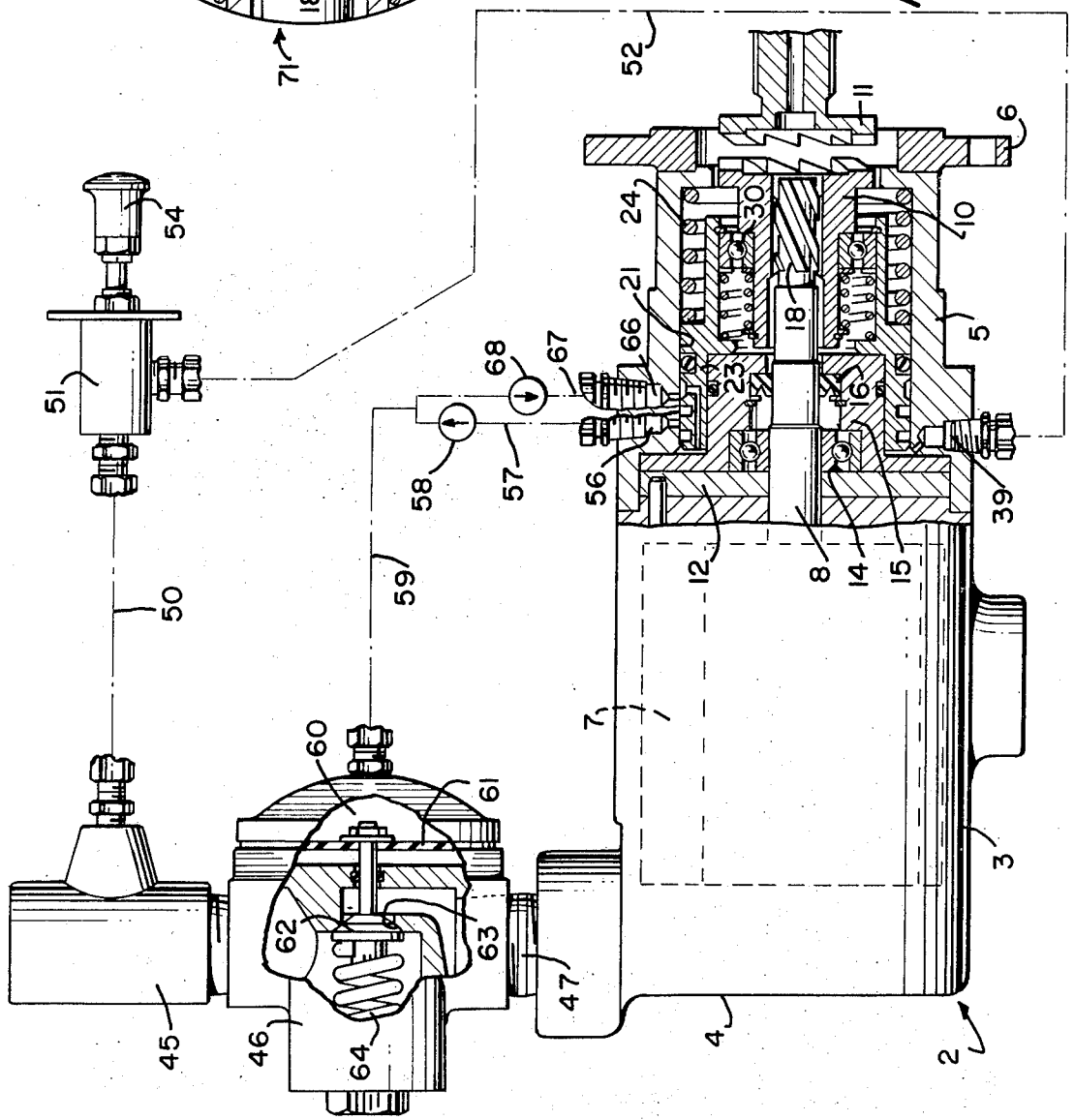
FIG. 4

FIG. 1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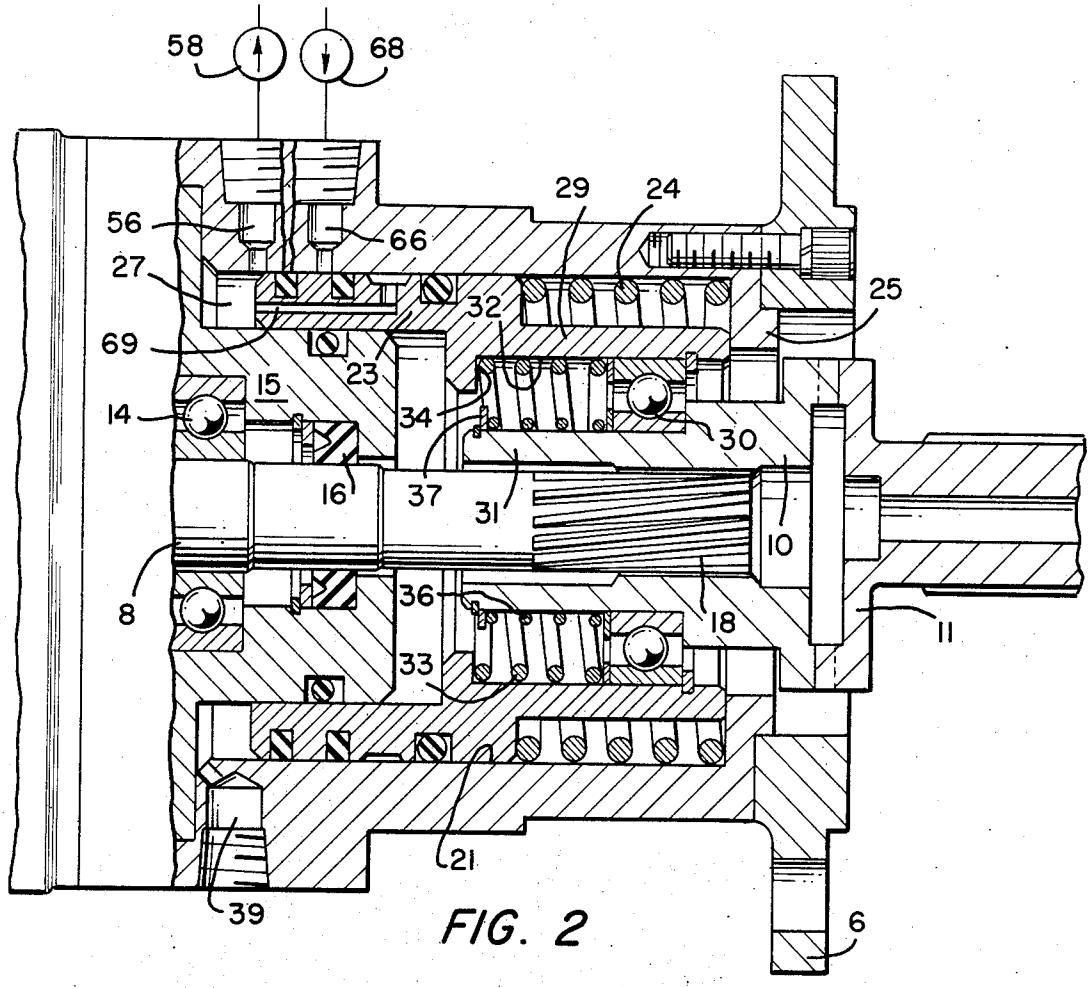
