Sept. 20, 1960 D. W. ADAMS ET AL 2,953,127

FLUID PRESSURE ENGINE STARTING SYSTEM

Filed April 8, 1959 2 Sheets-Sheet 1

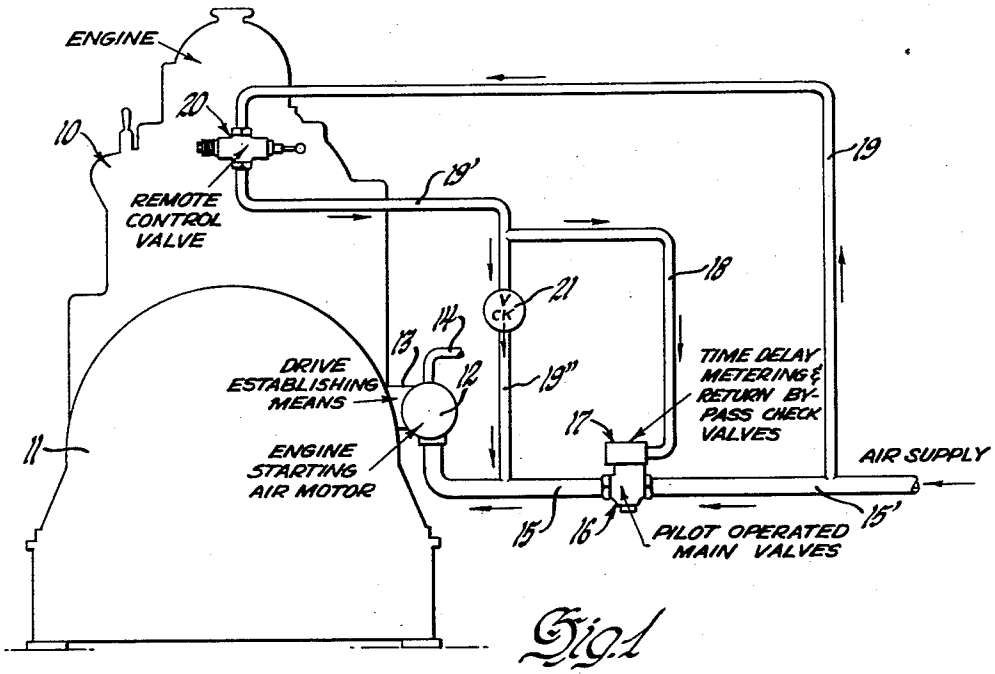

Fig. 1

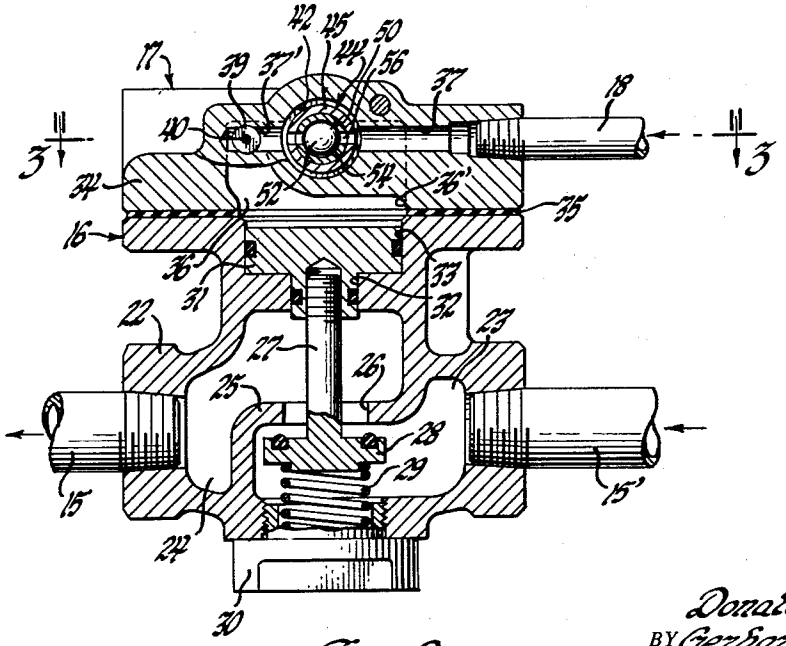

Fig. 2

