Nov. 8, 1960 E. C. SWANSON 2,959,009

FLUID PUMPING MECHANISM

Filed Jan. 20, 1958

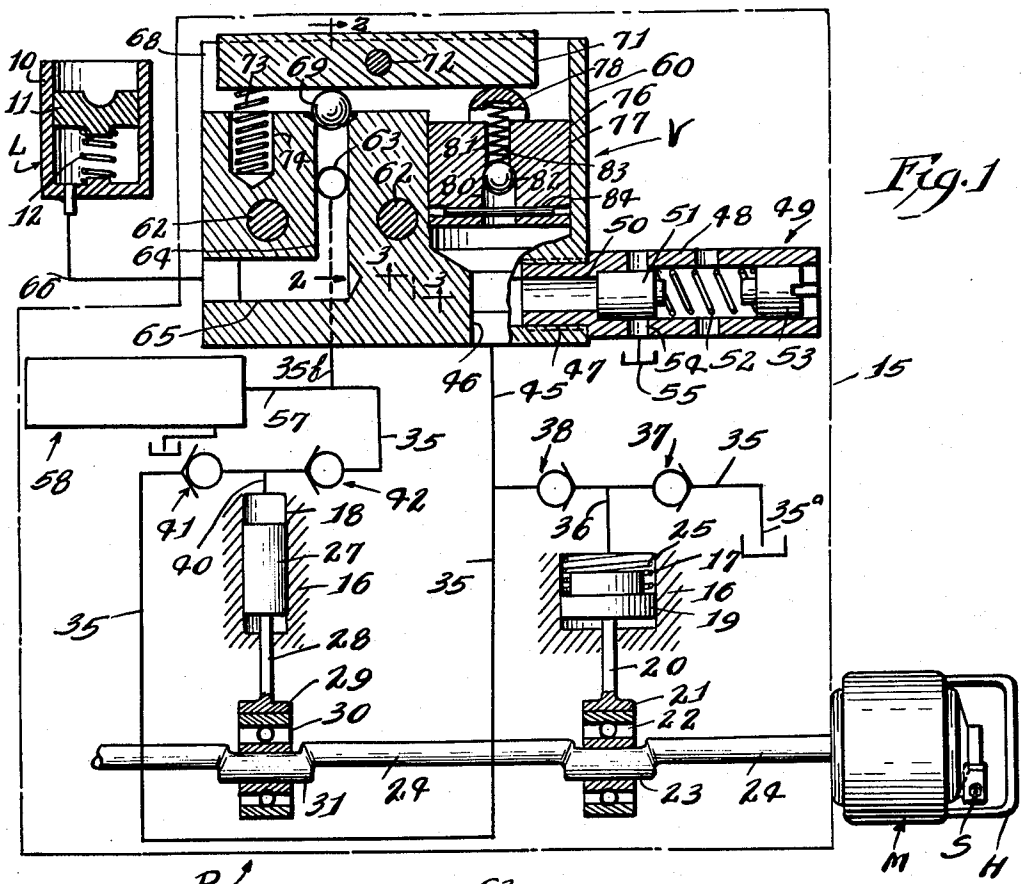

Fig. 1

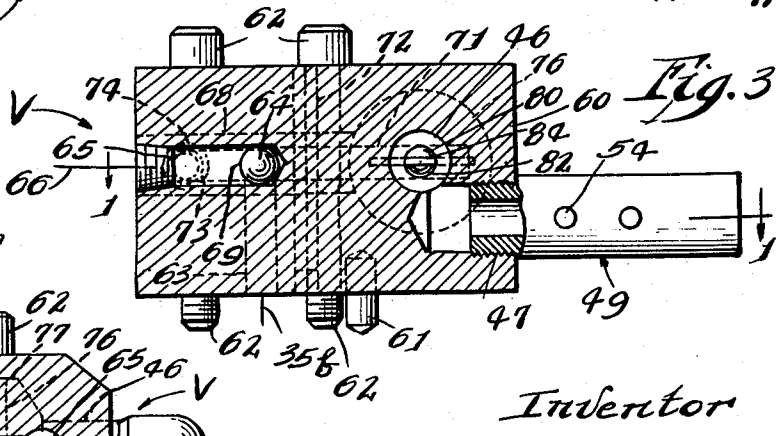

Fig. 3

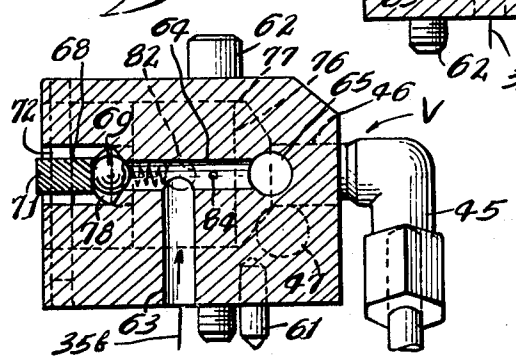

Fig. 2

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United States Patent Office 2,959,009 Patented Nov. 8, 1960

2,959,009

FLUID PUMPING MECHANISM

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Filed Jan. 20, 1958, Ser. No. 709,823

5 Claims. (Cl. 60—52)

This invention relates to a pumping mechanism for supplying fluid under pressure to a work device to move and hold a load and then release the load simply by starting and stopping a prime mover for the pumping mechanism.

It is a general object of the invention to provide a new and improved mechanism of the type described.

A more specific object is to provide a mechanism of the type described, for a spring or gravity retracted load bearing piston in a clamp or the like, including a pump for supplying high volume, low pressure fluid to move the piston through a major portion of its work stroke and for then supplying a low volume, high pressure fluid for completing the piston stroke and for holding the load, a prime mover for the pump, and a valve which is automatically closed by pressure fluid when the prime mover is started and which opens automatically when the prime mover is stopped to relieve the system pressure and release the load.

Other objects and advantages will become readily apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a diagrammatic illustration of a system embodying the principles of the present invention, including a sectional view, taken at about the line 1—1 of Fig. 3, through a control valve mechanism included in the system;

Fig. 2 is a sectional view through the control valve mechanism, taken at about the line 2—2 of Fig. 1; and

Fig. 3 is a sectional view through the valve mechanism, taken at about the line 3—3 of Fig. 1.

While an illustrative embodiment of the invention is shown in the drawings and will be described in detail herein, the invention is susceptible of embodiment in many different forms, and it should be understood that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiment illustrated. The scope of the invention will be pointed out in the appended claims.

