No. 822,595. PATENTED JUNE 5, 1906.

E. M. FRASER.

HYDRAULIC ELEVATOR AND OTHER HYDRAULIC APPARATUS.

APPLICATION FILED SEPT. 12, 1904.

4 SHEETS—SHEET 1.

Fig. 1

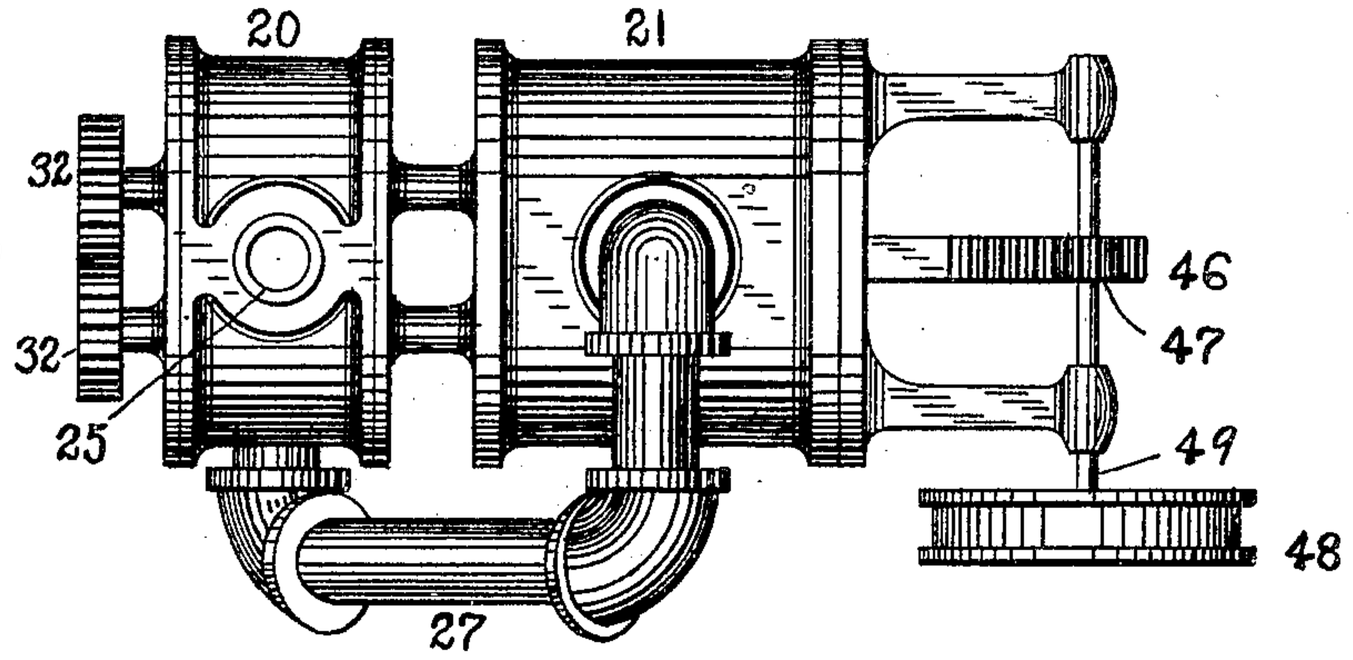