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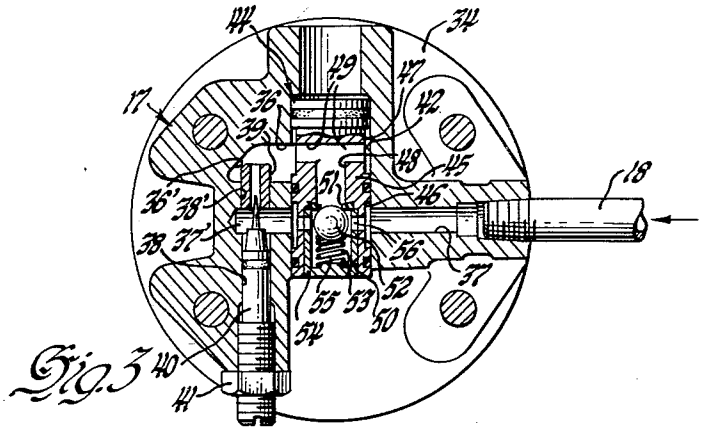

Fig. 3

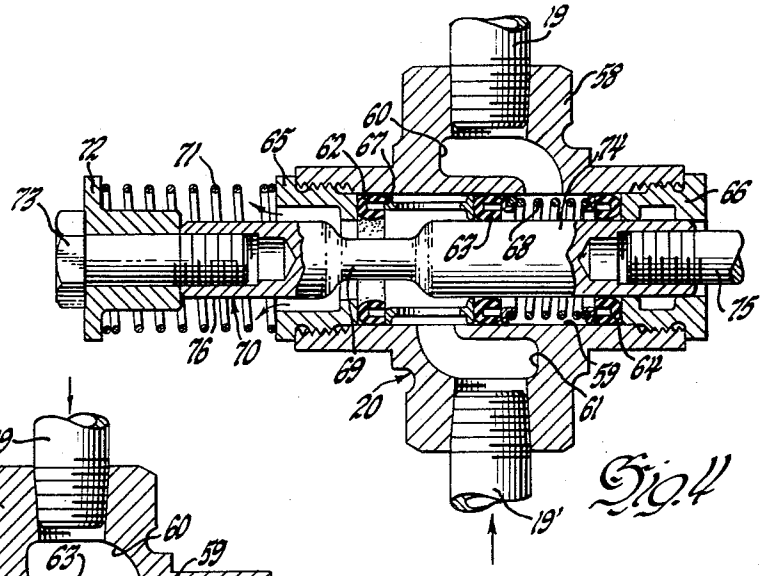

Fig. 4

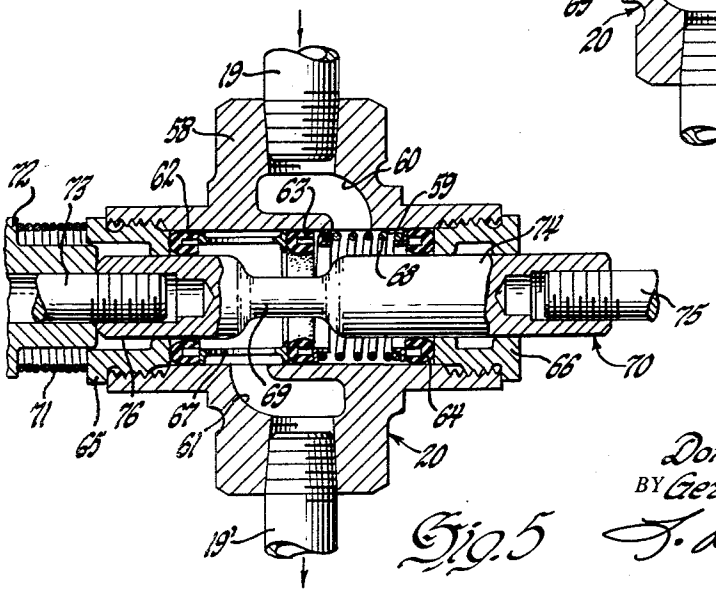

Fig. 5

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FLUID PRESSURE ENGINE STARTING SYSTEM