Referring to the drawings in more detail, the invention is embodied in a hydraulic fluid system comprising a fluid operable load device L which is supplied with fluid under pressure by a pumping mechanism P which includes a control valve mechanism V and a pump drive motor M.

The load device L may comprise a hydraulic clamping press of the type disclosed in my co-pending application Serial No. 562,981, filed February 2, 1956, now Patent No. 2,821,877, and as illustrated herein includes a cylinder 10 having a piston 11 slidable therein and retractable by a tension spring 12 having opposite ends connected to the piston and to the lower end of the cylinder. In a press of the type referred to, a clamping die, represented herein by the piston 11, is preferably advanced into clamping position by a high volume of low pressure fluid, held at the end of the stroke in clamping position as long as necessary by a low volume of high pressure fluid, and should be releasable for gravity or spring return when desired.

My co-pending application Serial No. 584,955, filed May 15, 1956, discloses a pump mechanism adapted for use with a load device of the type just described, and taking the form of a portable unit including a housing which provides a reservoir for hydraulic fluid, a pump block in the housing, pumping devices in the block respectively for supplying low pressure fluid to move the piston to clamping position and then for automatically supplying high pressure fluid to hold the piston in clamping position, an electric motor mounted on the housing to drive the pumping devices, and a manually operable valve mechanism mounted on the pump block to selectively effect clamping or release, while the motor runs continuously. The unit may be conveniently carried by hand and readily hoisted to an elevated work position, such as a pole or tower carrying power lines or telephone lines, for use with a clamping press of the type described, for splicing wires. The only external connection necessary for such an operation would be an electrical cable for supplying power to the motor from a suitable source such as a portable generator.

