

March 26, 1946.

C. F. WARREN ET AL
PUMP UNIT FOR IMPACT TOOL

2,397,174

Filed May 13, 1942

4 Sheets-Sheet 1

Fig. 1.

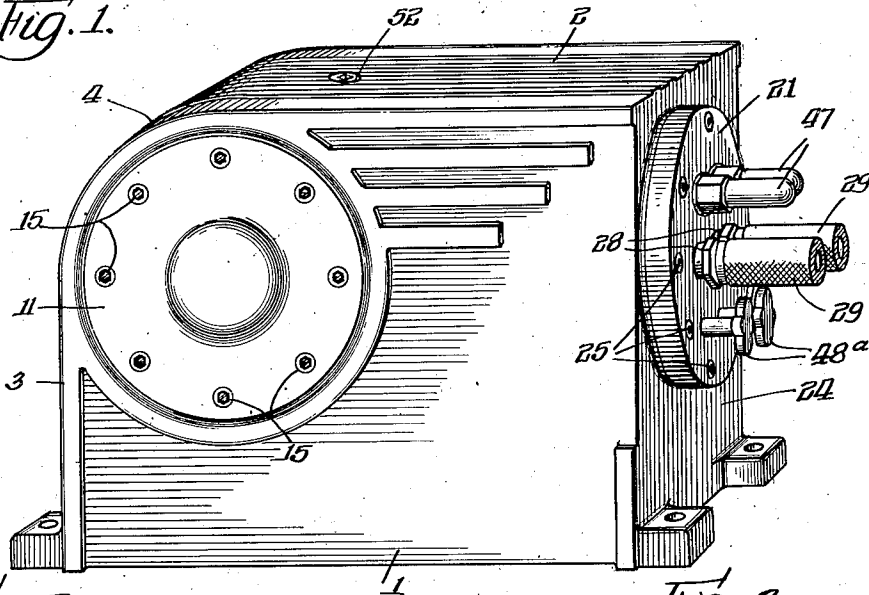


Fig. 2.

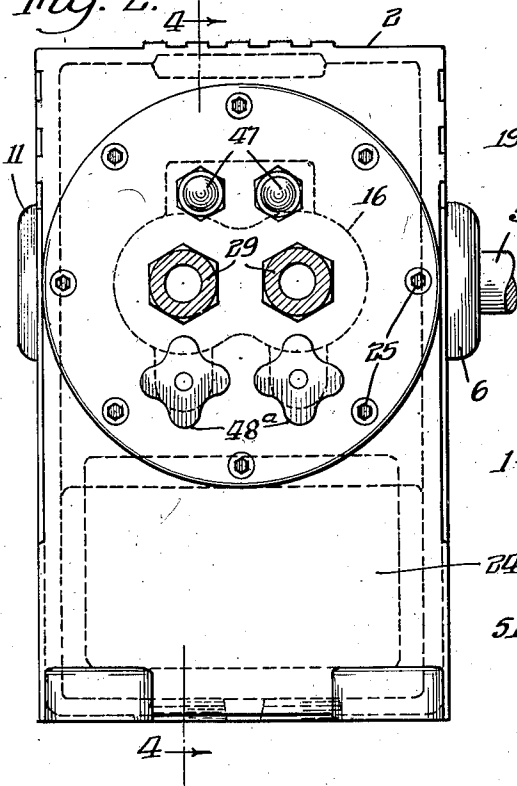
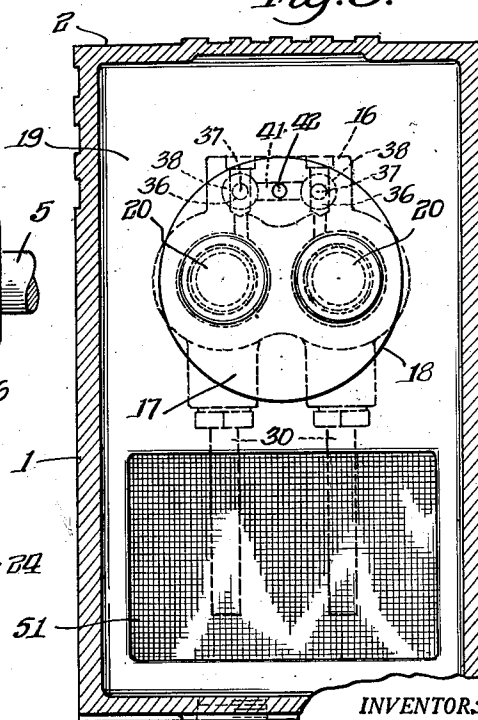


Fig. 3.