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FIG. 2

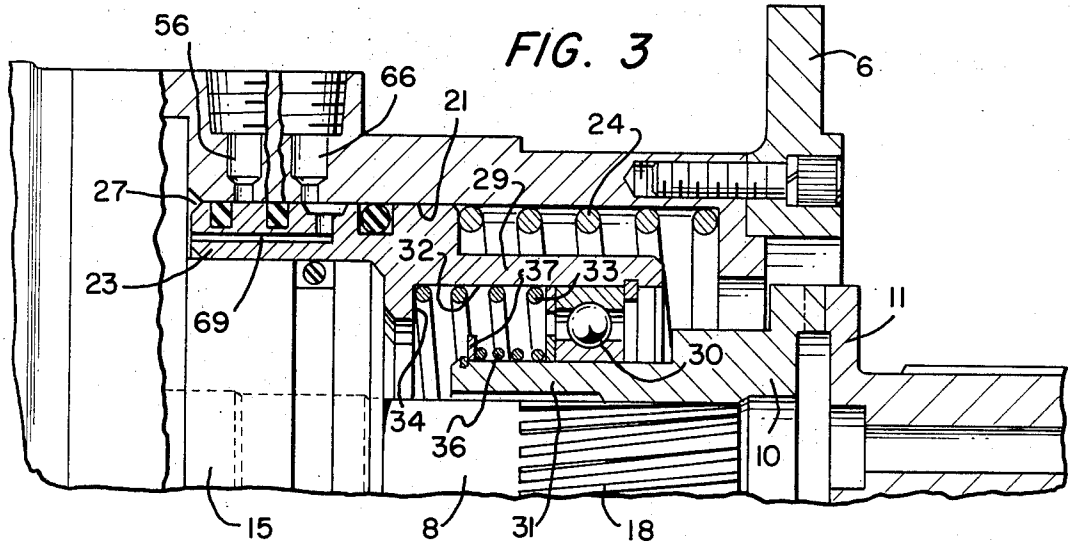
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FIG. 3