The pumping mechanism of this application comprises an improvement over the earlier disclosed pumping mechanism, and utilizes, instead of the manually controllable valve for effecting clamping and release, an automatically operable, fluid pressure controlled valve mechanism which permits clamping and release simply by starting and stopping the pump drive motor.

As seen in Fig. 1, pumping mechanism P includes a housing represented by a broken line box 15 which forms a reservoir for hydraulic fluid, and a pump block 16 suitably secured in the housing 15. The pump block 16 is formed with pumping cylinders illustrated herein as including a cylinder 17 of relatively large diameter and a cylinder 18 of relatively smaller diameter. A piston 19 is slidable in the cylinder 17 and includes a piston rod 20 having a shoe 21 bearing on the outer race of a ball bearing 22 having its inner race mounted on an eccentric portion 23 of a pump shaft 24 suitably mounted in the housing 15 and the pump block 16. The piston 19 is urged toward the inner limit of its intake stroke, illustrated in Fig. 1, by a spring 25 in the cylinder 17, and is forced outwardly through its pumping stroke by means of the eccentric 23 on rotation of the shaft 24.

A piston 27 is slidable in the cylinder 18 and has a piston rod 28 including a shoe 29 bearing on the outer race of a ball bearing 30 having its inner race on an eccentric 31 of the pump shaft 24. As will appear, the piston 27 is urged toward the inner limit of its intake stroke, illustrated in Fig. 1, by intake fluid supplied from the pump 17, 19 and is forced outwardly through its pumping stroke by the eccentric 31 on rotation of the shaft 24.

The pump shaft 24 is suitably connected to the drive shaft of the motor M which is preferably mounted directly on the reservoir-housing 15 to provide a unitary structure substantially as illustrated in application Serial No. 584,955. The motor M is provided with a handle H by which the unit may be conveniently carried, and a suitable switch S is provided for starting and stopping the motor. In application Serial No. 584,955, the pump cylinders 17 and 18 are concentrically disposed, and two such sets of cylinders are provided, located at diametrically opposite positions relative to the pump shaft 24 so that only one eccentric is necessary on the shaft, and it should be understood that the pumping mechanism of this application may comprise a similar arrangement.

Fluid flow in the pump block 16 is through a fluid delivery conduit 35 comprising a series of passages

through the pump block including an intake passage 35*a* opening from the cylinder block into the reservoir 15 and an outlet passage 35*b* leading from the pump block to the valve mechanism V from whence the fluid flows to the load L. A pump conduit 36 leads from the delivery line 35 to the pump cylinder 17 and fluid flows to and from the pump cylinder through this conduit. A ball check intake valve 37 in the delivery line 35 permits flow of fluid to the cylinder 17 on the intake stroke of the piston 19 and prevents return flow to the reservoir. A ball check exhaust valve 38 permits discharge of fluid from the pump cylinder 17 on the pump stroke of the piston 19 and prevents back flow through the delivery line from a conduit 45 leading to valve mechanism V.

A pump conduit 40 leads from the delivery line 35 to the cylinder 18, and fluid flows to and from the cylinder through this conduit. A ball check intake valve 41 in the delivery line admits fluid to the cylinder 18 on the intake stroke of the piston 27 and prevents backflow from pump piston 27 on its effort to direct pressure fluid through check valve 42 and line 35. A ball check exhaust valve 42 in the delivery line permits discharge of fluid from the cylinder 18 on the pump stroke of the piston 27 and prevents backflow from the load L.

A branch conduit 45 leads from the delivery line 35 to a bore 46 in the body of the valve mechanism V. The bore 46 intersects a threaded bore 47 which receives the threaded end portion of a tubular housing 48 of a low pressure relief valve 49. The housing 48 includes a stepped bore 50 which provides a seat for a valve member 51 urged toward a closed position by a spring 52 abutting the valve member and a threadably adjustable plug 53 in the housing. The housing is provided with a series of radially disposed outlet ports 54 which open from the bore 50 into the reservoir 15 as illustrated at 55. The valve 49 functions as a low pressure relief valve which limits the pressure in the delivery line ahead of the pumping mechanism 18, 27 to a predetermined value which in a typical installation is about 150 p.s.i.