Fig. 2

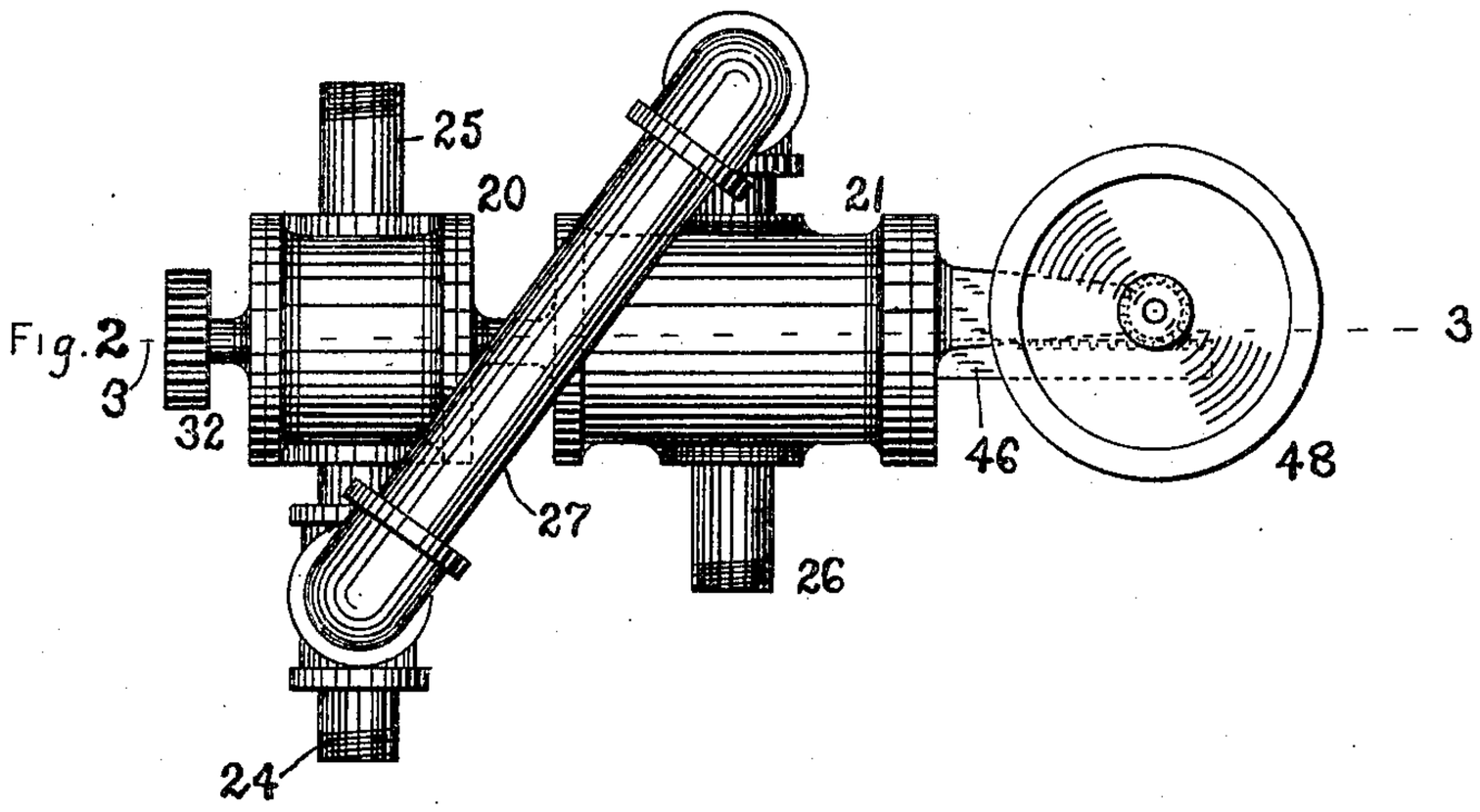
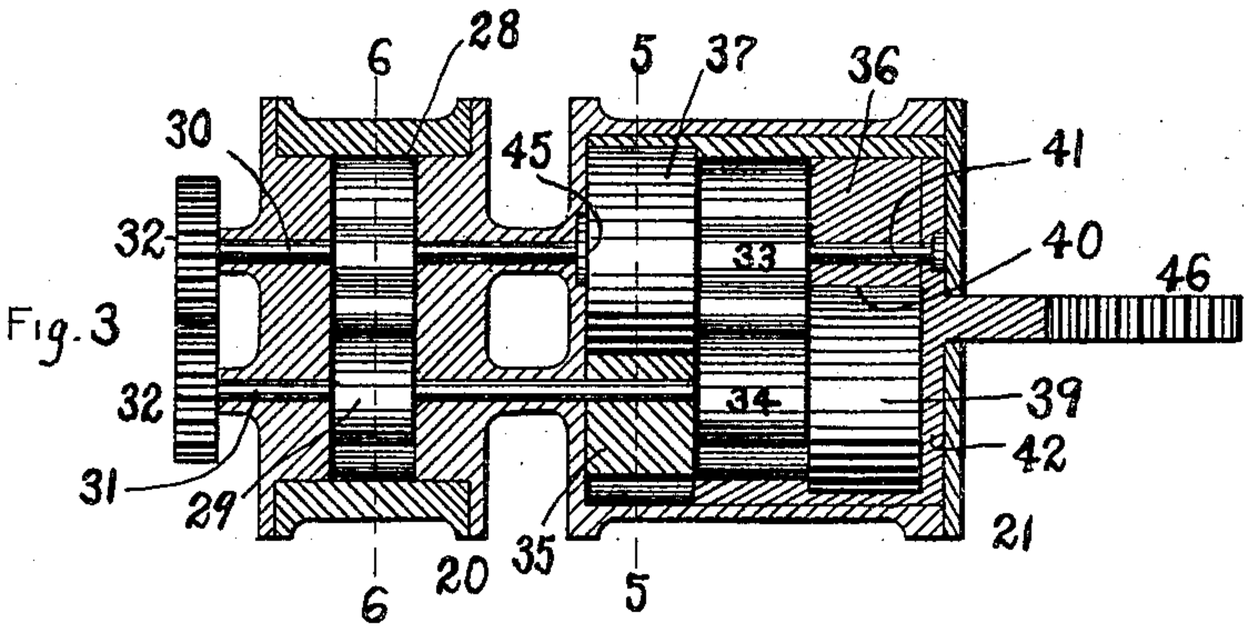


Fig. 3



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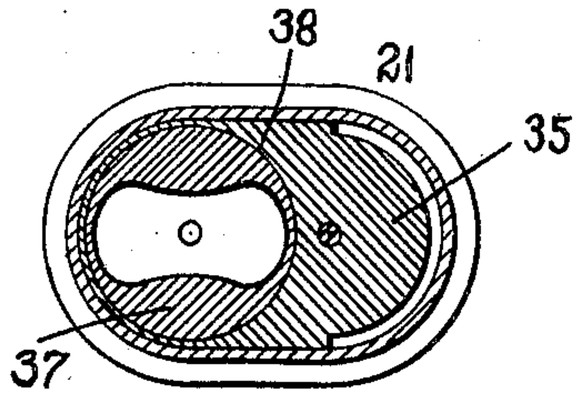


