F. H. RICHARDS.

FLUID CONTROLLED MECHANISM.

APPLICATION FILED OCT. 22, 1902.

919,465. Patented Apr. 27, 1909.

2 SHEETS—SHEET 1.

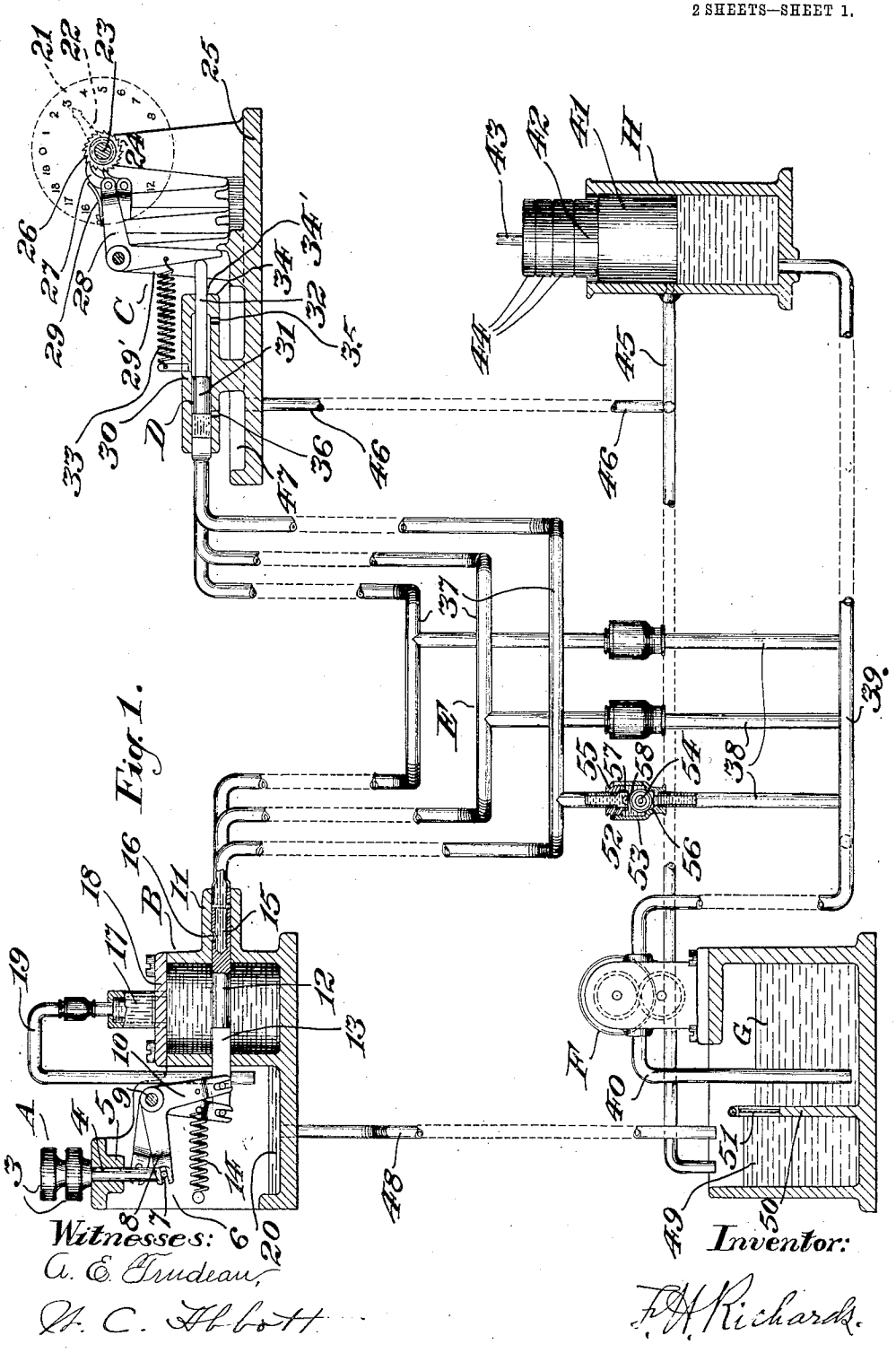


Fig. 1.

Witnesses:
A. E. Trudeau,
H. C. Abbott

Inventor:
F. H. Richards.