A branch conduit 57 leads from the delivery line 35 to a high pressure relief valve 58 which may be mounted on the pump block 16 and comprise a structure similar to that illustrated at 49 for limiting the pressure created in the delivery line by the pumping mechanism 18, 27 to a predetermined value of about 10,000 p.s.i., for example.

The pumping mechanism and the load thus far described are substantially the same as those disclosed in application Serial No. 584,955, and function in substantially the same manner. In operation, when the motor M is started, the shaft 24 rotates and the pistons 19 and 27 reciprocate. On the intake stroke of the piston 19 fluid is drawn into the cylinder 17 through intake valve 37, and on the exhaust stroke of the piston fluid is pumped out of the cylinder 17 through exhaust valve 38. Fluid pressure created by the piston 19 causes the piston 27 to move through an intake stroke, drawing fluid into the cylinder 18 past the intake valve 41 which is pumped out through the exhaust valve 42 on the discharge stroke of the piston 27. As the work piston 11 moves through its work stroke, toward a clamping position the resistance offered by the load will be relatively low, and as long as the pressure in the delivery line caused by the load resistance is less than the pressure for which the low pressure relief valve 49 is set, the fluid pumped by the piston 19 will have sufficient pressure to unseat the valves 41 and 42, and a relatively large volume of low pressure fluid will be delivered to the load cylinder 10. At the end of the stroke of the work piston 11, when the clamping dies engage the member to be clamped, the pressure in the delivery line automatically increases to a relatively high value which soon exceeds the setting of the relief valve 49. When this occurs, the intake valve 41 for the small cylinder 18 will remain closed during the work stroke of the piston 19, and only the output of the small piston 27 will pass to the load, the large piston 19 merely providing a charge of fluid under pressure for the small piston 27 which delivers a low volume of high pressure fluid to the load. So long as the motor M is running, the pumping mechanism will automatically deliver a sufficient volume of high pressure fluid to hold the work piston 11 at the end of its stroke, with the high pressure relief valve 58 functioning to bypass excess fluid to the reservoir 15.

According to the present invention, the valve mechanism V functions automatically to effect clamping movement of the piston 11 whenever the motor M is started, and to automatically relieve the pressure in the delivery line and thereby release the piston for return movement whenever the motor M is stopped. This valve mechanism comprises a valve block or body 60 which is attachable directly to the pump block 16 or a pump block such as that illustrated in application Serial No. 584,955 by means including a locating pin 61 (Figs. 2 and 3) projecting from the block 60 and engageable with a suitable recess in the pump block, and bolts 62 which pass through the valve body and into the pump block. The valve mechanism is thus mounted in the reservoir 15, as is the pump block.

The valve body 60 is formed with a series of passages providing a continuation of the delivery line 35, including an inlet passage 63 leading from the exterior of the valve body and adapted to register with the end portion 35*b* of the delivery conduit in the pump block. The inlet passage 63 intersects a transversely extending passage 64 leading to an outlet passage 65 adapted to have a conduit 66 connected therewith and to the work cylinder 10. The passages 63, 64 and 65 and the conduit 66 constitute a continuation of the delivery line 35 through which fluid flows from the pumping mechanisms to the load.

The transverse passage 64 also leads to a hollow portion 68 of the valve body which is open to the reservoir formed by housing 15. At the end of the passage 64 a seat is formed for a ball valve 69 which is movable relative to the valve seat between valve open and valve closed positions. A valve-operating lever 71 has a midportion pivoted at 72 on the valve body and an adjacent portion which engages the ball 69 to control the valve. A spring 73 seated in a recess 74 in the valve body normally biases the lever 71 to a valve open position.