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3 Claims. (Cl. 123—179)

This invention relates generally to a fluid pressure actuating system, and more particularly to an engine starting system for an internal combustion engine including a fluid pressure operated starting device which is mounted on and adapted to selectively drive an internal combustion engine during its starting phase of operation.

Fluid pressure operated engine starting devices of the above-mentioned type generally include a fluid pressure motor and means for establishing a driving connection between the fluid pressure starting motor and the flywheel ring gear of the associated engine. The driving connection between the motor and the engine may be such as to provide a continuous solid drive between the two units. To prevent engine driving of the starting motor during normal engine operation, however, a drive establishing means is generally provided which is operable to selectively engage and disengage the driving connection. Such drive establishing means generally comprises a clutch and/or a pinion gear which may be shifted axially into driving engagement with the flywheel ring gear of the associated engine. Drive establishing actuation of the clutch or shifting of the pinion gear may be effected manually or automatically by initial rotation of the starting motor or by fluid pressure means responsive to the supply of pressurized fluid to the starting motor. With fluid pressure engine starting devices having either continuous or selective drive means, the initial static frictional and inertial loads of the engine subject the starting drive connection and fluid pressure starting motor to extreme load conditions. In installations provided with selective drive establishing means, further destructive load conditions may be imposed on the starter drive and motor where the driving connection is not fully established prior to the full application of the supplied fluid pressure to the starting motor such as occurs due to improper clutch or gear tooth engagement.

The invention contemplates an improved fluid pressure engine starting system including remote control valve mechanism operable to first provide a restricted flow of actuating pressure to the starter motor for the purpose of establishing a proper driving connection between the starter device and the engine where selective drive means is provided, to initially impose the static frictional and inertial loading of the engine on the starter drive and motor under relatively low speed and torque conditions and to thereafter provide for substantially unrestricted flow of pressurized fluid to the starter motor through the operation of a time delayed, pilot operated main control valve.

The foregoing and other objects, features and advantages of the invention will become apparent from the following detailed description of a preferred embodiment thereof in which reference is made to the attached drawings, in which:

Figure 1 is a diagrammatic view of a pneumatic engine starting system embodying the invention;

Figure 2 is an enlarged detail sectional view of the time delayed, pilot operated control valve;

Figure 3 is a sectional view taken substantially in the plane of the line 3—3 in Figure 2; and

Figures 4 and 5 are sectional views showing different operative positions of the remote control valve mechanism.

Referring more particularly to Figure 1 of the drawings, the outline of an internal combustion engine is indicated at 10. An engine starting air motor 12 is mounted to one side of the engine flywheel housing 11 and is preferably drivingly connectable to the engine flywheel ring gear (not shown) by a suitable drive establishing means 13. The air motor 12 is provided with an exhaust vent to atmosphere indicated at 14 and is connectable through a main conduit 15, 15' to a suitable supply of high pressure air, such as an air pump charged reservoir. A main control valve 16 is interposed between main conduit portions 15 and 15' and serves to control the flow of pressurized air to the starter motor through the main conduit. Operation of the main control valve 16 is reponsive to a pilot pressure signal which is supplied thereto through a time delay metering valve 17. The main valve actuating pilot signal is supplied to the time delay metering valve through a branch line or conduit 18 which intersects a conduit portion 19' of a conduit 19, 19' and 19''. The conduit 19, 19' and 19'' is of restricted size and bypasses the main control valve. The flow of fluid pressure through the bypass conduit 19, 19' and 19'' is controlled by a three-way, open-end vent valve 20 which may be mounted directly on the engine or may be located in a remote engine control station. Where the valve 20 is mounted directly on the engine, as shown, it may be manually operated locally or may be operated remotely through suitable control linkages or cables, not shown. A check valve 21 mounted intermediate the conduit portions 19' and 19'' prevents reverse air flow from the air motor and main conduit portion 15 toward the valve 20 and the pilot control branch conduit 18.