Fig. 5

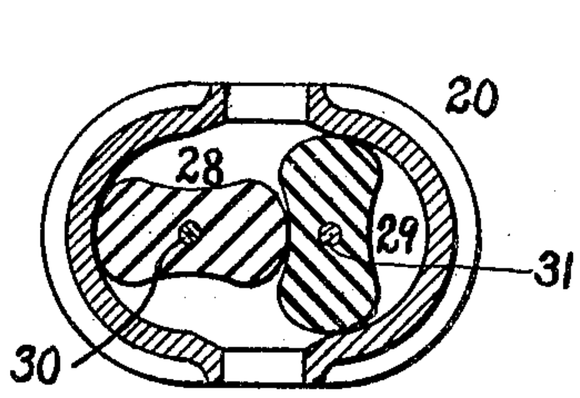


Fig. 6

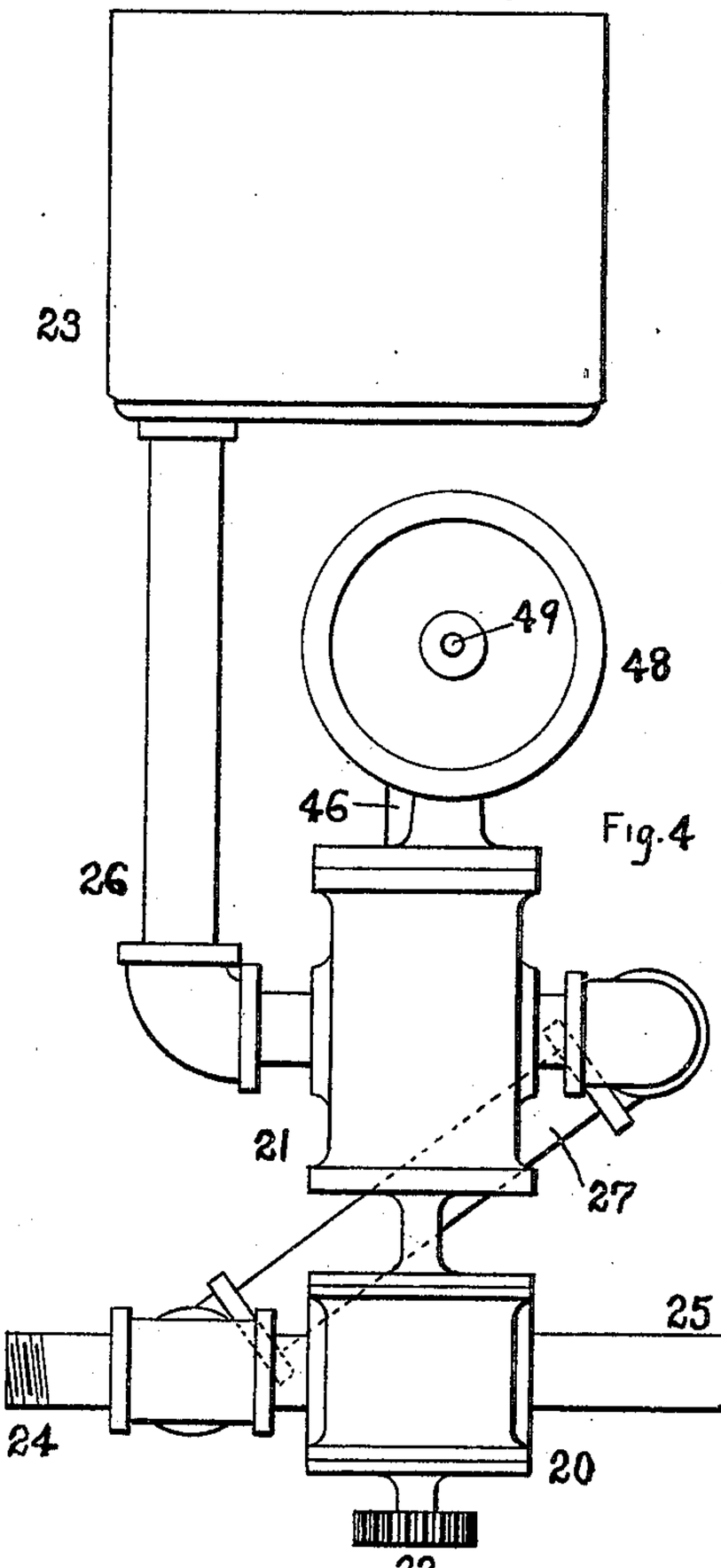
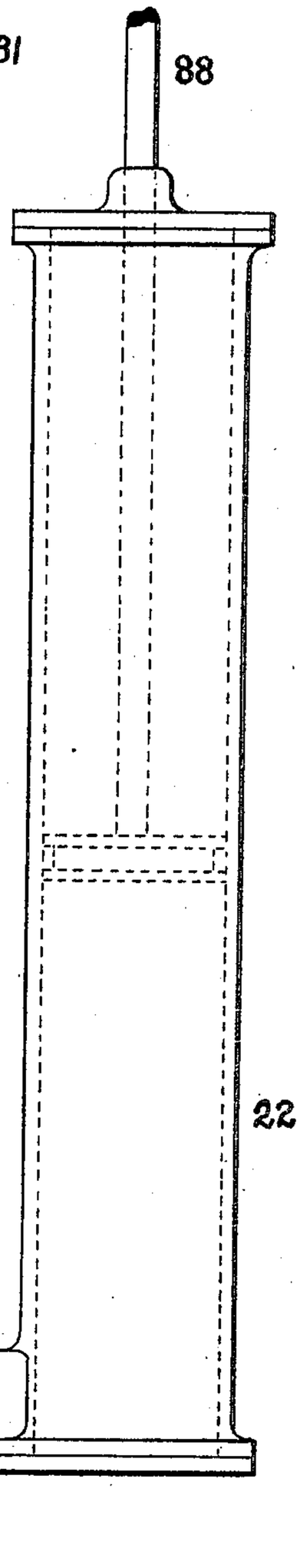