AIR STARTER

BACKGROUND OF THE INVENTION

This invention relates to a pneumatically operated "air" starter for cranking internal combustion engines to start them and more particularly to the type of starter known as the "pre-engaged" starter.

The pre-engaged starter has a mechanism for moving the starter clutch member into engagement with an engine clutch member prior to the rotation of the starter motor. Pre-engaged starters were developed because of the high shock loads accompanying the earlier developed inertial-engaged starters. High shock loads tend to excessively wear the clutch members interconnecting the starter and engine and can cause breakage of parts of both.

In certain applications of a pre-engaged starter, particularly in starting turbines, it has been found that damage may occur to the starter engagement clutch or the starter motor when the starter motor stops driving the clutch while the clutch teeth continue to be urged together. This harm is caused by the engine attempting to drive the starter and various devices have been used in the past to avoid such damage.

SUMMARY OF THE INVENTION

The principal object of this invention is to provide a pre-engaged air starter that continues to drive its clutch member until its clutch engagement means is retracted thereby avoiding the clutch being urged into engagement after the starter motor is no longer driving the engine.

A further important object is to eliminate the necessity for providing an air starter with a means allowing the engine to overrun the starter without harming the starter.

In general, the objects of this invention are attained in a starter having a piston for engaging the starter clutch, a one-way air circuit for opening the main valve for the starter with the arrival of the piston to its retracted position. This system insures that the power on the starter motor is not stopped until the engaging piston is retracted, thereby avoiding the possibility of the clutch teeth being urged together following the stoppage of power to the starter motor, which might cause damage to the starter clutch jaws.

BRIEF DESCRIPTION OF DRAWINGS

The invention is described in connection with the accompanying drawings wherein:

FIG. 1 is an elevational view of an air starter embodying the invention with portions being cut away, the control system schematically shown and with the starter clutch disengaged;

FIG. 2 is an enlarged fragmentary axial section of the starter front end with the starter clutch engaged and the engaging piston extended;

FIG. 3 is similar to FIG. 2 with the engagement piston returned to its retracted position; and

FIG. 4 is a fragmentary axial section of a starter front end with a spline type engagement clutch.

DESCRIPTION OF PREFERRED EMBODIMENTS

The air starter 1 shown in FIG. 1 includes a casing 2 comprising a motor housing 3 having a backhead 4 attached to its rear end and a clutch housing 5 attached

to its front end. The clutch housing 5 carries a flange 6 at its front end adapted to be bolted to an engine or turbine (not shown) for mounting the starter thereon. The motor housing 3 contains an air motor rotor 7 having a drive shaft 8 projecting into the clutch housing 5 and slidably connected to a starter clutch jaw 10. The starter clutch jaw 10 is adapted to engage the engine clutch jaw 11 with both having cooperating teeth thereon as shown in FIG. 1. All of the foregoing structure is conventional in the air starter art.

The motor shaft 8 extends through a front plate 12 mounted on the front end of the motor housing 3 and is supported in a bearing 14 mounted in a flanged sleeve 15 located next to the front plate 12 in the clutch housing 5. A seal ring 16 is mounted in the sleeve 15 to circle the shaft 8 forward of the bearing 14.

The starter clutch jaw 10 is axially slidable on helical splines 18 formed on the shaft 8 with the helical splines 18 extending at an angle to the direction of rotation of the shaft 8 so that the driving torque of the starter will urge the starter clutch jaw 10 axially forward toward engagement with the engine clutch jaw 11.

