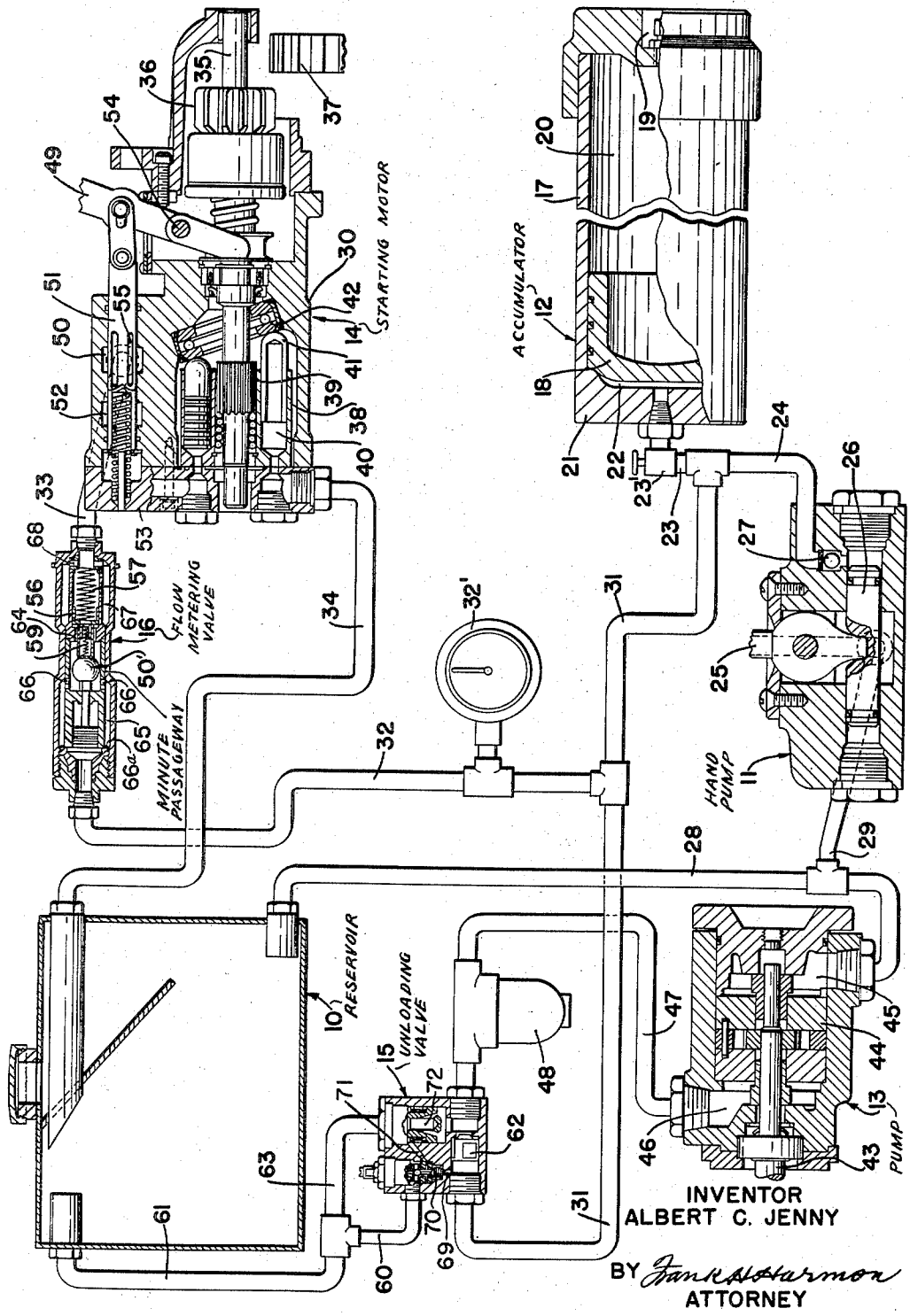
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HYDRAULIC STARTING SYSTEM FOR ENGINES

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HYDRAULIC STARTING SYSTEM FOR ENGINES

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1 Claim. (Cl. 60—51)

This invention relates to starting systems for internal combustion engines, and more particularly to an hydraulic system including a fluid pressure accumulator.