As best seen in Figure 2, the main control valve 16 comprises a valve body 22 which defines an inlet chamber 23 connected to the main air supply conduit portion 15' and an outlet chamber 24 connected to the main conduit portion 15 leading to the starter motor. A partition web 25 separates the inlet and outlet chambers 23 and 24 and has a port 26 extending therethrough. Fluid flow through the port 26 is controlled by a poppet valve member 27. The head portion 28 of the valve 27 is normally biased toward port sealing engagement with the web 25 by a spring 29 which is compressively interposed between the valve head 28 and a spring seating closure cap 30. The cap 30 is threadably mounted in a bore tapped in the valve body in axial alignment with the valve controlled port 26. A valve actuating piston 31 of stepped diameter is threadably mounted on the upper end of the valve stem of the poppet valve member 27 which extends axially from the valve head through the port 26 and through the outlet chamber 24. The stepped diameter land surfaces of the valve actuating piston 31 are slidably mounted and O-ring sealed with respect to a bore and counterbore 32 and 33, respectively, formed in the valve body 22 in axial alignment with the valve port 26.

The time delay metering valve 17 is combined with a check valve return bypass and comprises a valve body member 34 which is secured to the main valve body 22, being sealed with respect thereto by an interposed gasket 35. The metering valve body member is recessed at 36' and defines an expansible valve actuating chamber 36 with the valve actuating piston 31. A drilled inlet pas-

sage indicated at 37, 37' is connected to the pilot pressure supply conduit 18. A second drilled bore 38, 38' intersects and extends between the inlet passage portion 37' and the expansible chamber recess 36'. A valve seat and orifice defining sleeve 39 is mounted in the bore portion 38' by a suitable press fit. The flow of pressurized fluid through the orifice sleeve 39 and thereby the timing of main valve actuation is controlled by a needle valve member 40 which is threadably adjustable and O-ring sealed with respect to the bore 38. The time and flow regulating orifice size adjustment of the needle valve member 40 is maintained by a lock nut 41.

The valve body 34 is provided with a second larger bore 42 which intersects and extends between the drilled inlet passage portions 37, 37' and the expansible chamber recess 36. This bore mounts a pressure return bypass check valve assembly 44. This check valve assembly comprises a spool-shaped body member 45 having two reduced diameter lands 46, 47 which mate with the inlet passage 37, 37' and the expansible chamber recess 36, respectively. The end and intermediate large diameter land portions are O-ring sealed with respect to the bore 42. The spool body member is provided with a central bore 48 terminating at one end in radial ports 49 leading to the expansible chamber 36. The opposite end of the spool member is counterbored as indicated at 50 to provide shoulder embracing the bore 48 and supporting an annular valve seat member 51. Fluid flow through the bore 48 is controlled by a ball check valve member 52. The ball valve member 52 is biased toward seating engagement with the valve seat member 51 by a spring 53 which is compressively interposed between the ball member and a check valve retaining cap 54. The cap 54 is secured by press fitting it into the spool counterbore 50 and cooperates with the valve body spool 45 to define a check valve and spring mounting chamber 55. Radial ports 56 connect the chamber 55 to the pressure inlet chamber which is defined by the reduced diameter land 46 and the spool mounting bore 42 and further interconnects the inlet passage portions 37, 37'.