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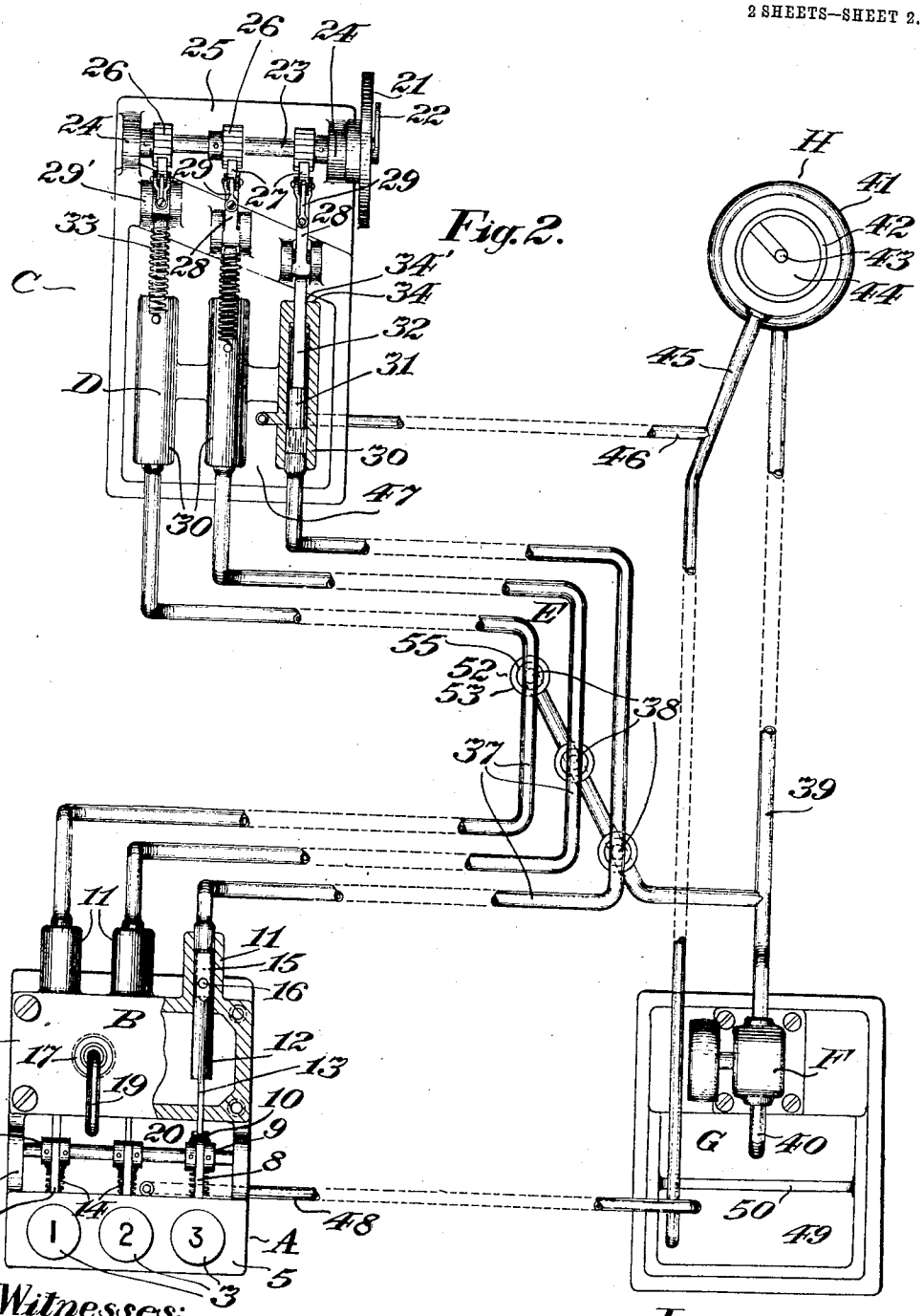


Fig. 2.

Witnesses:

A. E. Trudeau

A. C. Hollett

Inventor:

F. H. Richards.

UNITED STATES PATENT OFFICE.

FRANCIS H. RICHARDS, OF HARTFORD, CONNECTICUT, ASSIGNOR, BY MESNE ASSIGNMENTS, OF ONE-HALF TO AMERICAN TYPOGRAPHIC CORPORATION, A CORPORATION OF NEW JERSEY.

FLUID-CONTROLLED MECHANISM.

No. 919,465. Specification of Letters Patent. Patented April 27, 1909.

Application filed October 22, 1902. Serial No. 128,319.

To all whom it may concern:

Be it known that I, FRANCIS H. RICHARDS, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Fluid-Controlled Mechanisms, of which the following is a specification.

This invention relates to apparatus, or mechanism, in which it is desired to employ a confined volume of fluid for transmitting movements from an actuated device or mechanism to an actuatable device or mechanism, and has for its object to provide improved mechanism whereby such results may be accomplished and the efficiency of the apparatus maintained.

The present invention is in part in the nature of an improvement on the invention illustrated and described in Letters Patent of the United States No. 576,154, granted to me on Feb. 2, 1897, for hydraulic apparatus.

The present improvements relate more especially to means for supplying the apparatus with a constant, and a constantly renewed, supply of fluid. The manner of accomplishing this result is such that the containers for the confined volume of fluid between the actuating and the actuated devices are supplied with fluid independently of the working of the body of fluid in the transmission of the desired movements. This result may be accomplished by introducing the fluid supply at a point intermediate said devices and in controlling the admission of fluid for supplying and also surcharging the container, be this what it may and connected spaces so as not to interfere with the operation of the fluid in the container.

In carrying out my invention means is provided whereby a confined body of fluid has pressure applied to it for actuating a device or mechanism.

The apparatus may be a key controlled one and each of the keys may be in operative connection with some suitable device, such as a plunger or piston capable of taking a predetermined quantity of fluid from a reservoir and forcing it into a container inclosing a body of fluid, which container may be connected with a piston or other suitable pressure-actuated device so constructed that upon the increase of pressure upon the body of fluid incident to its increase in volume it will move the piston or device and impart movement to some portion of the apparatus, and if desired upon the movable part having completed a predetermined length or amount of movement the pressure may be relieved upon the body of fluid, if desired, by conveying such fluid away from the container. The piston or other device may then be returned by any convenient means, and the bevice for adding the fluid to the body may also be returned to its normal or initial position by some convenient means.

Upon each actuation the quantity of fluid, contained in the reservoir from which the measured fluid for the working impulse is taken, may be diminished and such diminishing of the fluid may be compensated for by fluid from some suitable source of supply.

All the several finger-keys may be operative upon pistons drawing their supply of fluid from the same reservoir, but each piston operative upon fluid contained in its individual container, which fluid will be operative upon its individual part of the apparatus. All the containers may be connected with a single pump drawing from a suitable source of supply and forcing the fluid into a main line to which all the containers may be connected. The main line may also be connected with a storage device. The overflow from all the parts may be connected with the supply for the pump.

In the drawings accompanying and forming part of this specification, Figure 1 is a diagrammatic view illustrating a form of apparatus embodying my invention, some of the various parts being shown in vertical section, and Fig. 2 is a plan view thereof showing some of the parts in horizontal section and also arranged diagrammatically.