Fig. 4



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4 SHEETS—SHEET 3

FIG. 7

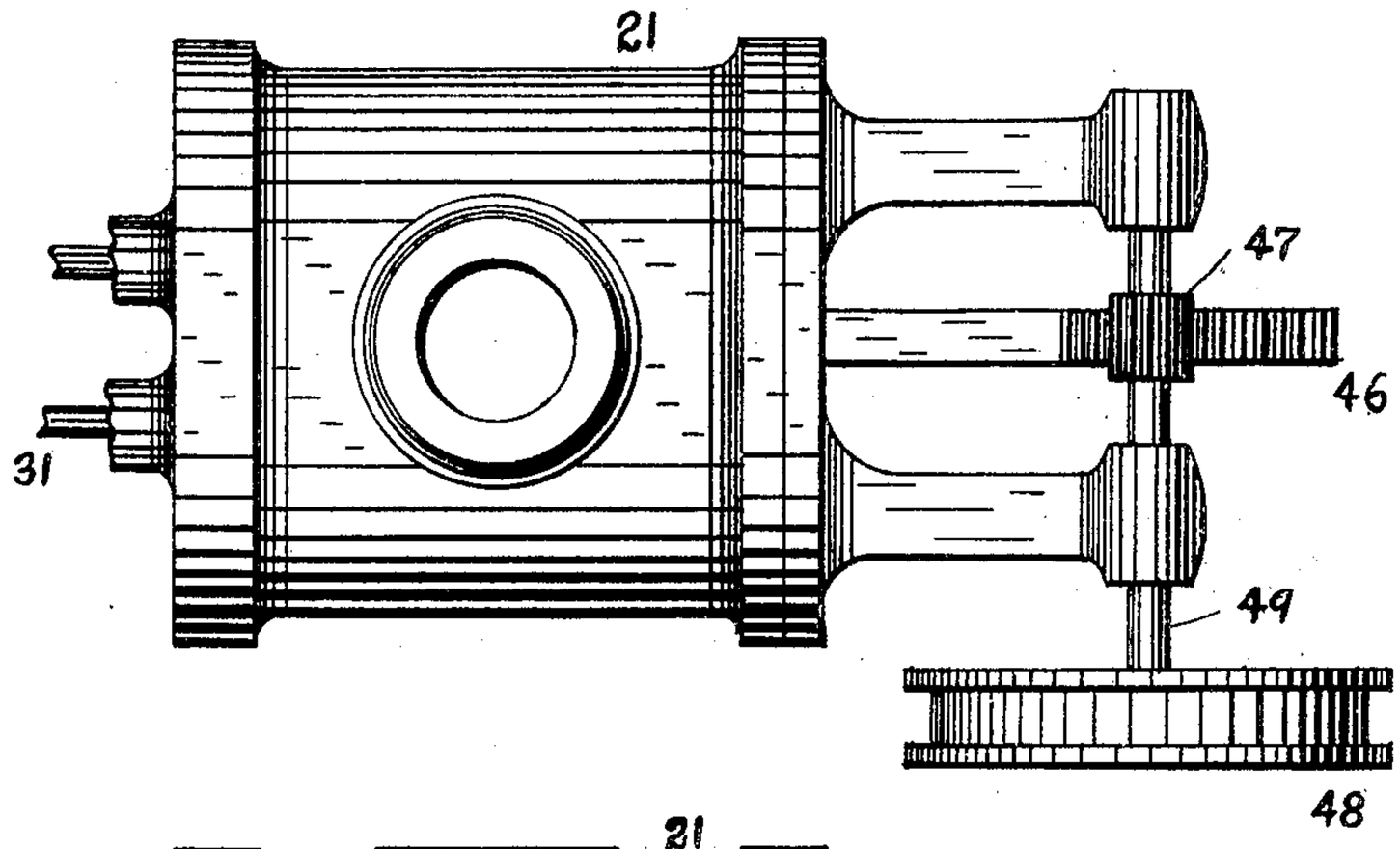


FIG. 8