As shown in Figures 4 and 5, the three-way, open end vent valve 20 comprises a valve body 58 having a central bore 59 extending therethrough. The valve body is recessed at 60 and 61 to define pressure inlet and outlet chambers opening in axially spaced relation on the central bore. Three resilient seal rings 62, 63 and 64 are maintained in axially spaced sealing relation within the central bore 59. The end seal rings 62 and 64, respectively, abut two bushings 65 and 66 which threadably engage the valve body adjacent the ends of the central bore 59. A perforated spacer sleeve 67 is interposed between the seal rings 62 and 63 and a helical spacer spring 68 is compressively interposed between the seal rings 63 and 64. A spool-type valve plunger 70 is reciprocably and sealably mounted by the bushings 65 and 66 and then seal rings 62, 63 and 64. The valve member 70 is normally biased to the position shown in Figure 4 by a valve return spring 71 which is compressively interposed between bushing 65 and an annular spring seat member 72 secured to the end of the valve plunger by bolt 73. In this position, the reduced diameter land 69 formed intermediate the ends of the valve member is spacedly embraced by the seal 62 and the bushing 65 and serves to vent the conduit portion 19' to atmosphere with consequent venting of the main valve actuating chamber 36 through the metering valve return bypass check valve 44. In this position of the control valve the supply pressure applied to the pilot valve and the inlet port intermediate the seals 63 and 64 acts to insure sealing engagement between these seals and the adjacent large diameter land 74 of the valve member 70.

Upon actuation of the valve member 70 by a suitable control knob or linkage connected thereto, as partially shown at 75, the large diameter land 76 adjacent the opposite end of the valve member is brought into pressure sealing engagement with the end seal ring 62 and the reduced diameter land 69 serves to interconnect the pressure inlet and outlet chamber 60 and 61. This position of the pilot control valve plunger thus permits the flow of the supplied pressurized air through the conduit portions 19, 19' and 19'' and the valves 20 and 21, as restricted by the size and length of the several conduit portions, to the engine starting air motor. This restricted flow of pressurized air to the air motor 12 serves to effect clutch engagement and/or pinion shifting into ring gear engagement, where such selective drive establishing means are provided, and to subject the starter motor to the static frictional and inertial resistance of the engine under relatively low speed, torque load conditions. The restriction of the conduit portions 19, 19' and 19'' is preferably sufficient to prevent any high speed, high torque cranking of the engine.

As indicated above, the conduit restricted flow of pressurized fluid through the pilot control valve 20 is delayed in its application to the expansible actuating chamber 36 by the setting of the needle valve 40. This introduces a time delay in the actuation of the main valve 27 by the piston 31 until after establishment of the driving connection between the starting motor and engine loading of the starter motor has occurred. Upon opening of the pilot operated main valve 16, the substantially unrestricted flow of pressurized air to the starter motor will be sufficient to crank the engine at an engine starting speed.

After engine starting has been accomplished and the pilot valve is released, the pilot valve plunger is biased to its venting position shown in Figure 4 by the return spring 71 thus venting the conduits 19' and 18 and the valve actuating expansible chamber 36. This venting of the expansible chamber 36 occurs rapidly through the metering bypass check valve 44 and permits return of the main control valve 27 to its closed position thereby conditioning the engine starting system for the next engine starting sequence.

While the foregoing description and figures have been confined to one embodiment of the invention, it will be apparent to those skilled in the art that numerous modifications may be made without departing from the spirit and scope thereof, as defined in the following claims.

We claim:

1. An engine starting system for an internal combustion engine including fluid motor means energizable to establish a driving connection with the engine, means for supplying pressurized fluid to said motor means including a first conduit means, a first valve means operable to control the flow of pressurized fluid through said first conduit means and including a first valve member movable between a closed position preventing fluid flow through said first conduit means and an opened position permitting fluid flow through said first conduit means, spring means normally biasing said valve member toward its closed position, and expansible chamber means associated with said valve member and operable in response to fluid pressure applied thereto to actuate said valve member to its opened position, a second conduit means bypassing said first valve means and of a size to provide restricted flow of pressurized fluid from said pressurized fluid supply means to said fluid motor means, a second valve means operable to control the flow of pressurized fluid through said second conduit means and including a second valve member movable between a first position wherein restricted flow of pressurized fluid to said motor means is permitted and a second position wherein pressurized fluid flow to said motor through said second conduit means is prevented, a first check valve means in said second conduit means intermediate said second valve means and said motor means for preventing reverse fluid flow in said second conduit means toward said second valve means from said motor means