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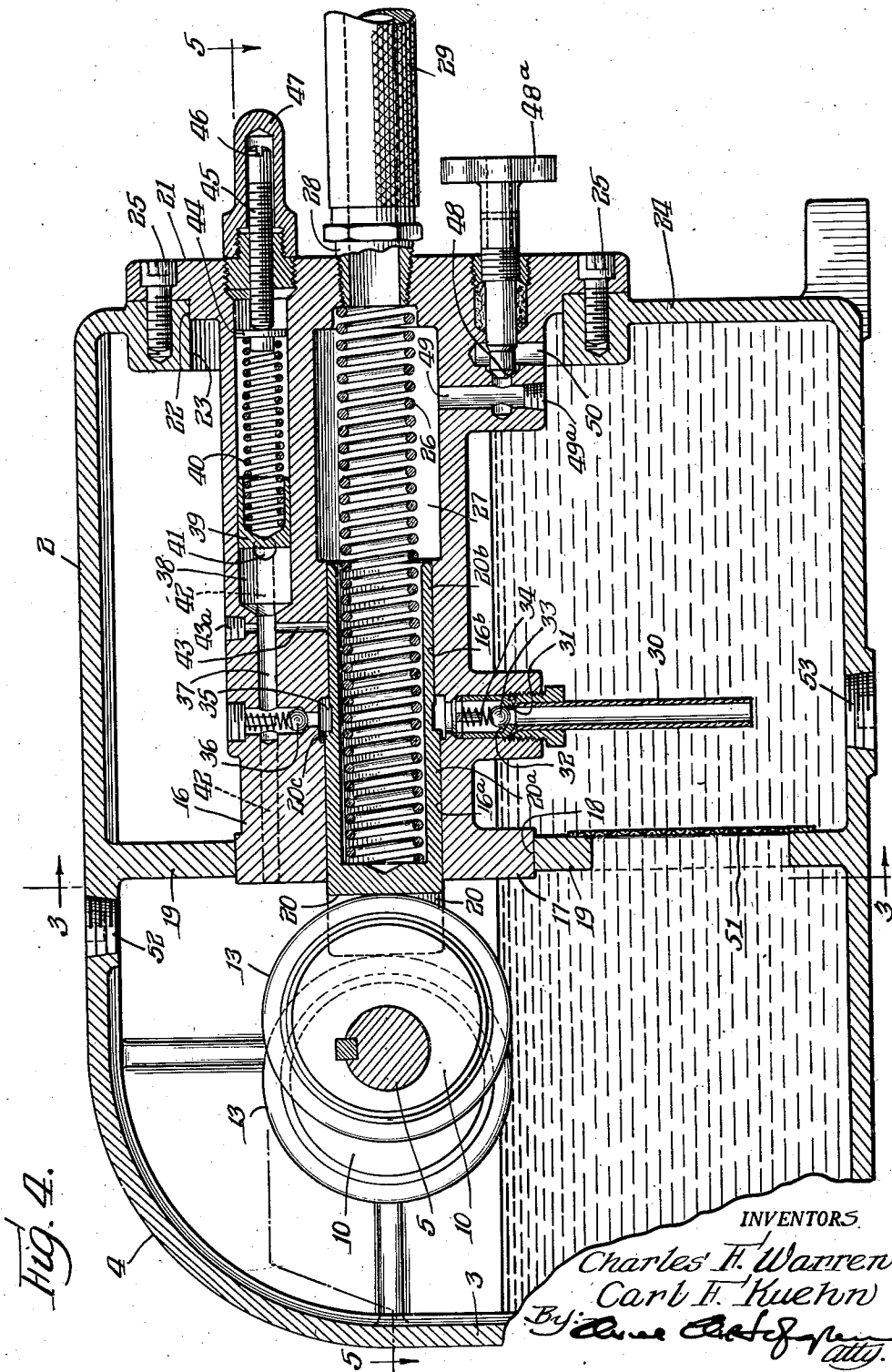
C. F. WARREN ET AL