One of the primary objects of the invention is to provide an improved engine starting hydraulic system which includes an hydraulic engine starting motor, and wherein hydraulic pressure energy for operating the starting motor is stored in an accumulator by an hydraulic hand pump for the initial start and for supplying motor operating fluid under pressure in the event of failure or exhaustion of the pressure fluid accumulator or failure of an engine driven hydraulic pump which is used to recharge the accumulator to the desired pressure.

Another object is to provide in such a system an unloading value so designed and incorporated in the hydraulic circuit that after the system is charged to the desired operating pressure, the unloading valve will relieve the engine driven pump load so that it will circulate hydraulic fluid through the system at a relatively low pressure and automatically cut in to recharge the accumulator to the regulated pressure when the stored fluid pressure drops to a predetermined degree.

Another object is to provide means in the form of an hydraulic fluid metering valve located between the accumulator and the motor that will be responsive to hydraulic fluid flow so as to limit the flow for each cranking cycle and prevent exhausting the accumulator in the event the engine fails to start.

With the foregoing and other objects in view, the invention resides in the combination of parts set forth in the following description and appended claim, certain embodiments thereof being illustrated in the accompanying drawing, wherein the single figure is a diagrammatic illustration of an hydraulic engine starting system illustrative of the invention, certain parts being broken away and shown in cross section to better illustrate the construction thereof.

Referring more particularly to the drawing, the system comprises, in general, a fluid tank or reservoir **10**, a hand pump **11**, a piston type accumulator **12**, an engine driven pump **13**, an hydraulic starting motor **14**, an unloading valve **15** and a flow metering valve **16**.

The accumulator is preferably a piston type hydropneumatic accumulator where fluid energy is stored under pressure for actuating the starting motor **14**. As shown, it comprises a cylinder **17** and a piston **18**, slidably mounted therein. A charge of gas under pressure is introduced by conventional means through the right end **19** of the cylinder into chamber **20** behind the piston **18**. Rigid with cylinder **17** is a cylinder head **21** to form an hydraulic fluid chamber **22** and an inlet condut **23** thereto from a conduit **24** from the discharge side of the hand pump **11**. I preferably employ a manual valve **23'** in conduit **23** adjacent the accumulator. When the valve **23'** is opened, the accumulator may be charged by hand pump **11**, when I desire to break the engine, or turn it over slowly. In the closed position of valve **23'**, the

pressure fluid pumped by the hand pump **11** is then conveyed through pipes **24**, **31**, **32** and **33** into the motor **14** and, when the pinion gear **36** has been first meshed with engine ring gear **37**, and the valve **51** opened to open passage from port **50** to **52**, this hand pumped hydraulic pressure turns the engine over.

The hand pump **11** is a manually operated double acting pump for building up pressure in chamber **22** of the accumulator in front of the piston and may comprise a suitable pivoted hand lever and plunger **26** actuated thereby for forcing hydraulic fluid under pressure past a check valve **27** through conduit **24** into the accumulator. In this pumping operation, hydraulic fluid is pumped from the reservoir **10** through suction line **28** and inlet conduit **29** into the hand pump casing.

The cranking motor **14** includes a housing **30** to receive inlet hydraulic pressure fluid from the accumulator through conduits **31**, **32**, metering valve **16** and conduit **33** which, after performing its function, is discharged out through conduit **34** back into the reservoir **10**. The starting, or cranking, motor is preferably an axial piston, rotating cylinder drive, wobble plate fluid motor with a drive assembly actuated by a fluid pressure charge from the accumulator through the hand valve when opened. Briefly, the starter drive shaft **35** is rotatably mounted in housing **30** and carries a cranking pinion **36** that is automatically extended to the right into mesh with an engine flywheel ring gear **37** carried by the engine crankshaft and spring returned after starting of the engine. A cylinder **38** is rotatably mounted in the housing **30** and is splined at **39** to shaft **35** to drive the latter. The cylinder is provided at its inner end with a plurality of bores **40**, each to receive an axially slidable piston **41** provided at its outer end with a spherical head that bears against an axially inclined wobble plate **42**. The inner ends of the cylinder bores, in the rotation of the cylinder, alternately register with inlet and outlet bores of a porting plate, to which the motor inlet and outlet conduits **33** and **34** are connected. Pressure fluid causes reciprocation of the pistons, due to the angle of disposition of the wobble plate and this, in turn, rotates the cylinder, and consequently the cranking shaft and pinion for the engine cranking operation.