The clutch housing 5 contains a cylindrical bore 21 extending coaxially with the shaft 8 and containing an annular piston 23 sliding therein and urged rearwardly by a spring 24 located in the bore 21 between the front end of the piston 23 and a shoulder 25 provided at the front end of the bore 21. The piston 23 slides on the sleeve 15 and cooperates with the sleeve 15 and bore 21 to form a chamber 27 at the rearend of the piston 23 adapted to receive compressed air or other fluid to urge the piston 23 forward.

The piston 23 includes an integral annular front section 29 projecting forward from the piston 23 surrounding the starter clutch jaw 10 and carrying a bearing 30 sliding on both the piston 23 and the clutch jaw 10. The clutch jaw 10 has a reduced diameter rear or tail section 31 slidably engaging the rear interior of the bearing 30 and the piston front section 29 contains a circular bore 32 slidably embracing the bearing 30. The bearing 30 is urged forwardly in the bore 32 by a spring 33 located between the outer race of the bearing and a shoulder 34 formed at the rear of the bore 32, and is urged forwardly on the tail section 31 by a spring 36 placed between the inner race of the bearing 30 and a lock ring 37 mounted at the rear end of the tail section 31.

Due to the slidable connections between the piston 23, the bearing 30, and the starter clutch jaw 10, the piston 23 can travel its full stroke forward without the jaw 10 being fully engaged, which might be caused by a mismatch of the jaws, and the piston 23 can return to its retracted position while the jaw 10 remains engaged, as shown in FIG. 3. It will be understood that when fluid pressure is introduced into the chamber 27, the piston 23 will move forward and carry the jaw 10 with it to engage the companion clutch jaw 11. When the fluid pressure is released from the chamber 27, the piston 23 will retract while the clutch jaws 10 and 11 will remain engaged as long as the starter 1 drives the engine, due to the action of the helical splines 18. Thus the piston 23 can return or retract before the driving fluid to the starter motor 7 is shut off.

Looking at FIG. 1, compressed air or other fluid is fed from a suitable source (not shown) to a T-fitting 45 mounted on the inlet side of a pilot valve or diaphragm controlled valve 46. The diaphragm valve 46 has its

outlet side connected by a nipple 47 to the inlet of the motor housing 3. In addition to being a pipe, the nipple 47 serves to support the diaphragm valve 46 on the starter casing 2.

The stem of the T-fitting 45 is interconnected by a suitable hose 50 to the inlet of a starter valve 51, which is normally mounted on the dashboard of a truck or other vehicle containing the starter 1. The outlet of the starter valve 51 is connected by a hose to the inlet port 39 of the piston chamber 27.

The starter valve 51 may be of any suitable type which in a closed position will exhaust the hose 52 to atmosphere and when open will admit compressed air from the hose 50 to the hose 52. The valve shown in FIG. 1 is of the pull-knob type and includes a body, also designated 51, and an axially movable knob 54 for opening the valve 51 when pulled.

Opening the valve 51 admits compressed air to the hose 52 and through the port 39 into the actuating chamber 27 of the piston 23. As previously explained, the compressed air forces the piston 23 forward and moves the clutch jaw 10 with it into engagement with the mating engine clutch jaw 11, as shown in FIG. 2.

After the piston 23 moves forward, it uncovers an outlet port 56 opening into the chamber 27 and connected to a line 57 containing a check valve 58. The check valve 58 is connected to a line 59 running to the diaphragm chamber 60 of the diaphragm valve 46. The check valve 58 allows fluid to flow to the valve 46 but prevents it from flowing in a reverse direction into the chamber 27.

The diaphragm valve 46 is conventional and includes a diaphragm chamber 60 that contains a flexible diaphragm 61 connected to a valve element 62 seating in a valve seat 63. A spring 64 urges the valve element 62 against the seat 63 to normally close the diaphragm valve 46 and shut off compressed air to the starter 1. After the piston 23 moves forward to open the port 56, air in the piston chamber 27 flows through the line 57, check valve 58 and line 59 to the chamber 60 to cause the valve 46 to open.

After the valve 46 is open, it will remain open as long as the piston remains in its forward position, even though the pressure in the piston chamber 27 is exhausted, due to the check valve 58 that prevents any reverse flow from the valve chamber 60 to the outlet port 56.