A designates in a general way a key-board wherein three keys 3 are shown, this number being employed in the present instance for the purpose of illustrating the invention, although it will be apparent that any number may be employed in practice. The keys are shown as provided with depending stems 4 passing through openings in a bar 5 secured to suitable framework 6. The key-stems are each shown as provided on the lower end with a pin 7 engaging a slot in one arm 8 of a bell-crank-lever pivoted at 9 upon the framework and having a slot in the other arm 10

Mounted contiguous to the keys is a reservoir, designated in a general way by B and in the present instance shown as rising from the base of the same frame to which the side members 6 are attached. Upon the opposite side of the reservoir from the bell-crank-levers are shown a series of cylinders 11 in each of which is mounted a piston 12 having a portion passing through or into the reservoir and an end or stem 13 passing through the side wall thereof and provided with a pin engaging the slot in the lower end of one of the bell-crank-levers. It will be seen that the cylinders 11 open into the reservoir B at a point below the top of this, which is to enable the piston to get a solid charge of fluid to force into the container, fluid which is not rendered elastic by presence of air bubbles which might be the case in certain forms of the device. Suitable means, here shown as springs 14, may be employed for returning the bell-cranks and the keys to their normal positions.

The working end of the piston is shown as comprising an open-ended hollow cylinder 15 having an entrance opening or port 16 capable of communicating with the interior of the reservoir. A suitable overflow may be provided for the reservoir, which in the present instance is illustrated as comprising a dome or bell 17 rising from the cover 18 and having an overflow pipe 19 leading from the same, which is shown as emptying in a tray 20 provided upon the base of the framework.

The actuated device, represented in a general way by C, which in the present instance for the purpose of illustrating a practicable employment for my invention comprises an adding machine embracing a stationary dial 21 and a movable index-finger 22, the finger in the present instance being carried by a shaft 23 mounted in suitable bearings 24 rising from a base frame 25 and a number of ratchet-wheels 26 mounted upon the shaft corresponding in number to the number of keys employed, to wit, in the present instance three.

Each ratchet-wheel is illustrated as having as many teeth as there are characters upon the dial. Each ratchet-wheel is capable of being moved forward by means of a pawl 27 carried upon the end of a bell-crank-lever 28, and spring pressed if desired, by a suitable spring 29. The bell-crank-levers are shown as mounted upon suitable bearings 29′ rising from the base of the frame. The bearings for the several bell-cranks are shown as mounted in a line at an angle to the axis of the shaft and each one is provided with an upper arm of a length different from the length of the upper arms of the other bell cranks whereby the shaft will be moved forward a different distance upon the same amount of movement of the lower arm of the bell-crank.

In the present instance the organization is supposed to represent that pressure on the key bearing the character one will move the shaft forward one tooth or step and the actuation of the key bearing the character three will move the shaft forward three teeth or steps, thus indicating upon the dial, by the advance of the indicator, the number of points corresponding with the number borne by the finger-key which has been depressed.

For moving each bell-crank-lever a suitable piston-chamber, designated in a general way by D, may be employed, which in the present instance comprises a cylinder 30 connected with a suitable base, which in the present instance is shown as the same base which carries the actuated device C. Each cylinder is shown as provided with a suitable piston 31 adapted to reciprocate in the cylinder, from which piston projects a stem 32 adapted to engage the lower end of its bell-crank and upon reciprocation in one direction to move the ratchet-wheel engaged by its pawl forward and upon the return to allow the pawl to ride over the ratchet-wheel when it is being returned by some suitable device, in the present instance shown as a spring 33. The forward end 34 of the cylinder in the present instance is shown as closed and having an opening 34′ forming a bearing and support for the stem 32. Each end of the cylinder 30 is provided with a vent. The vent 35 in front of the piston is quite near the bearing for the stem, and the vent 36 behind the piston is located in such a position that it will be uncovered by the piston when the same has reached the end of its working stroke. The vents are at each side of the space occupied by the piston at the completion of its working stroke, the vent 35 is for the purpose of admitting the free passage of air and for the overflow from any regitation, and the vent 36 for permitting the overflow of fluid from the cylinder to the end that the pressure upon the piston may be relieved and it be returned to its normal position.

Conduits, designated in a general way by E, and in the present instance comprising tubes 37 may be employed to communicate the movement from the selector and its piston to the selected actuated device, and each conduit is shown as entering the ends of a cylinder from each of the respective series and as bent downward and then sidewise. The conduit and cylinders constituting a fluid container and the increment of volume of fluid in the container will actuate the piston controlling the actuated device. Each of the tubes 37 is provided with a service pipe 38. The several service pipes are shown as connected with a main line 39. The main line in the present instance is shown as connected with a pump, designated in a general way by F, and may be of any suitable construction, which pump draws by means of a

suction pipe 40 from a source of supply, designated in a general way by G, and forces the fluid into the tubes 37, which tubes become filled from the piston-chambers 30 to the point where they enter the reservoir B and will upon becoming filled also fill such reservoir.

In some cases it will be desirable to employ a regulator or controlling device for insuring the proper pressure of the fluid supply and also for accommodating the intermittent admission of fluid to the main line from a supply mechanism operating continuously. This regulating device may consist of an accumulator of ordinary and of suitable proportions, and the surplus after filling the various parts of the apparatus may be conveyed along the main line to the accumulator, designated in a general way by H, which in the present instance comprises a cylinder 41 entered at its bottom portion by the main line and provided with a piston 42, here shown as of weighty construction and closely fitting the cylinder. A piston-rod 43 may be attached to the piston and to any suitable counterweight (not shown) for forcing the fluid up the service pipes and into the tubes, provided the drain from the reservoir is greater than the normal action of the pump will supply. Weights 44 may be placed upon the piston to regulate its pressure. A suitable overflow pipe 45 may run from the cylinder 41 to the supply tank G and a drain pipe 46 from a suitable tray 47 may connect therewith to carry off the overflow from the actuating pistons. A suitable overflow tube 48 may run from the tray 20, catching the surplus from the reservoir. The overflow pipes run into a portion 49 of the supply tank, which in the present instance is shown as divided by a partition 50 solid at its lower portion and provided at its upper portion with a screen 51 whereby any dirt or foreign substance carried by the fluid may be permitted to be thrown down or sink by gravity to the bottom and the upper part of the fluid be emptied in a clean condition into the side of the supply tank drawn from by the suction pump.