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4 Sheets-Sheet 2



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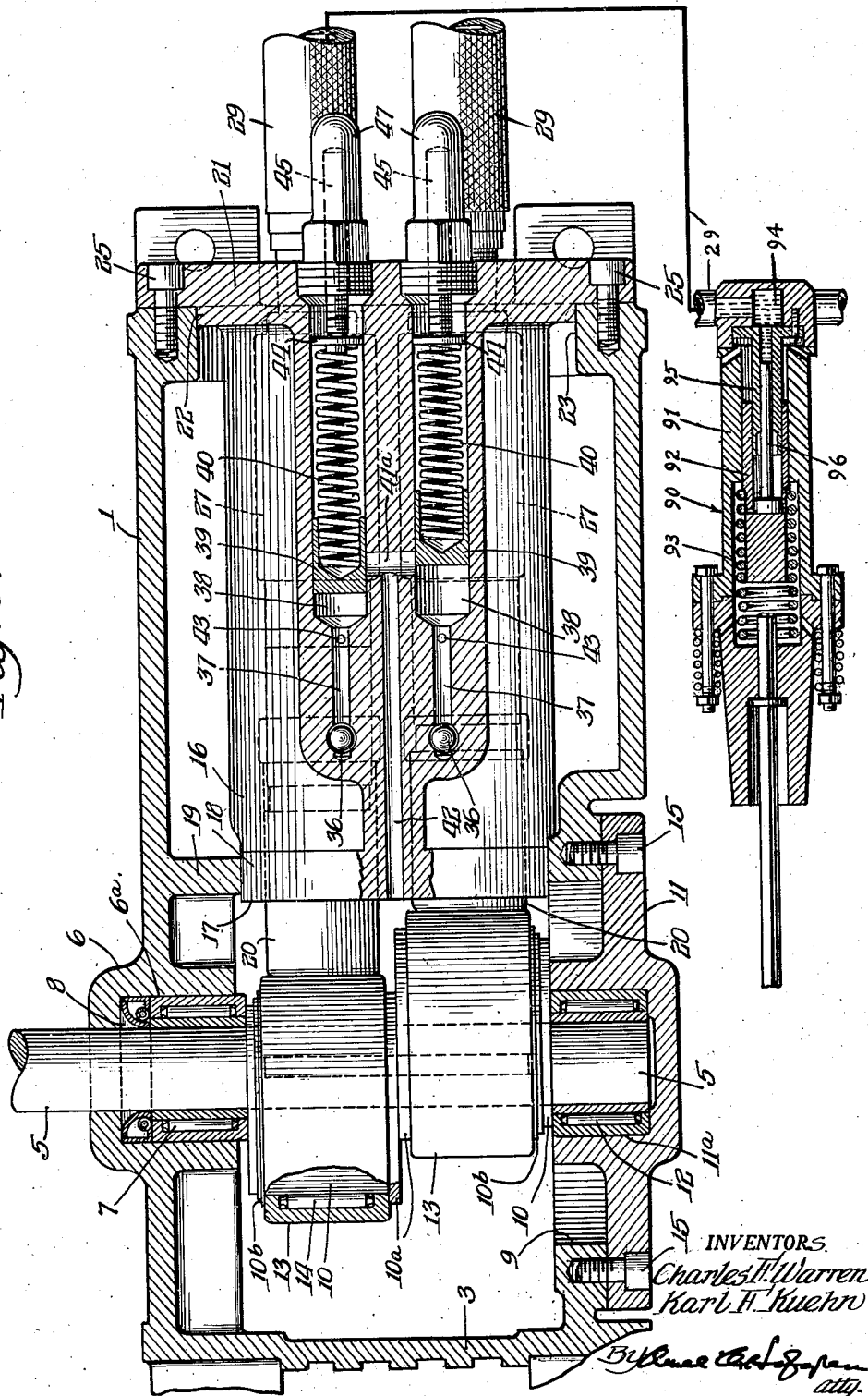
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4 Sheets-Sheet 3

Fig. 5.



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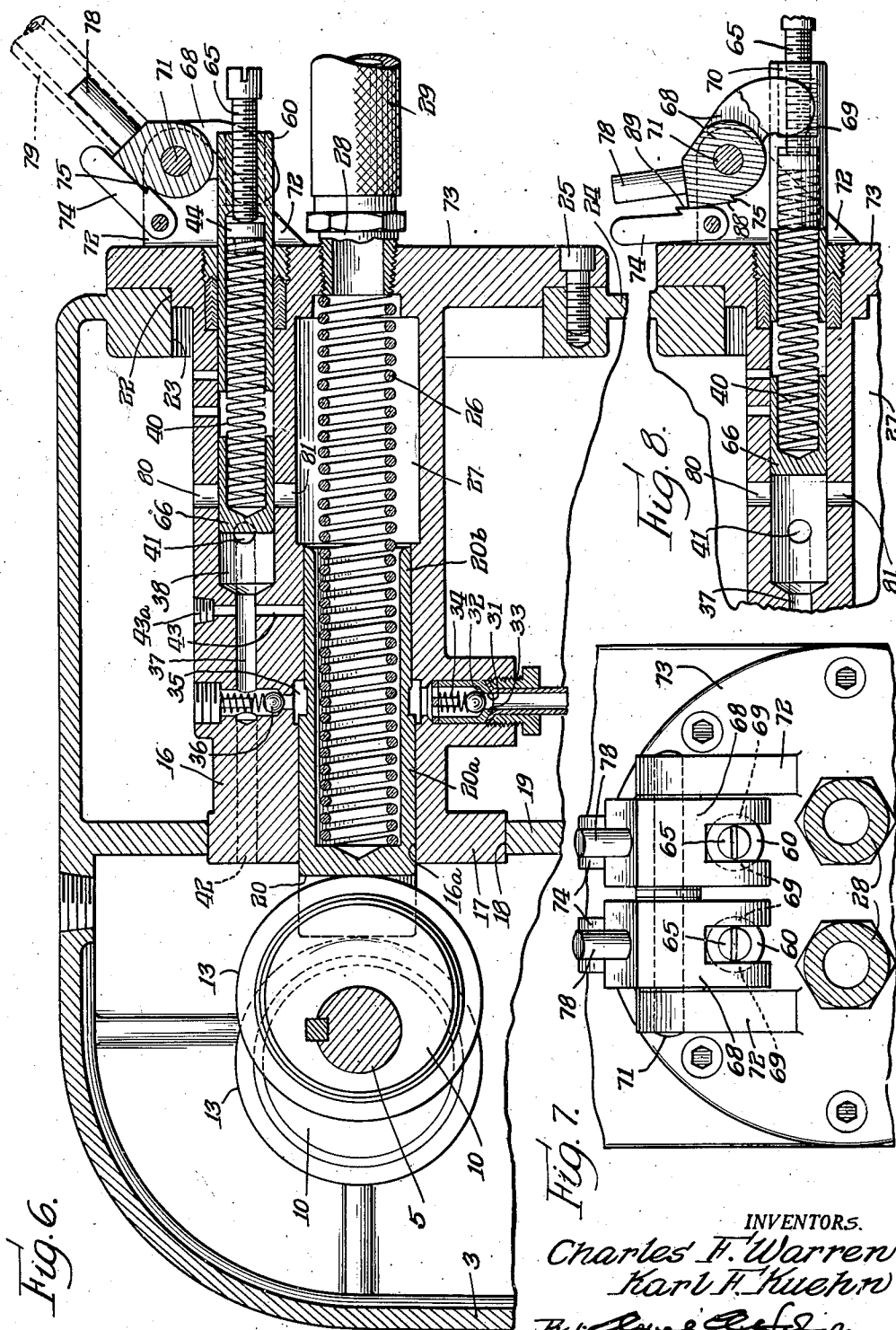
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PUMP UNIT FOR IMPACT TOOL