and said first conduit means, said second valve means being operable when said second valve member is in its second position to vent pressurized fluid from said second conduit means intermediate said second control valve means and said first check valve means, a branch conduit means interconnecting said expansible chamber means of said first valve to said second conduit means intermediate said second control valve means and said first check valve means, a metering valve means operable to restrict the flow of pressurized fluid in said branch conduit means to said expansible chamber means to delay actuation of said first valve member to its opened position, and a second check valve means bypassing said metering valve means and operable to permit unrestricted venting of said expansible chamber upon movement of said second valve member to its vent position.

2. A fluid pressure engine starting system for an internal combustion engine including fluid motor, means for establishing a driving connection between said motor and the engine, a source of pressurized fluid, means for supplying pressurized fluid from said source to said fluid motor including a first conduit means, a first valve means operable to control the flow of pressurized fluid through said first conduit means and including a first valve member movable between a closed position preventing fluid flow through said first conduit means and an opened position permitting fluid flow through said first conduit means, spring means normally biasing said valve member toward its closed position, and expansible chamber means associated with said valve member and operable in response to fluid pressure applied thereto to actuate said valve member to its opened position, a second means for supplying pressurized fluid from said source to said fluid motor including a second conduit means of a size to permit only restricted flow of pressurized fluid from said pressurized fluid supply means to said fluid motor, a second valve means operable to control the flow of pressurized fluid through said second conduit means and including a second valve member movable between a first position wherein restricted flow of pressurized fluid to said fluid motor is permitted and a second position wherein pressurized fluid flow to said fluid motor through said second conduit means is prevented, a first check valve means in said second conduit means intermediate said second valve means and said fluid motor for preventing reverse fluid flow in said second conduit toward said pilot valve from said fluid motor and said first conduit means, said second valve means being operable when said second valve member is in its second position to vent said second conduit means intermediate said second control valve means and said first check valve means, a branch conduit means interconnecting said expansible chamber means of said first valve means to said second conduit means intermediate said second control valve means and said first check valve means, and flow control valve means operable to restrict the flow of pressurized fluid through said branch conduit means to said expansible chamber means to delay actuation of said first valve member to its opened position and to permit unrestricted venting of said expansible chamber upon movement of said second valve member to its vent position.

3. A pneumatic engine starting system for an internal combustion engine including an air motor, means energizable to establish a driving connection between said motor and engine, a source of pressurized air, a first means for supplying pressurized air from said source to said air motor including a first conduit means, a first valve means operable to control the flow of pressurized air through said first conduit means and including a first valve member movable between a closed position preventing air flow through said first conduit means and an opened position permitting air flow through said first conduit means, spring means normally biasing said valve member toward its closed position, and an expansible chamber means associated with said valve member and operable in response to air pressure applied thereto to actuate said valve member to its opened position, a second means for supplying pressurized air from said source to said air motor including a second conduit means of a size to provide restricted flow of pressurized air from said source to said air motor, a second valve means operable to control the flow of pressurized air through said second conduit means and including a second valve member movable between a first position wherein restricted flow of pressurized air to said air motor is permitted and a second position wherein pressurized air flow to said motor through said second conduit means is prevented, a first check valve means in said second conduit means intermediate said second valve means and said air motor for preventing reverse air flow in said second conduit means toward said second valve means from said air motor, said second valve means being operable when said second valve member is in its second position to vent said second conduit means intermediate said second control valve means and said first check valve means to atmosphere, a branch conduit means interconnecting said expansible chamber means of said first valve to said second conduit means intermediate said second control valve means and said first check valve means, a metering valve means operable to restrict the flow of pressurized air through said branch conduit means to said expansible chamber means to delay actuation of said first valve member to its opened position, and check valve means bypassing said metering valve means and operable to permit unrestricted venting of said expansible chamber upon movement of said second valve member to its vent position.

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