Each of the service pipes may be provided with suitable means for preventing the pressure of the actuation of one device being communicated to the entire system, which in the present instance are shown as ball-valves 52 comprising casings 53 each secured at its lower end upon the service pipe and at its upper portion connected thereto by a gland 55 and containing a ball 54 seating by gravity or pressure upon the bottom of the chamber, which constitutes a valve seat 56. The valve is provided with a downwardly-projecting flange 57 having an opening 58, so that upon the rise of the ball from its seat it will engage such flange, but the passage of fluid will not be checked thereby owing to the opening in the flange. To prevent lost motion and the smallest amount of loss of pressure the ball or other valve employed may be organized to be efficient upon a small amount of movement, whereby upon the application of pressure to the fluid the ball will immediately seat itself and very little movement will be lost.

In operation this apparatus, supposing it is empty of fluid, first supplies fluid by the action of the pump, or other supply mechanism, through a suitable main line and the check-valve, into the conduits or individual lines at a point between the actuating and actuated mechanisms connected thereby. The fluid passing into the conduits in this way naturally flows in both directions, thus expelling the air contained therein and finally reaching both mechanisms and flowing out through all of the spaces and clearances until the entire apparatus is fully supplied with fluid and the various pipes and spaces thereof are surcharged with the fluid. A particular advantage of this mode of supplying the apparatus is the rapid and effectual expulsion of air from the connecting conduits and the interior spaces of the two apparatuses. For it will be remembered that notwithstanding the substantially inelastic character of ordinary fluids, such as water or oil, if a column of considerable length of such fluid contains even a small percentage of air in the form of bubbles, the column, considered as a whole, thereby becomes elastic, and its efficiency is greatly depreciated when applied to the transmission of mechanical movements from one apparatus to another.

In the apparatus described in my aforesaid prior Letters Patent the fluid for maintaining the supply in the conduit passes through the ports or spaces formed in connection with the actuating piston; and while that method is found effective even in mechanisms of small dimensions (for which purpose the present improvements are more especially intended) the present method has been found more effective for use under a wider range of conditions, especially when using oil.

Each of the actuated devices, in the present instance, has its selector for actuating it, and upon the depression of a selector, illustrated as a finger-key, the piston connected thereto will force an amount of fluid from a reservoir B, common to several of such pistons into a container for a confined volume of fluid, and here illustrated as the conduit E connecting the cylinder of such piston with the cylinder of the device selected for actuation. The former piston upon entering its cylinder cuts off or valves the communication between the reservoir and the conduit; the further entry of the piston and the increased volume of fluid within the conduit causes the piston at the other end of the con-

duit or container to advance and actuate the selected member of the actuated mechanism. Upon the latter piston completing its working stroke it uncovers the vent, the increment of fluid is vented out or withdrawn from the conduit and the piston may then be returned to its initial position either by the return of the actuated device or otherwise. The reservoir is always in communication with the supply and regulator through the non-active conduits, and is replenished and maintained constant from the regulating accumulator and the pump and the volume of fluid or the pressure in the conduits is maintained normally constant or at not less than normal. The back-pressure valves may be constructed to have the minimum of movement in seating and rising so that there will be but small loss of pressure upon the actuation of the piston.

Of course, many changes in detail may be had in practice without departure from the spirit of my invention. The number of actuated devices and selectors may be varied as the requirements of each particular employment may demand. And the invention may be applied to an actuated device wherein several selectors may put into operation a number of actuated members simultaneously, and the reservoir and conduits in such case will be replenished through the conduits not in use at that particular actuation, so that upon any of the individuals of one combination being repeated in the next successive combination the fluid in the reservoir will be efficient and the pump and regulator will have filled the conduits of such individuals instantly. The pressure and volume of fluid throughout the entire apparatus is maintained constant, except during the brief instant of the increase in any conduit for actuation and the decrease due to venting the actuated cylinder.

Having described my invention, what I claim and desire to secure by Letters Patent is—

1. The combination with a fluid container, of a movable device actuatable by a predetermined change of volume of fluid in the container, a fluid reservoir, means for removing a volume of fluid equal to said predetermined volume from the reservoir and introducing the same into the container, means for replenishing the reservoir to the normal volume of fluid, and means continuously in communication with the container for supplying fluid from the replenishing means to the container.

2. The combination with a fluid container, of a device capable of reverse movements connected therewith and actuatable in the respective directions by increment and decrement of fluid in the container, a fluid reservoir, means continuously in communication with the container for introducing fluid into the container and from the container into the reservoir to maintain the volume of the fluid in each of these at not less than normal, and means for introducing fluid from the reservoir into and withdrawing the same from the container to vary the volume therein and cause the respective movements of the said device.

3. The combination with a fluid container, of a movable device connected therewith and movable upon change of pressure within the container, a fluid reservoir, means for introducing a portion of fluid from the reservoir into the container, and means continuously in communication with the container for maintaining the fluid within the container constant.

4. The combination with a series of fluid containers, of a plurality of devices connected therewith, severally capable of reverse movements, and actuated by a change of fluid conditions in the connected container, a fluid reservoir connected to each of the containers; means for introducing fluid into the containers and maintaining the pressure of the fluid at not less than normal, and for introducing fluid into the reservoir through the idle containers; means for stopping the flow of fluid from a selected container into the reservoir and for introducing fluid from the reservoir into said selected container, and means to withdraw fluid from said selected container, for varying the pressure therein and causing the respective movements of the elements connected therewith.