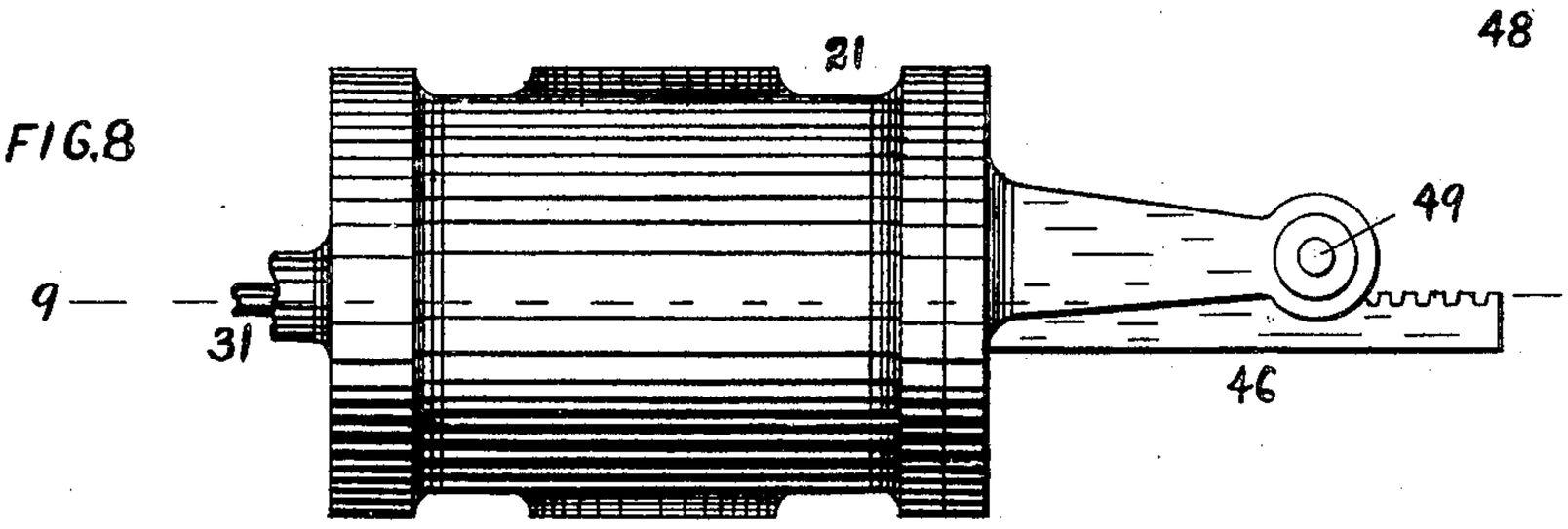
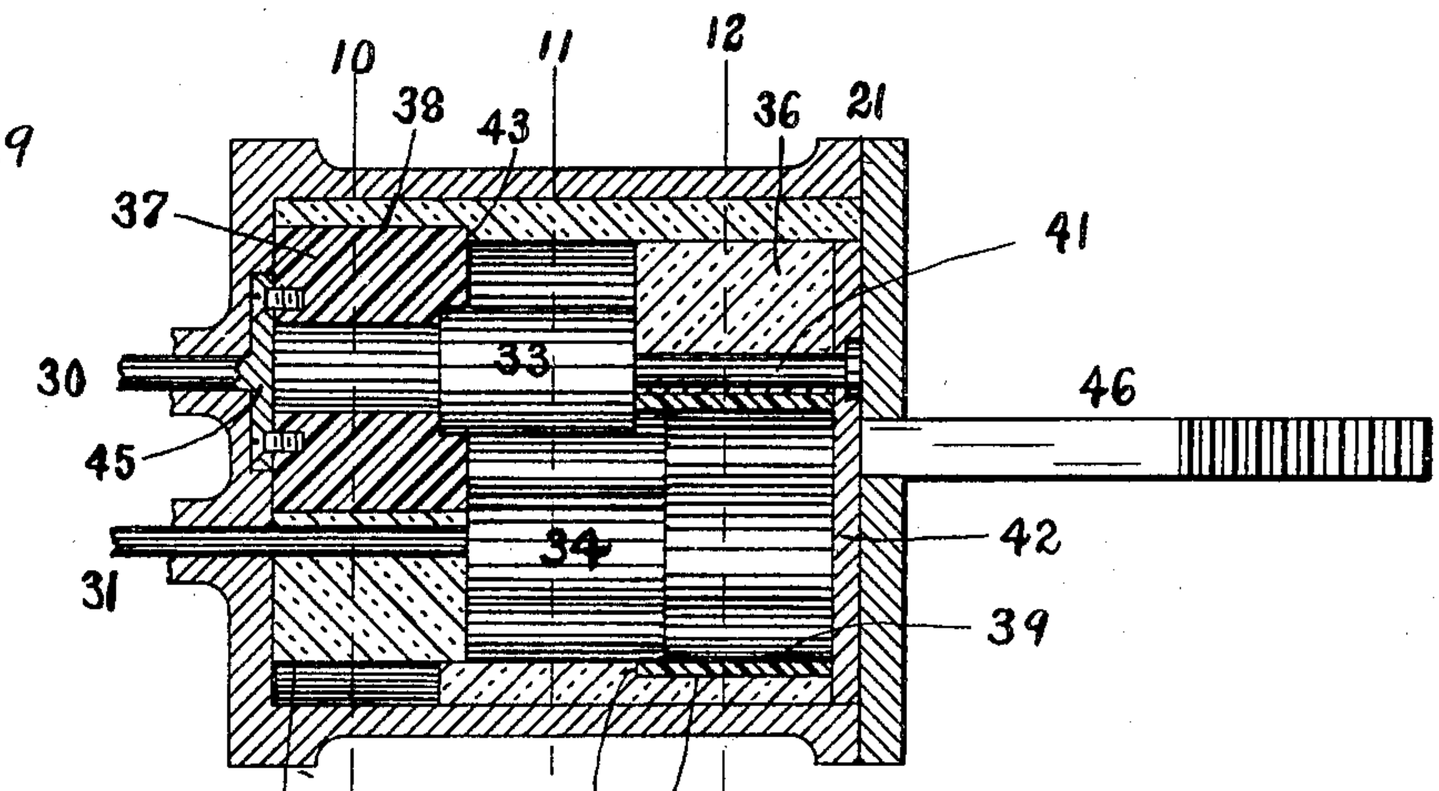


FIG. 9



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4 SHEETS—SHEET 4.