The valve operating lever 71 is movable toward a valve closed position by means of a fluid operable piston and cylinder device including a piston 76 slidable in a cylinder 77 formed in the valve body. The piston includes a rod portion 78 which engages the lever 71 at one end of the cylinder which is open to the hollowed portion 68 of the valve body and thus open to drain. The opposite end of the cylinder 77 communicates with the inlet 46 to the valve body which in turn connects with branch conduit 45 leading from the pump block. Thus, it will be seen that pressure fluid pumped into the delivery conduit by the pumping mechanism 17, 19 is delivered to the cylinder 77 for effecting movement of the piston and valve operating lever toward valve closed position. This operation occurs simply by starting the pump drive motor M, whereupon the valve 69 is closed to permit a build up of pressure in the delivery line.

On stopping the pump drive motor M, fluid leaks past the piston 76 at a slow rate, allowing return of the piston and the operating lever 71 to valve open positions under urge of the spring 73. However, unless special measures are taken, this return movement occurs quite slowly rather than immediately allowing the valve 69 to open and release the piston 11. Accordingly a control valve mechanism is provided in the piston 76 and includes a passage 80, 81 through the piston, connecting opposite ends of the cylinder, and a ball valve member 82 urged toward open position by coil spring 83 and adapted to

seat at the juncture of the passage portions **80** and **81**. The ball **82** is retained in the passage **80** by a pin **84** extending transversely through the piston **76**.

In a typical embodiment, the passage **81** has a diameter of 7/32 inch, the ball **82** a diameter of 9/32 inch with a clearance of 1/64 inch between the ball and the wall of the passage **80**. Thus, when the pump drive motor is started, the rush of fluid into the passage **80**, **81** moves the ball **82** to a valve closed position against the urge of spring **83** and immediately traps fluid in the cylinder to thereby move the piston and operating lever toward valve closed positions. On stopping the drive motor M, the leakage of fluid past the piston **76**, while occurring at a relatively slow rate, will almost immediately allow the spring **83** to move the ball **82** to a valve open position, thereby relieving the pressure of fluid in the cylinder and allowing an immediate return of the piston and valve operating lever toward valve open positions under the urge of spring **73**. The ball **69** is thereby freed for movement to a valve open position to immediately relieve the pressure in the delivery line and allow return of the work piston **11**.

It is believed the operation of the system described will be clear from the description already given.

I claim:

1. A control valve having an inlet connectable to a fluid supply line and an outlet connectable to drain, a control valve operating member movable between valve open and valve closed positions, a fluid operable piston for moving the valve operating member to valve closed position, a cylinder slidably housing the piston and having one end connectable to drain, a conduit for conducting fluid under pressure to the opposite end of the cylinder, a passage connecting opposite ends of the cylinder, an auxiliary control valve in the passage, a spring urging the auxiliary valve to open toward said opposite end of the cylinder, said auxiliary valve being closable by pressure fluid in said conduit to trap fluid in the cylinder for moving the piston and valve operating member to closed positions, thereby to permit the supply of pressure fluid to move and hold the load, said spring being operable to open the auxiliary valve as fluid leaks past the piston after supply of fluid to the cylinder is stopped, thereby to relieve the pressure in the cylinder, and spring means operable to move said control valve operating member to valve open position when pressure is relieved in the cylinder.

2. A fluid pumping mechanism for a fluid operable load to be moved, held and released, comprising, a fluid delivery line for conducting fluid under pressure to the load, a high volume, low pressure pumping device for supplying fluid to the delivery line to move the load, a low volume, high pressure pumping device for supplying fluid to the delivery line to hold the load, a single prime mover for driving both pumping devices, a first check valve in the delivery line between the two devices preventing flow of fluid backwardly from the high pressure device to the low pressure device, a second check valve in the delivery line between the high pressure device and the load for preventing backflow from the load to the devices, the delivery line being open between the second check valve and the load, a control valve having an inlet connected to the delivery line downstream from the second check valve and an outlet connected to drain, a control valve operating member movable between valve open and valve closed postion, a fluid operable device for moving the valve operating member to valve closed position, a conduit for conducting fluid from the delivery line between the two jumping devices to the fluid operable device to cause movement of the valve operating member to valve closed position when the prime mover is started, thereby to close the control valve and permit supply of pressure fluid to move and hold the load, and spring means for moving the valve operating member to valve open position when the pump is stopped, thereby to relieve the pressure in the delivery line and release the load.