5. In a device of the character specified, the combination with a series of movable devices; a series of pistons connected therewith and mounted in piston chambers; a series of actuators; a series of pistons mounted in piston chambers operated thereby; a series of conduits respectively connecting the piston chambers from each series; a fluid reservoir for supplying fluid to the pistons of the second named series, and through which said pistons pass; a supply main; a service pipe connecting each of the conduits with the main, back pressure valves in each of the service pipes, the organization being such that fluid may be supplied to the conduits at all times irrespective of the position of the parts, and that fluid will be supplied to the reservoir from the conduits, which for the time being are idle.

6. The combination with a plurality of fluid containers, of a piston cylinder located within each container; a piston mounted within each cylinder and actuated by a change of pressure within its container; a plurality of devices severally capable of a number of movements and each controlled by one of the pistons; a fluid reservoir; means continuously open for the introduction of fluid into the containers to maintain the pressure of the fluid therein and in the

reservoir at not less than normal; and means for introducing fluid from the reservoir into and withdrawing fluid from a selected container to vary the pressure therein and cause the respective movements of the device connected therewith.

7. The combination with a plurality of fluid containers, of a piston cylinder connected with each container; a piston mounted within each cylinder and actuated by a change of volume of fluid within its connected container; a plurality of devices severally capable of a number of movements and each controlled by one of the pistons; a fluid reservoir; continuously active means for supplying fluid; a connection and a back pressure valve between each container and said supplying means; and means for introducing fluid from the reservoir into and withdrawing the fluid from a selected container to vary the volume of fluid therein and cause the respective movements of the devices connected therewith.

8. In a device of the character specified, the combination with mechanism embodying a series of work performing members, of a reservoir means for operating the members and each embodying a cylinder connected to the reservoir; a piston mounted therein; a stem on the piston for engaging the member; means for guiding and supporting the piston stem; and a vent in the cylinder at each side of the space occupied by the piston at the completion of its working stroke; a fluid conduit in communication with each cylinder; a fluid reservoir; means for constantly introducing fluid from the reservoir into the conduit operative upon a selected member to actuate the member; and means for replenishing the reservoir and maintaining the pressure within the conduits at not less than normal.

9. In a device of the character specified, the combination with a container; of a series of movable members located therein; means for operating said members and embodying a series of cylinders; pistons mounted therein for actuating the members; and a vent in each of the cylinders behind the space occupied by the piston at the completion of its working stroke; selectors for the members; a reservoir for containing fluid; a series of piston cylinders connected with the reservoir; conduits each connecting a piston cylinder from each series; pistons mounted in the piston cylinders opposite the reservoir and each controlled by a selector and embracing in a hollow open ended cylinder; and a port in the same adapted to make communication between the interior of the reservoir and the conduit and establishing communication between the same, and upon movement into the cylinder to cut off and also introduce a predetermined amount of fluid from the reservoir into the conduit and upon a selected member to actuate the member, and means for replenishing the selector and maintaining the fluid in the conduit normally constant.

10. In a device of the character specified, the combination with a series of movable members, of means for operating the members and embodying a series of cylinders, pistons mounted therein for actuating the members, and a vent in each of the cylinders behind the space occupied by the piston at the completion of its working stroke; selectors for the members; a reservoir for containing fluid; a series of piston-cylinders connected with the reservoir; conduits each connecting a piston-cylinder from each series; pistons mounted in the piston-cylinders of the reservoir and each controlled by a selector and embracing an open-ended hollow cylinder, and a port in the same adapted to permit communication between the interior of the reservoir and the conduit and establish communication between the same and upon movement into the cylinder to cut off and also introduce a predetermined amount of fluid from the reservoir into the conduit and operative upon the selected member to actuate the member; and means embodying a source of fluid supply, a pump drawing therefrom, connections between the pump and the conduits, an accumulator fed by the surplus delivery of the pump; and connections between the accumulator and conduits for replenishing the reservoir and maintaining the fluid in the conduits normally constant.

11. In a device of the character specified, the combination with a series of movable members, of means operable by change of fluid for actuating the members; selectors for the members; a reservoir for containing fluid; a series of piston-cylinders connected with the reservoir; conduits each connecting a piston-cylinder and an actuating means; pistons mounted in the piston-cylinders and each controlled by a selector and embracing an open-ended hollow cylinder; a port in the same adapted to permit communication between the interior of the reservoir and the conduit and establish communication between the same and upon movement into the cylinder to cut off and also introduce a predetermined amount of fluid from the reservoir into the conduit and operative upon the selected member to actuate the member; and means for replenishing the reservoir through said conduits and maintaining the fluid in the conduits normally constant.

12. In a device of the character specified, the combination with a series of movable members, of means operated by change of fluid for actuating the members; selectors for the members; a reservoir for containing fluid; a series of piston-cylinders connected with the reservoir; conduits each connecting a piston-cylinder and an actuating means; pistons mounted in the piston-cylinders and

each controlled by a selector and embracing an open-ended hollow cylinder; a port in the same adapted to permit communication between the interior of the reservoir and the conduit and establish communication between the same and upon movement into the cylinder to cut off and also introduce a predetermined amount of fluid from the reservoir into the conduit and operative upon the selected member to actuate the member; and means embodying a source of fluid supply, a pump drawing therefrom, connections between the pump and the conduits; an accumulator fed by the surplus delivery of the pump; and connections between the accumulator and conduits for replenishing the reservoir and maintaining the fluid in the conduits normally constant.

13. The combination with a plurality of fluid conduits, of a plurality of devices, severally capable of a number of movements, respectively connected therewith and each controlled by change of volume of fluid within its respective conduit; means for introducing fluid from the reservoir into and withdrawing fluid from a selected conduit to vary the volume therein and cause the respective movements of the device connected therewith; and means for replenishing the reservoir and maintaining the fluid in the conduits normally constant and embodying a source of fluid supply, a pump drawing therefrom, a main supplied by the pump and an accumulator fed by the surplus delivery of the pump and comprising a cylinder in communication with the main, a pressure-piston therein and means for varying the pressure of the piston.