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,397,174

PUMP UNIT FOR IMPACT TOOL

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Application May 13, 1942, Serial No. 442,730

6 Claims. (Cl. 60—54.5)

This invention relates to improvements in power tools of the impact operated type, and it is particularly concerned with the pump or impact producing unit of such a tool. The objects of the invention include:

First, to provide a new and improved hydraulically actuated impact tool system.

Second, to provide a pump unit for hydraulically actuated impact tools which shall be relatively simple and economical to manufacture and to repair.

Third, to provide a pumping device comprising three principal parts, namely, a housing which serves also as a reservoir for fluid, a pump assembly supported in the housing and removable as a unit therefrom, and a drive shaft with its operating eccentrics and bearings also removable as a unit from the housing.

Fourth, to provide a pump having a compound piston which operates simultaneously as an impact producing element and as a make-up pump to maintain the impact transmitting column of fluid at all times.

Fifth, to provide a pressure regulator which is included in the pump assembly within the housing and which cooperates with the make-up pump to keep the hydraulic column under a predetermined initial pressure.

Sixth, to provide a pumping device for a hydraulic transmission system which employs a column of liquid under pressure and a pressure regulator having a spring-pressed piston operable to maintain liquid under a predetermined pressure, and to provide a drain port for the liquid column controlled and normally covered by such piston, and means for shifting the piston at will to a position at which it uncovers the drain port for dissipating the hydraulic pressure of the column, rendering it temporarily ineffective for transmission purposes.

Other objects and advantages will appear from the following specification taken in connection with the accompanying drawings, in which:

Fig. 1 is a perspective view of a pump unit embodying this invention.

Fig. 2 is an end elevation of the pump unit.

Fig. 3 is a vertical sectional view taken substantially as indicated at line 3—3 on Fig. 4 to clarify certain details of construction.

Fig. 4 is a vertical section taken substantially as indicated at line 4—4 on Fig. 2, and on a larger scale.

Fig. 5 is a plan section taken as indicated at line 5—5 on Fig. 4 together with a diagrammatic

illustration of an implement connected to the pump unit.

Fig. 6 is a partial vertical sectional view similar to Fig. 4, but showing a modified construction.

Fig. 7 is a partial end elevation taken as indicated at line 7—7 on Fig. 6.

Fig. 8 is a detail section at the same plane as Fig. 6, showing the pressure regulator piston in released position for draining the hydraulic column.

While the invention is susceptible of various modifications and alternative constructions, the embodiments shown in the drawings and described hereinafter are by way of preferred illustration only, and it is not intended that the invention be limited thereto or thereby, but it is the intention to cover all modifications and alternative constructions falling within the scope of the invention as defined by the claims.