3. In a fluid system having a fluid operable work piston to be moved through a work stroke, held at the end of the stroke, and released, a fluid reservoir, a fluid delivery line for conducting fluid from the reservoir to the work piston, a prime mover, a first piston pumping mechanism driven by the prime mover and connected to the delivery line for pumping a high volume of low pressure fluid to move the work piston through a work stroke, a second piston pumping mechanism driven by the prime mover and connected to the delivery line intermediate the first mechanism and the work piston for automatically pumping a low volume of high pressure fluid to hold the work piston at the end of the work stroke, a first check valve in the delivery line preventing backflow of fluid from the high pressure mechanism to the low pressure mechanism, and a second check valve in the delivery line between the second pumping mechanism and the work piston for preventing backflow of fluid from the work piston to the second mechanism, the delivery line being unobstructed between the second mechanism and the work piston, the improvement comprising, a control valve having an inlet connected to the delivery line between the work piston and the second pumping mechanism and an outlet connected to drain, a control valve operating member movable between valve open and valve closed positions, a fluid operable control piston for moving the valve operating member to valve closed position, a cylinder slidably housing the piston and having one end connected to drain, a conduit for conducting fluid under pressure from the delivery line intermediate the two pumping mechanisms to the opposite end of the cylinder, a passage connecting opposite ends of the cylinder, an auxiliary control valve in the passage, a spring urging the auxiliary valve to open toward said opposite end of the cylinder, said auxiliary valve being closable by pressure fluid when the pump is started to trap fluid in the cylinder for moving the control piston and valve operating member to valve closed positions, said spring being operable to open the auxiliary valve as fluid leaks past the control piston after the pump is stopped, thereby to relieve the pressure in the cylinder, and spring means operable to move said control valve operating member to valve open position when pressure is relieved in the cylinder.

4. A control valve mechanism comprising, a valve body having a valve seat, a valve inlet passage leading to the seat and a valve outlet passage from the seat, a valve member movable relative to the seat between valve open and valve closed positions, a valve operating lever pivoted on the valve body, acting on the valve member and movable between valve open and valve closed positions, a cylinder formed in the valve body, a piston slidable in the cylinder connected to the lever for positively pivoting the lever to valve closed position, a passage in the valve body separate from the valve inlet passage for conducting fluid under pressure to the cylinder to move the piston in a valve closing direction, and a spring acting against the lever and the valve body for moving the lever to a valve open position when pressure in the cylinder is relieved by leakage of fluid past the piston in the cylinder.

5. A control valve mechanism, comprising, a valve body having a valve seat, a valve inlet passage leading to the seat and a valve outlet passage from the seat, a valve member movable relative to the seat between valve open and valve closed positions, a valve operating lever having a midportion pivoted on the valve body and a portion acting on the valve member and movable between valve open and valve closed positions, a cylinder in the valve body having one end open to drain, a piston slidable in the cylinder and engaging one end of the lever to pivot the lever to valve closed position, a passage in the valve body for conducting fluid under pressure to the opposite end of the cylinder, a passage through the piston

connecting opposite ends of the cylinder, a control valve in the piston passage, a spring urging the control valve to open toward said opposite end of the cylinder, said control valve being closable by pressure fluid admitted to the cylinder to trap the fluid in the cylinder for moving the piston and lever to valve closed positions, said spring being operable to open the control valve as fluid leaks past the piston when supply of fluid to the cylinder is stopped, thereby to relieve the pressure in the cylinder, and spring means acting against the valve body and the opposite end of the lever to move the lever to valve open position when the pressure in the cylinder is relieved.

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