Means is provided to keep the valve 46 open until the piston 23 returns to its retracted position. The clutch housing contains a third port 66 connected to a line 67 containing a check valve 68 connected to the line 59 running to the valve chamber 60. The check valve 68 allows fluid to flow from the valve chamber 60 to the piston chamber 27 but prevents a reverse flow. A passage 69 is provided in the piston 23 to interconnect the port 66 to the chamber 27 with the piston 23 in its rear position, as shown in FIG. 3, otherwise the piston 23 seals the port 66 when in its forward position.

OPERATION

When the starter is at rest, both of the air lines 52 and 59 are vented to atmosphere, the piston 23 is retracted and the starter clutch jaw 10 is disengaged from the engine clutch jaw 11. The starter valve 51 and diaphragm valve 46 are closed and the rotary motor 7 is stationary. When it is desired to use the starter, the operator opens the starter valve 51 and the remainder of the operation proceeds automatically.

The opening of the starter valve 51 feeds compressed air through the hose 52 and port 39 into the piston chamber 27 causing the piston 23 to move forward to the front of its travel and to urge the starter clutch jaw 10 into engagement with the engine clutch jaw 11, as shown in FIG. 2. The forward travel of the piston 23 uncovers the port 56 and air in the chamber 27 flows through the lines 57 and 59 to the diaphragm valve 46 causing it to open and feed compressed air to the starter motor, causing it to rotate.

After the engine fires or a selected time period, the operator will close the valve 51, allowing the exhaust of air from the piston chamber 27. When the pressure is exhausted from the chamber 27, the piston 23 will return to its rear position. However, the check valve 58 will prevent the line 59 from being exhausted until the piston 23 returns. With the return of the piston 23, the line 59 will exhaust through the check valve 68 and the passage 69 in the piston 23 and allow the valve 46 to close, thereby stopping the motor. Once the driving torque on the shaft 8 by the starter motor is discontinued, the helical splines 18 will automatically retract the starter clutch jaw 10.

SECOND EMBODIMENT

The second embodiment 71 differs from the first starter embodiment merely by using a pair of spline-type clutch jaws 72 and 73 in place of the dental type of clutch jaws 10 and 11 of the first embodiment.

While two embodiments of the invention are shown and described in detail, this invention is not limited simply to the specifically described embodiments, but comtemplates other embodiments and variations utilizing the concepts and teachings of this invention.

We claim:

1. A fluid operated pre-engaged starter comprising:

a casing containing a fluid operated motor driving a shaft;

a starter clutch member rotatably mounted on said casing in driving connection with said motor shaft and slidable axially between a disengaged position and an engaged position with an engine clutch member;

a piston slidably mounted in a fluid chamber in said casing and operative in response to the introduction of fluid pressure into said chamber to move from a retracted position to an extended position;

said piston being connected to said starter clutch member causing said piston in moving to its extended position to move said starter clutch member toward its engaged position;

a fluid supply line for supplying operating fluid to said motor and containing a fluid operated valve for opening and closing said supply line;

means for opening said valve to operate said motor in response to the movement of said piston toward its extended position, corresponding to the engaged position of said starter clutch member; and

means for maintaining said valve in its fully open position during return movement of said piston and for closing said valve to stop said motor only in response to the arrival of said piston at its retracted

position whereby said motor continues to operate until said piston discontinues urging said starter clutch member into engagement with the engine clutch member.

2. The starter of claim **1** wherein:

said connection between said piston and said starter clutch allows said piston to be retracted while said starter clutch remains in its engaged position.

3. The starter of claim **2** including:

means on said starter clutch member operative in response to the driving torque of said motor to cause said starter clutch member to remain in engagement with an engine clutch member after said piston returns to its retracted position.

4. The starter of claim **3** wherein:

said means for opening said valve includes a line running from said chamber to said valve and containing a check valve that allows a fluid signal to flow to said valve and prevents reverse flow through said check valve into said chamber.

5. The starter of claim **4** wherein:

said means for closing said valve is a second line running from said chamber to said valve and containing a second check valve that prevents flow through said second check valve from said chamber to said valve, and a passage in said piston for communicating said second line to said chamber with the return of said piston to its retracted position.

6. The starter of claim **5** wherein:

said connection between said piston and said starter clutch allows said piston to move into its extended position even though said clutch fails to engage fully.

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