Impact driven tools of the character to which this invention relates are in the nature of hammers, drills and tampers, which are similar in function to corresponding pneumatically driven tools. However, such tools of the pneumatic type require the provision of an air compressor unit accompanied by an internal combustion motor or other prime mover of substantial power, whereas the combination of an impact pump and an impact driven tool directly connected to the pump by means of a hose line, which confines a continuous column of fluid extending from the pump to the tool, constitutes a much more efficient mechanism which employs only a fraction of the power for driving the pump and thus operating the tool. The pump unit which is the subject of this invention is intended for use in such a combination, although it should be understood that it may serve to operate hydraulically driven motor devices in a wide range of mechanisms. It is of the same general character as the pumps shown in the copending application of Charles F. Warren, Serial No. 377,271, filed February 3, 1941, and in Patent No. 2,260,268, issued to Charles F. Warren and William R. Smith, dated October 21, 1941, and it is intended for use in combination with impact driven tools and other mechanisms similar to those described in said application and patent.

The operating elements of the pumping unit are mounted in the housing 1 which serves also as a reservoir for the hydraulic fluid and which is seen in Fig. 1 as of substantially rectangular form except that the top wall 2 and one end wall 3 are connected by a curved portion 4 substantially concentric with the axis of the drive shaft 5. This shaft extends through a hollow boss 6

in one side wall of the housing, and the boss 6 provides a pocket or recess 6^a which seats the roller bearing 7 for the shaft together with a packing element 8. A circular opening 9 in the opposite side wall of the housing is large enough to permit insertion or withdrawal of the shaft 5 with its driving eccentrics 10, 10 together with the bearing assembly 7; and this opening 9 is closed by a cover plate 11, which includes an inwardly open pocket or recess 11^a to support a roller bearing 12 for the inner end of the shaft 5. Each of the eccentrics 10 carries a ring 13 confined between a flange 10^a and a retainer ring 10^b with interposed bearing rollers, 14, so that the eccentric may turn freely within the ring 13. Thus in the process of assembly, the shaft 5, with its bearings 7 and 12 in place and with its eccentrics 13 fitted with their rings 14, may be inserted as a unit through the opening 9, and its mounting in the housing will be completed by application of the cover plate 11 and securement thereof by means of fastening screws 15. It may be understood, that the projecting end of the shaft 5 will be fitted with any suitable pulley or gear for operative connection with a prime mover such as an electric motor or internal combustion engine.

The pumping unit proper is contained in a casting 16 having a circular inner end portion 17 which fits snugly into a circular opening 18 in a diaphragm or partition wall 19 extending across the housing 1, as seen in Figs. 3 and 4. This provides support for the inner end of the casting 16 and locates the closed ends of the pistons 20, 20 in operative relation to the rings 13 on the driving eccentrics 10, 10. At its outer end the pump casting 16 is formed with a flange 21 having a circular shoulder 22 which fits into a circular opening 23 in the end wall 24 of the housing 1. The pumping unit is secured in place by screws 25 extending through said flange 21 into the end wall 24 adjacent its opening 23. Thus the insertion of the unit 16, with the pistons 20 and other operative parts already assembled in it, completes the assembly of the pumping device.

Each of the pistons 20 is hollow and open at one end to accommodate a spring 26 which reacts against the end wall of a chamber 27 formed in the casting 16; and each piston includes a larger portion 20^a and a slightly smaller portion 20^b, the casting 16 being formed with corresponding bores 16^a and 16^b in which these portions of the piston reciprocate respectively. The bore 16^b communicates directly with the chamber 27, and said chamber terminates in a threaded opening into which the terminal 28 of the flexible hose 29 is secured, as seen in Fig. 4. Thus, when the hollow piston 20 and chamber 27 and hose line 29 are filled with fluid the reciprocatory movements of the piston are transmitted longitudinally by the column of fluid to a tool or other apparatus with which the hose 29 is connected as shown somewhat diagrammatically in Fig. 5.

In Fig. 5 there is illustrated an implement 90 of the type disclosed in said co-pending application of Charles E. Warren, Serial No. 377,271. This implement consists generally of a barrel 91 with a striking plunger 92 reciprocably mounted therein and having its movement in one direction opposed by a coil spring 93. The conduit 29 communicates with a chamber 94 in one end of the barrel, this chamber in turn communicating with a cylinder 95 in which a conduit terminal or closure 96, in the form of a piston, reciprocates. The conduit 29 is normally provided with sufficient fluid to initially compress the spring 93 to

an extent sufficient to place the fluid column under a predetermined static or normal pressure. It is to be understood, as disclosed in said co-pending application and said Warren and Smith patent, that the column of liquid in the conduit 29 reciprocates as a rigid body when the corresponding piston 20 is reciprocated, the liquid column being moved in one direction by the impact produced by the piston 20 and being moved in a return direction by the coil spring 93.