The engine driven pump **13** may be of any suitable type to include an engine driven pump shaft **43** carrying suitable gears **44** to draw hydraulic fluid from the reservoir **10** through the suction line **28** through the pump inlet **45** and out through the outlet **46** from which the hydraulic fluid flows through conduit **47** past a high pressure filter through the unloading valve assembly **15** and out through the conduit **31** into the accumulator **12**.

In the operation of the device, the hydraulic energy for cranking the engine is stored in the accumulator by means of the hydraulic hand pump for the initial start. This hydraulic fluid energy is stored in chamber **22** in the cylinder ahead of the piston **18** against the expansive force of the gas in chamber **20** behind the piston.

In this system, the extension of the starter pinion for the admission of hydraulic pressure fluid is accomplished by a single hand lever **49**. In the drawing, the hand lever is shown to be in a position to retract the starter pinion **36** out of engagement with the engine ring gear **37**. While hydraulic fluid is free to enter the intake port **50** into the motor housing from conduit **33**, the plunger valve **51** remains closed to prevent flow through the outlet port **52** to the porting plate **53** and the chambers **40** back of the pistons **41** in the cylinder **38** for operating the motor. In order to start the motor, the hand crank **49** is moved counter-clockwise about its pivot **54**. This forces the starter pinion **36** into mesh with the engine flywheel ring gear **37**. At the same time, it moves the

plunger valve 51 to the left to establish communication between the inlet 50 which is closed by a ball as shown and the outlet 52. The plunger valve is formed with grooves 55 to permit a finely metered flow from inlet 50 to outlet 52 to initiate a slow rotation of pinion 36 near its final stage of extension to insure proper mesh with ring gear 37. In this manner, the hydraulic energy stored up in the accumulator rotates the cranking motor for starting of the engine.

I have found it advisable to provide some precautionary means against the continued flow of hydraulic pressure fluid from the accumulator to the starting motor after a predetermined number of revolutions of the starting pinion during a given cranking cycle. This is in order to avoid the dissipation of all of the stored energy in the accumulator for a single cranking cycle when, for some mechanical or electrical reason, the engine fails to start. One means of accomplishing this is an hydraulic metering fuse valve assembly generally indicated at 16 which may be of the type shown in Patent 2,592,486. The purpose of this valve 16 is to provide some means that is strictly responsive to fluid flow volume rather than to fluid pressure. It may comprise a sleeve 56 normally urged to open position by a spring 59. Thus, upon operation of the hand lever 49 to extend the starter piston and to open communication between the inlet 50 and the outlet 52 to the porting plate of the motor, the operating parts of the metering valve 16 are open to permit flow from the accumulator to the conduit 33 and then through the starting motor. Upon the completion of a pre-determined volume of flow of such hydraulic fluid from the accumulator, the ball closing inlet 50 and sleeve are forced to the right against the action of their respective springs to discontinue such flow.

As stated before, the accumulator is initially charged by the hydraulic hand pump. After the engine has been started, it drives the engine pump 13 in order to re-charge the accumulator and keep it charged to the desired pressure. After the system has been charged by the engine pump to the desired operating pressure, the unloading valve 15 in the circuit relieves the engine pump work load in order to circulate the hydraulic fluid through the system from the reservoir through the suction line 28 out through conduit 47 and past the unloading valve casing through conduit 63 and conduit 61 back into the reservoir 10. A movable valve element of the unloading valve itself is indicated at 62 as being urged to the right in response to a pre-determined pressure in chamber 22 in the accumulator ahead of the piston 18 conveyed through conduit 31. With this element 62 of the unloading valve being closed, the flow from the engine pump through conduit 47 does not enter conduit 31, but is bypassed through port 69 opening sensing valve 70 to permit pressure fluid to go through passage 71 to unseat bypass valve 72. The fluid bypass valve 72 when opened by the sensing valve 70 is directed through line 63 and conduit 61 to the reservoir 10. If desired, a drain pipe 60 may be provided from the by-pass line 61 back into the loading valve housing 15 behind the sensing valve 70. The purpose of the unloading valve is that of a pressure regulator to convert pressure from the engine driven pump over to a low circulating pressure after the accumulator has reached the desired maximum setting. When the stored fluid pressure in the accumulator drops to a predetermined degree, the unloading valve automatically cuts in and permits the engine driven pump to re-charge the accumulator to the regulated pressure so that it can be re-charged to any desired maximum setting.