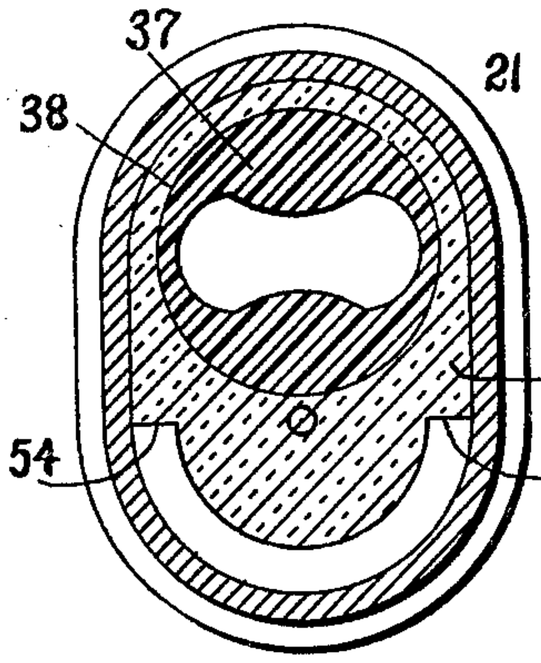

FIG. 10

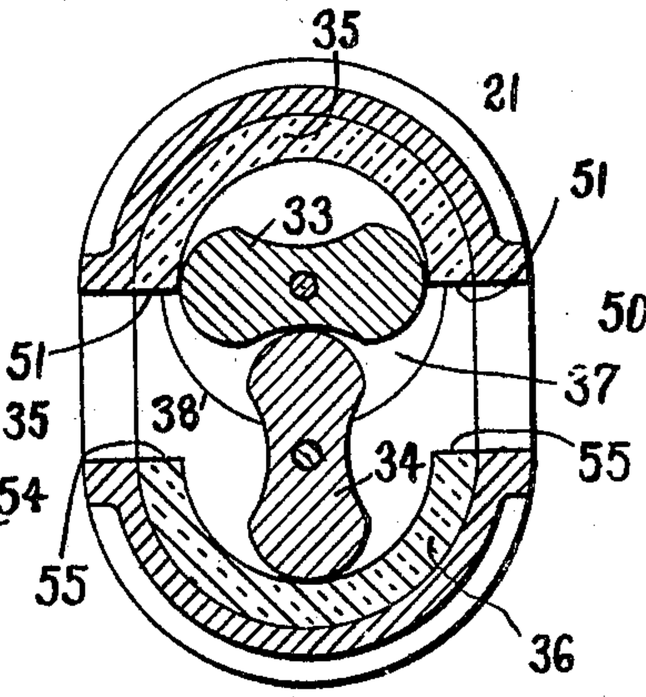

FIG. 11

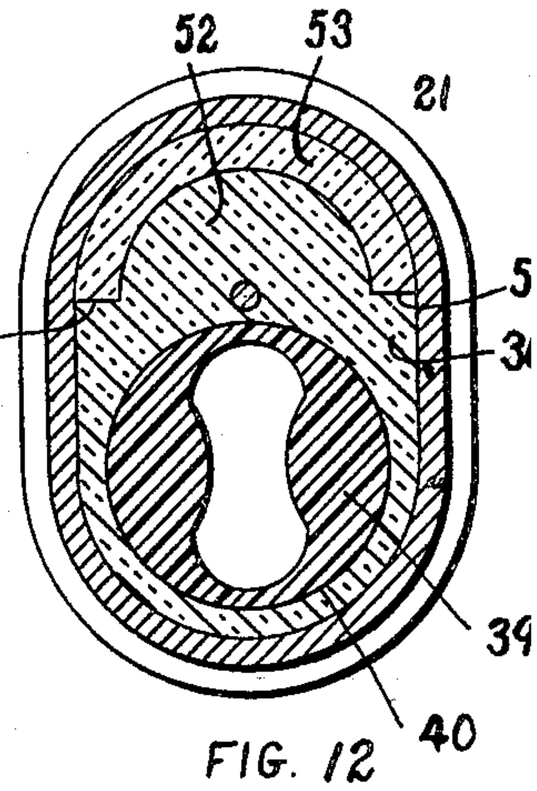

FIG. 12

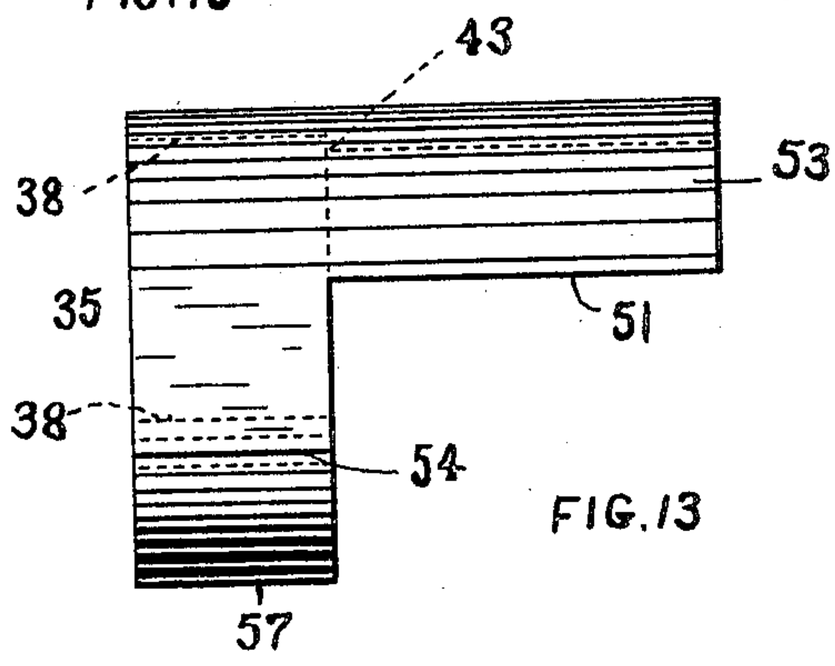

FIG. 13

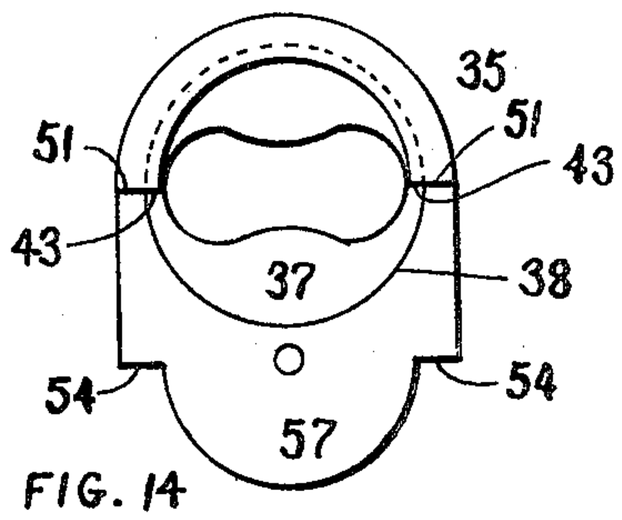

FIG. 14

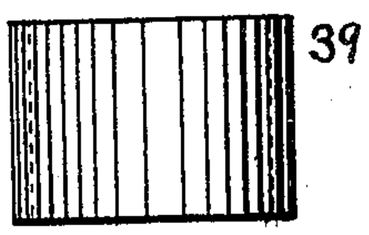

FIG. 18

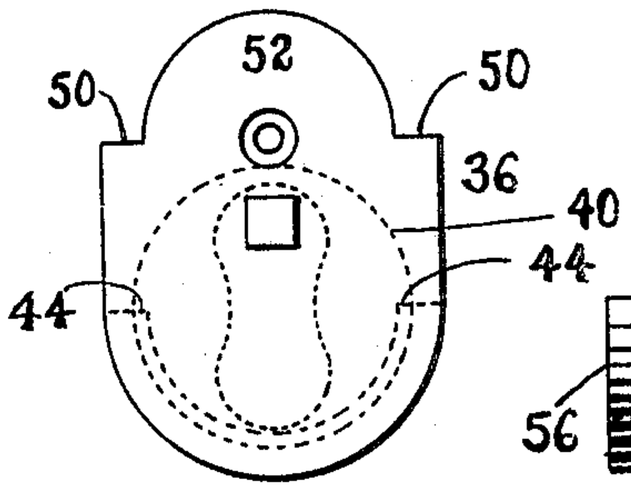

FIG. 16

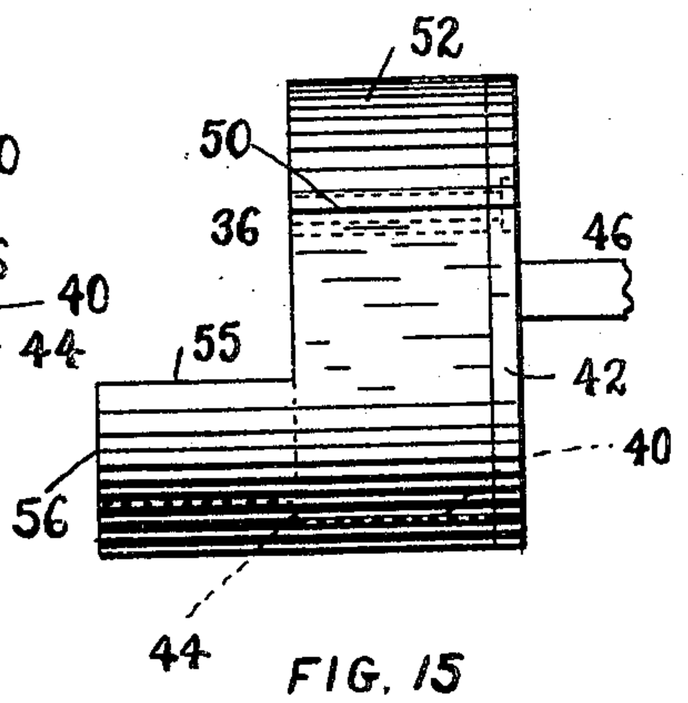

FIG. 15

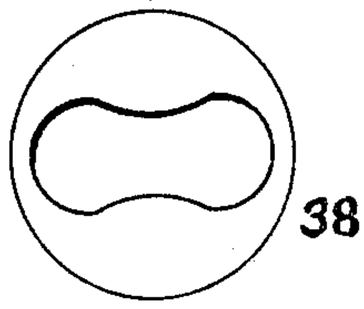

FIG. 17

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UNITED STATES PATENT OFFICE.

ETHELBERT M. FRASER, OF YONKERS, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO FRASER HYDRAULIC COMPENSATOR COMPANY.

HYDRAULIC ELEVATOR AND OTHER HYDRAULIC APPARATUS.

No. 822,595. Specification of Letters Patent. Patented June 5, 1906.

Application filed September 12, 1904. Serial No. 224,101.

To all whom it may concern:

Be it known that I, ETHELBERT M. FRASER, a citizen of Canada, and a resident of Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Hydraulic Elevators and other Hydraulic Apparatus, of which the following is a specification.

The invention relates to improvements in hydraulic elevators and other hydraulic apparatus; and it consists in the novel features, principles, arrangements, and combinations of parts hereinafter described, and particularly pointed out in the claims.

The object of the invention is to provide efficient means interposed between the supply-main and the cylinder or actuating-motor whereby the amount of water from the supply-main used in the said cylinder or motor is directly proportional to the load lifted or the work performed.

A further object of the invention is to provide means whereby the work done by the descending car and its load may be stored up and subsequently utilized in raising the car and its load.

In accordance with my invention I provide intermediate the supply-main and cylinder very simple and easily-controlled and installed means for regulating the water-supply, so that the water used from the supply-main may be directly proportional to the load raised or lowered in an elevator or in other apparatus to the amount of work done, my purpose being, among other objects, to avoid the waste incident to the use of hydraulic elevators and other hydraulic apparatus in which the amount of water used is a fixed quantity at a fixed pressure regardless of the work done or whether the load is light or heavy.