14. In a device of the character specified, the combination with a series of movable members, of means operable by change of volume of fluid for actuating the members; selectors for the members; a reservoir for containing fluid; a series of piston-cylinders connected with the reservoir; conduits each connecting a piston-cylinder and an actuating means; pistons mounted in the piston-cylinders and each controlled by a selector and adapted to permit communication between the interior of the reservoir and the conduit and establish communication between the same and upon movement into the cylinder to cut off and also introduce a predetermined amount of fluid from the reservoir into the conduit operative upon the selected member to actuate the member; and means for replenishing the reservoir and maintaining the fluid in the conduits normally constant and embodying a source of fluid supply, a pump drawing therefrom, a main supplied by the pump and an accumulator fed by the surplus delivery of the pump and comprising a cylinder in communication with the main and a pressure-piston therein.

15. In a device of the character specified, the combination with a series of movable members, of means operated by change of volume of fluid for actuating the members; selectors for the members; a reservoir for containing fluid; a series of piston-cylinders connected with the reservoir; conduits each connecting a piston-cylinder and an actuating means; pistons mounted in the piston-cylinders and each controlled by a selector and adapted to permit communication between the interior of the reservoir and the conduit and establish communication between the same and upon movement into the cylinder to cut off and also introduce a predetermined amount of fluid from the reservoir into the conduit operative upon the selected member to actuate the member; and means for replenishing the reservoir and maintaining the fluid in the conduits normally constant and embodying a source of fluid supply, a pump drawing therefrom, a main supplied by the pump and an accumulator fed by the surplus delivery of the pump and comprising a cylinder in communication with the main, a pressure-piston therein and means for varying the pressure of the piston.

16. In a device of the character specified, the combination with a series of movable members, of means operated by change of volume of fluid for actuating the members; selectors for the members; a reservoir for containing fluid; a series of piston-cylinders connected with the reservoir; conduits each connecting a piston-cylinder and an actuating means; pistons mounted in the piston-cylinders and each controlled by a selector and adapted to permit communication between the interior of the reservoir and the conduit and establish communication between the same and upon movement into the cylinder to cut off and also introduce a predetermined amount of fluid from the reservoir into the conduit operative upon the selected member to actuate the member; and means for replenishing the reservoir and maintaining the fluid in the conduits normally constant and embodying a source of fluid supply, a pump drawing therefrom, a main supplied by the pump, a cylinder in communication with the main, a weighted piston within the cylinder and means for adjustably varying the weight thereof.

17. In a device of the character specified, the combination with a series of movable members, of means operated by change of volume of fluid for actuating the members; selectors for the members; a reservoir for containing fluid; a series of piston-cylinders connected with the reservoir; conduits each connecting a piston-cylinder and an actuating means; pistons mounted in the piston-cylinders and each controlled by a selector and adapted to permit communication between the interior of the reservoir and the conduit and establish communication be-

tween the same and upon movement into the cylinder to cut off and also introduce a predetermined amount of fluid from the reservoir into the conduit operative upon the selected member to actuate the member; and means for replenishing the reservoir and maintaining the fluid in the conduits normally constant and embodying a source of fluid supply, a pump drawing therefrom; a main supplied by the pump, an upright cylinder in communication with the main, a piston within the cylinder and weights for adjustably varying the pressure thereof.

18. In a device of the character specified, the combination with a series of movable members, of means operated by change of volume of fluid for actuating the members; selectors for the members; a reservoir for containing fluid; a series of piston-cylinders connected with the reservoir; conduits each connecting a piston-cylinder and an actuating means; pistons mounted in the piston-cylinders and each controlled by a selector and adapted to permit communication between the interior of the reservoir and the conduit and establish communication between the same and upon movement into the cylinder to cut off and also introduce a predetermined amount of fluid from the reservoir into the conduit operative upon the selected member to actuate the member; and means for replenishing the reservoir and maintaining the fluid in the conduits normally constant and embodying a source of fluid supply, a pump drawing therefrom, a main supplied by the pump, a cylinder in communication with the main, a weighted piston within the cylinder and means for adjustably varying the weight thereof.

19. The combination with a fluid-container, of a movable device connected therewith and operable upon change of volume of fluid within the container; a fluid reservoir; means for introducing a portion of fluid from the reservoir into the container; and means for replenishing the reservoir and for maintaining a volume of fluid within the container not less than the normal volume and embodying a source of fluid supply, a pump drawing therefrom, a main supplied by the pump, an upright cylinder in communication with the main, a piston within the cylinder and weights for adjustably varying the pressure thereof.

20. In a device of the character specified, the combination with mechanism embodying a series of work-performing members; means for yieldably holding the members in their idle positions, means for operating the members and each embodying a cylinder; a piston mounted therein; a stem on the piston for engaging the member; and means for guiding and supporting the piston-stem and comprising a closed end of the cylinder provided with an opening; a vent in front of the piston; a vent behind the piston; a reservoir for containing fluid; a series of piston cylinders connected with the reservoir; tubes each connecting a piston cylinder from each series; pistons mounted in the piston cylinders of the reservoir and each embracing an open-ended hollow cylinder; a port in the same adapted to communicate with the interior of the reservoir and establish communication between the same and the cylinder and upon movement into the cylinder to cut off; a stem on each piston passing through the wall of the reservoir; a series of depressible finger-keys; a stem depending from each key; a bell-crank-lever connected with the stem of each key and with the stem of one of the pistons; means for retracting the pistons; a fluid-supply tank; a pump for drawing fluid therefrom; a supply main connected to the pump; a service pipe connected to the main for each tube; a back-pressure valve in each service pipe; an accumulator connected with the main and embodying a cylinder; a piston therein; weights for regulating the pressure of the piston; a receiving compartment in the supply tank embodying a partition closed at its lower portion and provided at its upper portion with a screen communicating with the body of the tank; an overflow pipe from the accumulator to the receiving compartment; an overflow pan for receiving the fluid from the actuated pistons; a conduit therefrom to the receiving compartment; a valve overflow connected with the reservoir; means for catching the overflow; and means for conveying the same to the receiving compartment.