The lower portion of the housing 1 serves as a reservoir for the fluid which will be maintained always at a level considerably above the lower end of the supply pipe 30 which depends from the pump casting 16 and is secured therein by a gland 31 which also supports the valve seat 32 for a ball check valve 33 normally seated by its spring 34. The check valve 33 controls access to an annular passage 35 formed in the casting 16 at the junction of the bores 16^a and 16^b. The shoulder 20^c of the piston 20 which defines the outer end of the larger portion 20^a operates as a secondary piston head as said larger portion 20^a of the piston reciprocates in the bore 16^a. As the piston moves toward the axis of the shaft 5, the suction or partial vacuum operating in the annular passage 35 lifts the check valve 33 from its seat and tends to draw liquid through the supply pipe 30 into the passage 35 and into the bore 16^a adjacent the shoulder 20^c of the piston. Then, upon the return stroke of the piston, the shoulder 20^c forces the fluid past a second check valve 36 and through a passage 37 which leads into the regulator chamber 38. This chamber is provided with a movable wall or piston 39 backed up by a spring 40 for maintaining the liquid under a definite pressure at all times. When the pressure in the chamber 38 is sufficient to force the piston 39 back to a point at which it uncovers a relief port 41 in the wall of the chamber 38, any excess of liquid thereafter supplied by the pumping action of the secondary piston 20^c will escape through the port 41 and through the connected passage 42 which discharges the fluid, preferably oil, directly onto the eccentric rings 13 so that it serves for lubricating them and the ends of the pistons 20. Eventually the oil returns by gravity to the lower portion of the housing 1, which acts as a reservoir therefor.

With a quantity of fluid thus held in the chamber 38 under pressure supplied by the spring 40, the operating column of liquid extending from the piston 20 through the chamber 27 and hose 29 is maintained at all times and any loss of fluid therein is replenished by way of an injector duct 43 which connects with the passage 37 and opens into the smaller bore 16^b at a terminal port which will be uncovered when the smaller portion 20^b of the piston arrives at the limit of its retreating or idle stroke, that is, at the opposite limit of its movement from that at which it is shown in Figure 4. Thus, for a brief interval during each reciprocation of the piston 20, the bore 16^b and the chamber 27 are placed in communication with the pressure regulating chamber 38 by way of the duct 43. If the loss of fluid in the operating line is not wholly replaced by a single injection of fluid from the chamber 38 through this duct 43, it will be quickly made up by the rapidly repeated injections which will occur with each successive piston stroke until the pressure is equalized with that in the chamber 38. The fluid thus transferred from the chamber 38 will be promptly replaced by the action of the secondary piston 20^c drawing liquid from the reserve supply in the lower portion of the housing

1 and transferring it through the passage 37 to the chamber 38. The pressure spring 40 is seated against a flange or button 44 which may be regulated by means of a threaded stud 45 to secure the desired tension in the spring 40 and the resultant pressure upon the liquid at 38, and preferably the slotted end 46 of the stud 45 is enclosed in a removable cap 47 to prevent tampering or accidental change in its adjustment.

To interrupt or terminate the operation of the tool or apparatus which is driven by the impact transmitted through the hose line 29, it is only necessary to open a by-pass valve 48 which permits escape of the liquid from the chamber 27 through a drain passage 49 and its outlet portion 50, thus dissipating the pressure in the hydraulic transmission line and allowing the liquid to be merely pumped around and around a by-pass circuit through the reservoir in the housing 1. A hand wheel 48^a is conveniently accessible outside the end wall 24 of the housing 1 for adjusting the valve 48. The shaft 5 and its eccentrics 10, 10 may continue to operate and reciprocate the pistons 20, 20 so that the transmission of power will be resumed promptly upon closing of the valve 48, a few revolutions of the shaft 5 serving to replenish the oil supply in the chamber 27 by way of the supply pipe 30 and injector duct 43, as already described.

In the construction herein illustrated, with the two eccentrics 10, 10 set 180° apart on the shaft 5, the mechanism is in the nature of a duplex pump with the two pistons 20, 20 operating alternately and thus transmitting separate impulses through the two hose lines 29 which are connected respectively to the two chambers 27. Preferably, each pressure line is provided with its individual regulator chamber 38, but the relief ports 41 for these chambers open into a common passage 41^a through which they communicate with a single discharge passage 42 which is conveniently formed in the casting 16 between the passages 37, as seen in Fig. 5.

The unitary casting 16 in which the pumping mechanism is carried is so designed that all bores and passages can be very conveniently completed by simple drilling and tapping operations. The chambers 27 are cored in the casting and the bores 20^a and 20^b are readily formed by drilling and reaming, if desired. Passages such as those at 43 and 49 are readily drilled and then closed by screw plugs, as shown at 43^a and 49^a; and other finishing operations are equally simple. Preferably, the circular flange 17 and the circular shoulder 22 are coaxial so that they can be finished in a single turning operation and the openings in which they are to fit in the housing 1 can also be finished in a single setting of the machine on which the work is done. Therefore, it is possible to manufacture the pumping unit rapidly and economically, and its installation in the housing 1 is an extremely simple matter, as already described.