I present my invention in this application as embraced in a hydraulic elevator and as comprising intermediate the supply-main and power-cylinder or motor an apparatus consisting of a rotary pump (which at times operates as a motor) of fixed capacity connected at one side with the supply-main and at the other side with the power-cylinder or motor, a storage-tank for water, a variable rotary motor (which at times operates as a pump) connected at one side with said storage-tank and at its other side with the supply or main side of said pump, and means for varying the capacity of said rotary motor, whether acting as a motor or a pump, from nothing to the maximum at will. The said rotary pump or motor and said variable rotary motor or pump are preferably of the impeller class and by preference of the two-cycloidal impeller type and are arranged end to end, so that one pair of parallel shafts may extend through both of them and receive the impellers, the major axis of the corresponding impellers in both pumps or motors being on the same plane. The said variable rotary motor or pump is provided with rotary cylindrical envelops for its impellers and with means for effecting the exposure to a greater or less extent of the adjoining ends of said impellers beyond said envelops and of placing said exposed portions of said impellers into coöperative relation to each other, the purpose being that only so much of said impellers shall be exposed for duty as may from time to time be requisite for pumping or consuming, as the case may be, the required volume of water. The said variable rotary motor or pump comprises a stationary frame forming a seat for the rotary envelop of one impeller and a movable frame affording a seat for the rotary envelop of the other impeller and being connected with the impeller of the said stationary frame, the arrangement being such that as said movable frame is moved toward the stationary frame it will move its envelop over and partly or wholly conceal its impeller and at the same time and in the same degree force the other impeller into the envelop of said stationary frame and that as said movable frame is moved outwardly from said stationary frame it will withdraw its envelop from over its impeller and at the same time and in the same degree withdraw the other impeller from the envelop of the stationary frame and place the exposed portion of same into coöperative relation with the exposed portion of the impeller of the movable frame.