21. In a device of the character specified, the combination with a shaft, of ratchet-wheels mounted thereon; a series of bell-crank-levers mounted adjacent thereto and all having one arm of uniform length and the other arm of dissimilar length; a pawl carried by each of the dissimilar arms for engaging the ratchet-wheel; yieldable means for holding the bell-cranks in their initial positions; means for operating the several bell-cranks and each embodying a cylinder; a piston mounted therein; a stem on the piston for engaging the bell-crank; and means for guiding and supporting the piston-stem and comprising a closed end of the cylinder provided with an opening; a vent in front of the piston; a vent behind the piston; a reservoir for containing fluid; a series of piston cylinders connected with the reservoir; tubes each connecting a piston cylinder from each series; pistons mounted in the piston cylinders of the reservoir and each embracing an open-ended hollow cylinder; a port in the same adapted to communicate with the interior of the reservoir and establish communication between the same and the cylinder and upon movement into the cylinder to cut

off; a stem on each piston passing through the wall of the reservoir; a series of depressible finger-keys; a stem depending from each key; a bell-crank-lever connected with the stem of each key and with the stem of one of the pistons; means for retracting the pistons; a fluid-supply tank; a pump for drawing fluid therefrom; a supply main connected to the pump; a service pipe connected to the main for each tube; a back-pressure valve in each service pipe; an accumulator connected with the main and embodying a cylinder; a piston therein; weights for regulating the pressure of the piston; a receiving compartment in the supply tank embodying a partition closed at its lower portion and provided at its upper portion with a screen communicating with the body of the tank; an overflow pipe from the accumulator to the receiving compartment; an overflow pan for receiving the fluid from the actuated pistons; a conduit therefrom to the receiving compartment; a valve overflow connected with the reservoir; means for catching the overflow; and means for conveying the same to the receiving compartment.

22. The combination with a plurality of fluid-containers, of a piston-cylinder connected with each container a piston mounted within each cylinder and actuated by change of pressure within its container, a vent to relieve the pressure upon each piston at the completion of its stroke, a plurality of devices capable of a number of movements and each controlled by one of the pistons, a fluid reservoir, means for introducing fluid into the containers to maintain the pressure of the fluid at not less than normal and from the idle containers into the reservoir, and means for introducing fluid from the reservoir into and venting fluid from a selected container to vary the pressure therein and cause the respective movements of the device connected therewith.

23. The combination with a plurality of fluid-containers, of a piston-cylinder connected with each container, a piston mounted within each cylinder and actuated by change of volume of fluid within its container, a vent to relieve the pressure upon each piston at the completion of its stroke, a plurality of devices severally capable of a number of movements and each controlled by one of the pistons, a fluid reservoir, means for introducing fluid into the containers to maintain the volume of fluid at not less than normal and from the idle containers into the reservoir, and means for introducing fluid from the reservoir into and venting fluid from a selected container to vary the volume of fluid therein and cause the respective movements of the device connected therewith.

24. The combination with a plurality of fluid-containers, a piston-cylinder connected with each container, a piston mounted within each cylinder and actuated by change of pressure within its container, a vent behind each piston, a plurality of devices severally capable of a number of movements and each controlled by one of the pistons, a fluid reservoir, means for introducing fluid into the containers to maintain the pressure of the fluid at not less than normal and from the idle containers into the reservoir, and means for introducing fluid from the reservoir into and discharging fluid from a selected container to vary the pressure therein and cause the respective movements of the device connected therewith.

25. The combination with a plurality of fluid-containers, of a piston-cylinder connected with each container, a piston mounted within each cylinder and actuated by change of volume of fluid within its container, a vent behind each piston, a plurality of devices severally capable of a number of movements and each controlled by one of the pistons, a fluid reservoir, means for introducing fluid into the containers to maintain the volume of fluid at not less than normal and from the idle containers into the reservoir, and means for introducing fluid from the reservoir into and discharging fluid from a selected container to vary the volume of fluid therein and cause the respective movements of the device connected therewith.

26. The combination with a plurality of fluid-containers, of a piston-cylinder connected with each container, a piston mounted within each cylinder and actuated by change of pressure within its container, a vent from the cylinder at each side of the space occupied by the piston at the completion of its working stroke, a plurality of devices severally capable of a number of movements and each controlled by one of the pistons, a fluid reservoir, means for introducing fluid into the containers to maintain the pressure of the fluid at not less than normal and from the idle containers into the reservoir, and means for introducing fluid from the reservoir into and venting fluid from a selected container to vary the pressure therein and cause the respective movements of the device connected therewith.

27. The combination with a plurality of fluid-containers, of a piston-cylinder connected with each container, a piston mounted within each cylinder and actuated by change of volume of fluid within its container, a vent from the cylinder at each side of the space occupied by the piston at the completion of its working stroke, a plurality of devices severally capable of a number of movements and each controlled by one of the pistons, a fluid reservoir, means for introducing fluid into the containers to maintain the volume of fluid at not less than normal and from the idle containers into the reservoir, and means

for introducing fluid from the reservoir into and venting fluid from a selected container to vary the volume of fluid therein and cause the respective movements of the device connected therewith.