It will thus be seen that I have provided an hydraulic cranking system for cranking an engine where the energy is stored in an accumulator by means of an hydraulic hand pump for the initial start. After the engine is started, the engine driven hydraulic pump re-charges the accumulator to the desired operating pressure. After the system is charged to the desired operating pressure, the unloading valve in the circuit relieves the engine pump work load so that it will circulate hydraulic fluid through the system at a low pressure. When the stored fluid in the accumulator drops to a pre-determined degree, the unloading valve automatically cuts in and re-charges the accumulator to the regulated pressure. Means have also been provided in the form of the metering valve assembly 16 to prevent the dissipation of all of the stored energy in the accumulator for a single cranking cycle in the event that the engine does not start after a pre-determined number of revolutions of the starter pinion.

The operation of the valve 16 is dependent upon operation of the hand valve 49 which will open the line 33, behind the valve 16. Fluid pressure from the line 32 will act on the internal telescopic sleeve 56 to move this sleeve like a piston to the right as viewed in the drawing against the action of spring 57 and spring 59, thereby permitting a predetermined volume of fluid to pass the valve to operate the motor 14.

After a number of revolutions of the motor, as determined by the volume of the fluid, flow is cut off by the seating of the ball 50' in the valve 16 against the seat 64 in valve 16. This condition will remain until the handle 49 is moved to the inoperative position, thereby blocking off the flow from line 33 to the motor 14.

The valve 16 is further provided with a chamber 65 fed through passages 66*a* to ducts 66. The valve chamber 65 is connected by a minute passageway not shown to a second chamber 67 which bleeds a certain amount of the pressure fluid from chamber 65 to chamber 67 from whence it is led by passages 68 to the underside of the ball 50' and the sleeve 56. At this point, with the handle 49 jn the closed position and the bleed fluid building up in pressure behind the ball, the combination of such increasing fluid pressure and the springs 57 and 59 will force the ball 50' from the seat 64 to thereby permit a further operation of the system when the handle 49 is again moved to the operative position.

The hand pump is, of course, always available for storing energy in the accumulator at any time, should the energy stored by the engine driven pump be insufficient for starting purposes. Moreover, by the provision of manual valve 23', I may open it to charge the accumulator by the hand pump or the engine driven pump. I may also close valve 23' and crank the engine slowly by the hand pump.

I claim:

An hydraulic engine starting system comprising an hydraulic starting motor, an hydraulic reservoir, a pneumatic-hydraulic accumulator for storing fluid under pressure, a normally closed hand operable valve mounted on the starting motor, a conduit connecting said accumulator to said valve to deliver pressure fluid thereto, said valve when opened delivering said pressure fluid to the starting motor to operate the same, a conduit leading from the discharge side of the starting motor to the reservoir, a hand pump, conduit means connecting said hand pump to the accumulator and to the conduit between the accumulator and the starting motor, check valve means positioned in the conduit between the hand pump and accumulator to prevent reverse flow from the accumulator or from the conduit between the accumulator and the starting motor back to said hand pump, conduit means connecting said hand pump with the reservoir, an engine driven pump, a conduit connecting said engine driven pump to the accumulator, an automatic pressure responsive valve connected in the conduit between the accumulator and the hand operated valve for limiting the volume of fluid directed to the starting motor on each operation of the hand operated valve, said pressure responsive valve acting thereby to preserve the pressure in the accumulator while supplying enough fluid under pressure to operate the starting motor adequately for engine starting purposes, conduit means connecting said engine driven pump with said reservoir, an automatic unloading valve connected in

the conduit between the engine driven pump and the accumulator, and conduit means connecting said unloading valve with the reservoir, said unloading valve being operative through its connection with the reservoir to bypass fluid from said engine driven pump at a preselected pressure level of the system to prevent too great a build up of pressure on the system by the engine driven pump, and said unloading valve including a check valve to prevent return flow of fluid from the accumulator to the engine driven pump.

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