In operation it is most convenient to use oil for the impact transmitting medium and to employ the same oil for lubrication of the mechanism; accordingly, the web or partition 19 is formed with an opening in its lower portion which affords communication between the space in the housing directly under the drive shaft 5 and the space extending below the pump cylinder casting 16. Preferably this opening is covered by a screen 51. A screw plug 52 is removable from the top wall above the shaft 5 for adding oil as required. Although the feed tubes 30 and check valve as-

semblies 31, 32, 33, 34 can be originally attached to the cylinder casting 16 and entered with it through the opening 23, it may be desirable to remove these parts occasionally without withdrawing the cylinder units and to facilitate this the bottom wall of the housing is formed with threaded openings directly below the tubes 30, these openings being normally closed by screw plugs 53, as shown in Fig. 4.

Figs. 6, 7 and 8 illustrate a modified construction in which the draining function of the by-pass port 49 and valve 48 is accomplished by a slight change in the structure associated with the pressure regulator. Instead of having the adjusting screw for the pressure spring 40 secured in a threaded bushing which is fixed in the end wall 21 of the cylinder casting 16 (as shown in Fig. 4) the regulator screw 65, shown in Fig. 6, is engaged in the threaded bore of a plug 60 which is in the form of a sleeve so that the abutment disk or button 44 for the spring 40 is carried and guided within it. The sleeve or plug 60 is slidably fitted in the outer end of the regulator cylinder 38 with the spring 40 reacting between the button 44 and the regulator piston 66. Thus the pressure of the spring is transferred to the plug 60. The plug itself is normally locked in position by means of a bifurcated lever 68 having arms which bear against shoulders 69 formed by cutting flats 70 on two sides of the end portion of the plug 60. The lever is fulcrumed at 71 in fixed brackets 72 projecting from the end wall 73 of the cylinder casting which is modified to this extent as compared with the structure shown in Fig. 4. A latch dog 74 engages the shoulder 75 on the lever member 68 to restrain it against rotation about its fulcrum pin 71; thus as long as the latch 74 remains in locking engagement with the lever 68, it holds the plug 60 in position to maintain the regulator spring 40 under compression corresponding to the hydraulic pressure acting against the piston 66. As in the structure of Fig. 4, an increase in the hydraulic pressure forces the piston 66 back against the spring 40 sufficiently to uncover the relief port 41 to prevent the hydraulic pressure exceeding the predetermined value corresponding to the adjustment of the pressure screw 65.

But in addition to the relief port 41, the cylinder casting 16 is provided with a drain port 80 and a supplemental passage 81, both of which are normally covered by the piston 66. If it is desired to interrupt the operation of the tool or device to which the hydraulic conduit is connected by way of the hose 29, the latch 74 is released so as to allow the bifurcated lever 68 to swing outwardly as shown in Fig. 8, thus permitting the hydraulic pressure to force the piston 66 back far enough to uncover the drain port 80 and the supplemental passage 81 which leads directly from the chamber 27. This promptly results in dissipating the pressure in the hydraulic conduit and thus rendering the operation of the pump ineffective for the time being for transmitting impacts through the hydraulic column. Since the pressure of the locking shoulder 75 against the latch dog 74 is rather heavy, and since preferably the engaged faces of these parts are slightly undercut to prevent the dog from jarring out of locking position in response to vibration of the mechanism, the lever 68 is provided with an arm 78 to which a handle sleeve may be applied as indicated at 79 for relieving pressure on the latch 74 so that it may be readily disengaged when the plug 60 is to be released for opening

the drain port 20 as described. It may be noted that the outward swing of the arms 68 is limited by encounter of a flat face 83 of the lever with the flat side 89 of the latch dog 74, as shown in Fig. 8; and that at this limit of their outward swing the arms of the lever remain in contact with the shoulders 69 of the plug 60 so as to prevent escape of the latter from the end of the cylinder 38.

We claim as our invention:

1. In a hydraulic impact-transmitting system which includes a conduit confining a rigid reciprocable column of liquid with a work-delivering piston closing one end of the conduit and spring means backing said piston, an impact-producing unit comprising a housing, a rotary shaft journaled therein and extending outside the housing for connection with a driving means, an impact pump and a make-up pump with piston means for said pumps operatively engaged with said shaft and all contained within said housing, the impact pump constituting the other end of said conduit, the housing containing a supply of liquid, an intake passage in the housing from said supply to the make-up pump, a pressure regulating chamber in the housing, a delivery passage from said make-up pump to said chamber and an injector passage connecting said chamber with the impact pump and closed by the piston thereof except at the end of its return stroke, said housing including means for coupling thereto a pipe in communication with the impact pump therein and constituting a portion of the said conduit, said regulating chamber comprising a cylinder disposed within the housing with a piston in said cylinder constituting a movable wall thereof, said yielding means comprising a spring reacting against the piston, a plug slidably disposed in said cylinder engaging one end of the spring and normally holding it compressed against the piston to maintain a predetermined hydraulic pressure in the system, a drain passage for the conduit extending to said cylinder, said passage opening directly into the housing and being normally closed by the regulator piston therein, and locking means holding the plug and piston in such normal position but releasable at will to relieve the spring pressure on the piston, permitting the same to open said drain passage and release the liquid from the conduit through said passage and into the housing, thereby dissipating the pressure of the liquid column.