28. The combination with a plurality of fluid containers, of a piston cylinder connected with each container; a piston mounted within each cylinder and actuated by change of pressure within its tube; a plurality of devices severally capable of a number of movements and each controlled by one of the pistons; a fluid reservoir; means for introducing fluid into the tubes to maintain the pressure of the fluid at not less than normal and from the idle containers into the reservoir; means for introducing fluid from the reservoir into a selected tube to vary the pressure therein and cause a movement of the device connected therewith; and a vent from the cylinder behind the space occupied by the piston at the completion of its working stroke for permitting another movement of the device.

29. The combination with a plurality of fluid containers, of a piston-cylinder connected with each container, a piston mounted within each cylinder and actuated by change of volume of fluid within its container, a plurality of devices severally capable of a number of movements and each controlled by one of the pistons, a fluid reservoir, means for introducing fluid into the containers to maintain the volume of fluid at not less than normal and from the idle containers into the reservoir. means for introducing fluid from the reservoir into a selected container to vary the volume of fluid therein and cause a movement of the device connected therewith, and a vent from the cylinder behind the space occupied by the piston at the completion of its working stroke for permitting the escape of fluid and another movement of the device.

30. The combination with a series of fluid-containers, of a series of movable devices severally connected therewith and movable upon change of pressure within the respective containers, a fluid reservoir, means for introducing a portion of fluid from the reservoir into each container, and means for maintaining the fluid within the reservoir constant from the idle containers.

31. The combination with a fluid-container, of a movable device connected therewith and operable upon change of pressure within the container, a fluid reservoir, a piston-chamber in communication with the container and with the reservoir below the upper portion thereof, and a piston mounted in the chamber and comprising an open-ended hollow cylinder and a port for opening and closing communication between the reservoir and container, the open end of said cylinder being directed toward the container.

32. In a device of the character specified, the combination with a plurality of fluid-containers, mechanism connected with each of these and operable upon change of volume of fluid within the container, a piston-chamber connected with each container, a fluid reservoir in communication with all of the piston-chambers, a piston provided with a hollow end working in each of the piston-chambers and provided with an inlet-port through which the reservoir and chamber may be put in inter-communication, a stem depending from each of the keys, and a bell-crank-lever engaged by each of the key-stems and engaging the respective piston-stems.

33. The combination with a fluid-container, of a movable device connected therewith and movable upon change of pressure within the container, means for introducing fluid into the container to maintain the pressure of the fluid at not less than normal, means for introducing fluid into the container to raise the pressure therein and move the device, and means for back-valving the normal pressure maintaining means during the increment of pressure.

34. The combination with a fluid-container, of devices capable of a plurality of movements, connected therewith and controlled by change of pressure within the container, means for introducing fluid into the container to maintain the pressure of the fluid at not less than normal, and means for introducing fluid into and withdrawing fluid from the container to vary the pressure therein and cause the respective movements of the device, and means for back-valving the normal pressure maintaining means during the increment of pressure.

35. The combination with a fluid-container, of devices capable of a plurality of movements in the container, connected therewith and controlled by change of volume of fluid within the container, means for introducing fluid into the container to maintain the volume of the fluid at not less than normal, and means for introducing fluid into and withdrawing fluid from the container to vary the volume therein and cause the respective movements of the device, and means for back-valving the normal pressure maintaining means during the increment of pressure.

36. The combination with a plurality of fluid-containers, of a plurality of devices severally capable of a number of movements, respectively connected therewith and each controlled by change of pressure within its respective container, means for introducing fluid into the containers to maintain the pressure of the fluid at not less than normal, and means for introducing fluid into and withdrawing fluid from a selected container to vary the pressure therein and cause the respective movements of the device connected therewith, and means for back-valving the

normal pressure maintaining means during the increment of pressure.

37. The combination with a plurality of fluid-containers, of a plurality of devices severally capable of a number of movements, respectively connected therewith and each controlled by change of volume of fluid within its respective container, means for introducing fluid into the containers to maintain the volume of the fluid at not less than normal, means for back-valving the normal pressure maintaining means during the increment of pressure, and means for introducing fluid into and withdrawing fluid from a selected container to vary the volume therein and cause the respective movements of the device connected therewith.

38. In a device of the character specified, the combination with a shaft, of ratchet-wheels mounted thereon, a series of bell-crank-levers mounted adjacent thereto and all having one arm of uniform length and the other arm of dissimilar length, a pawl carried by each of the dissimilar arms for engaging the ratchet-wheel, yieldable means for holding the bell-cranks in their initial positions, and fluid-actuated means for operating the respective bell-cranks.

39. In a device of the character specified, the combination with a shaft, of ratchet-wheels mounted thereon, a series of levers mounted adjacent thereto and all having one arm of uniform length and the other arm of dissimilar length, pawls carried by the dissimilar arms for engaging the ratchet-wheels, yieldable means for holding the levers in their initial positions, and fluid-actuated means for operating the respective levers and engageable with the arms of uniform length, a plurality of ratchet-wheels, a series of levers mounted adjacent thereto and all having one arm of uniform length and the other arm of dissimilar length, means of connection between the several arms of uniform length and the respective pistons, pawls carried by the arms of dissimilar length, for engaging the ratchet-wheels, and means for maintaining the levers at initial position.

40. The combination with a plurality of fluid containers, of a piston cylinder connected with each container, a piston mounted within each cylinder and actuated by change of volume of fluid within its connected container, a plurality of ratchet-wheels, a series of levers mounted adjacent thereto and all having one arm of uniform length and the other arm of dissimilar length, means of connection between the several arms of uniform length and the respective pistons, pawls carried by the arms of dissimilar length, for engaging the ratchet-wheels, and means for maintaining the levers at initial position.

In testimony whereof, I have hereunto signed my name at Nos. 9–15 Murray street, New York, N. Y., this 21st day of October, 1902.

FRANCIS H. RICHARDS.

Witnesses:
FRED. J. DOLE,
JOHN O. SEIFERT.