2. In a hydraulic impact-transmitting system which includes a conduit confining a rigid reciprocable column of liquid with a work-delivering piston closing one end of the conduit and spring means backing said piston, an impact-producing unit comprising a housing, a rotary shaft journaled therein and extending outside the housing for connection with a driving means, an impact pump and a make-up pump with piston means for said pumps operatively engaged with said shaft and all contained within said housing, the impact pump constituting the other end of said conduit, the housing containing a supply of liquid, an intake passage in the housing from said supply to the make-up pump, a pressure regulating chamber in the housing, a delivery passage from said make-up pump to said chamber and an injector passage connecting said chamber with the impact pump and closed by the piston thereof except at the end of its return stroke, said housing including means for coupling thereto a pipe in communication with

the impact pump therein and constituting a portion of the said conduit, said regulating chamber comprising a cylinder disposed within the housing with a piston in said cylinder constituting a movable wall thereof, said yielding means comprising a spring reacting against the piston, a plug slidably disposed in said cylinder engaging one end of the spring and normally holding it compressed against the piston to maintain a predetermined hydraulic pressure in the system, drain passages for the conduit and for the regulating chamber both discharging directly into the housing but normally closed by the regulator piston therein, and locking means holding the plug and piston in normal position but releasable at will to relieve the spring pressure on the piston, allowing said piston to uncover the drain passages and release liquid from the conduit and from the regulator chamber simultaneously into the housing, thereby dissipating the pressure of the liquid column.

3. In a hydraulic impact-transmitting system which includes a conduit confining a rigid, reciprocable column of liquid with a work-delivering piston closing one end of the conduit and spring means backing said piston, an impact-producing pump including a cylinder and a piston therein closing the other end of said conduit, together with a pressure-regulating chamber comprising a cylinder with a piston therein and a spring opposing movement of the piston, in response to the hydraulic pressure, a plug in the regulator cylinder with abutment means engaging one end of the spring normally holding it compressed against the piston to maintain a predetermined hydraulic pressure in the system, a drain passage for the conduit normally closed by said regulator piston, and locking means holding the plug and piston in such normal position but releasable at will to relieve the spring pressure on the piston and permit it to uncover said drain port, thereby dissipating the pressure of the liquid column, said locking means comprising a lever fulcrumed adjacent the outer end of said plug with the arm of the lever bearing against a transverse shoulder of the plug, and a pivoted latch dog releasably restraining the lever against movement about its fulcrum.

4. In the combination defined in claim 3, means limiting the swing of the lever when released to prevent escape of the plug from the regulator cylinder.

5. In a hydraulic impact-transmitting system, a pump comprising a cylinder having a larger bore and an adjacent smaller bore with an annular channel of relatively limited axial extent and of greater diameter than the larger bore formed in the cylinder between the adjacent ends of said bores, a unitary piston having a larger portion fitted in the larger cylinder bore and a smaller portion fitted in the smaller bore, said piston having an annular shoulder defining the end of its larger portion adjacent its smaller portion, means engaging the opposite end of said larger portion to reciprocate the piston, intake and delivery passages communicating with said annular channel with check valves controlling said passages, a hydraulic transmission conduit in direct communication with the smaller bore, the said intake passage leading from a supply of liquid and the delivery passage furnishing liquid to said conduit with the annular shoulder of the piston reciprocating in said larger bore toward and from the annular channel and thus function-

ing as a make-up pump when the piston is reciprocated.

6. In a hydraulic impact-transmitting system, a pump comprising a cylinder having a larger bore and an adjacent smaller bore with an annular channel of relatively limited axial extent and of greater diameter than the larger bore formed in the cylinder between the adjacent ends of said bores, a unitary piston having a larger portion fitted in the larger cylinder bore and a smaller portion fitted in the smaller bore, said piston having an annular shoulder defining the end of its larger portion adjacent its smaller portion, means engaging the opposite end of said larger portion to reciprocate the piston, intake and delivery

5 passages communicating with said annular channel with check valves controlling said passages, a hydraulic transmission conduit in direct communication with the smaller bore, the said intake passage leading from a supply of liquid and the delivery passage leading into the smaller bore of the cylinder through a port which is uncovered by the smaller portion of the piston at the commencement of the working stroke of the piston, 10 whereby the annular shoulder of the piston then acts as a make-up pump to supply liquid to the conduit from said annular channel of the cylinder.

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