The invention will be fully understood from the detailed description hereinafter presented, reference being had to the accompanying drawings, in which—

Figure 1 is a side view of apparatus embodying the invention, this figure showing the pump or motor of fixed capacity to be connected with the supply main and cylinder and the variable motor or pump to be

connected with the storage-tank and the main side of said pump or motor. Fig. 2 is an edge view of same. Fig. 3 is a longitudinal section of same on the dotted line 3 3 of Fig. 2. Fig. 4 is a front view of same shown in connection with the storage-tank and the cylinder. Fig. 5 is a sectional view through the variable motor or pump on the dotted line 5 5 of Fig. 3. Fig. 6 is a like section through the pump or motor of fixed capacity on the dotted line 6 6 of Fig. 3. Fig. 7 is an enlarged side elevation of the variable rotary motor or pump. Fig. 8 is an edge view of same. Fig. 9 is a longitudinal section of same on the dotted line 9 9 of Fig. 8. Fig. 10 is a transverse section of same on the dotted line 10 10 of Fig. 9. Fig. 11 is a like section of same on the dotted line 11 11 of Fig. 9. Fig. 12 is a like section of same on the dotted line 12 12 of Fig. 9. Fig. 13 is a side elevation of the stationary frame detached from the variable motor or pump. Fig. 14 is an end view of same looking at the right-hand end of Fig. 13. Fig. 15 is a side elevation of the movable frame detached from the variable motor or pump. Fig. 16 is an end view of same looking at the right-hand end of Fig. 15. Fig. 17 is a detached end view of one of the rotary envelops detached from the variable motor or pump, and Fig. 18 is a top view of same.

In the drawings, 20 designates the pump or motor of fixed capacity; 21, the motor or pump of variable capacity; 22, the cylinder or motor for converting hydraulic into mechanical power; 23, the storage-tank for water; 24, the pipe connection whereby the water main or supply may be connected to one side of the pump or motor of fixed capacity; 25, a pipe connecting the other side of said pump or motor with the aforesaid cylinder; 26, a pipe connecting the storage-tank 23 with one side of the variable motor or pump; 27, a pipe connecting the other side of said variable motor or pump with the pipe 24 at the main side of the pump or motor 20.

The cylinder 22 is of familiar type and requires no special explanation, said cylinder being provided with the usual piston and piston-rod 88, by means of which the hydraulic power may be converted into mechanical power for actuating the elevator-car (not shown) or other device or mechanism. The cylinder 22 represents a known form and construction of motor and is not separately claimed herein.

The storage-tank 23 is simply a receptacle to contain a suitable supply of water proportioned to the size of the cylinder 22 and the capacity of the apparatus, and said tank 23 possesses in itself no special structural features requiring description.

The pump or motor 20 comprises in the present instance the exterior casing and two coöperative impellers 28 29, mounted upon shafts 30 31, respectively, which are parallel with each other and connected together by gear-wheels 32. The pump or motor 20 is in itself of known form and construction and is not separately claimed herein, nor is the present invention limited in every instance to the special construction of rotary pump or motor 20, although I prefer in carrying out my invention to employ the special rotary pump or motor 20 shown. The impellers 28 29 are of cycloidal outline; but it is well known that the impellers in the class of apparatus to which the pump or motor 20 belongs are of various outlines, some being, for illustration, in the form of gear-wheels of comparatively large pitch rotating in close contact within the casing. The rotary pump or motor 20 is therefore a known type of rotary pump or motor, and, as usual, it has a fixed capacity, at all times pumping or consuming a fixed volume of water. The pump or motor 20 may operate with equal efficiency either as a motor or as a pump, and, as hereinafter explained, the said pump or motor 20 sometimes operates as a pump driven by the variable pump or motor 21 as a motor and sometimes as a motor to drive the variable pump or motor 21 as a pump.

The variable motor or pump 21 comprises, in its preferred form, the exterior casing, impellers 33 34, a stationary frame 35, Figs. 3, 9, 10, 13, and 14, located at the left-hand side, looking at Fig. 9, of the passage through said casing, a movable frame 36, located at the right-hand side of the passage through the casing, Figs. 3, 9, 12, 15, and 16, a rotary cylindrical envelop 37 mounted within an opening 38 in said frame 35 and having an opening conforming to the outline of the impeller 33 held thereby, Figs. 9, 10, and 11, a rotary cylindrical envelop 39 mounted within an opening 40 in the movable frame 36 and having an opening corresponding with the outline of the impeller 34, Figs. 9, 12, held thereby, and means for moving the frame 36 toward and from the frame 35, so that during the movement of said frame 36 toward and from the frame 35 the envelop of the frame 36 may be more or less moved upon and conceal the impeller 34 and that said frame 36 may during such movement force the impeller 33 more or less into its envelop 37, thereby regulating the exposure of the surface area of said impellers. When the frame 36 is moved outwardly in a direction from the frame 35, it will withdraw its rotary envelop 39 from off of the impeller 34 and withdraw the impeller 33 from its envelop 37 and move the inner end of said impeller 33 into coöperative relation to the like portion of the impeller 34.

The impeller 34 is mounted upon the shaft 31, which extends through the pump or motor 20 and into the variable motor or pump 21, and the impeller 33 is mounted upon or connected with a shaft 41, which, as shown in

Fig. 9, is mounted in a longitudinal bearing aperture in the movable frame 36, the inner transverse edge of the transverse portion of said frame 36 being in close relation to the outer or right-hand end edge, looking at Fig. 9, of the impeller 33, and the outer end of the shaft 41 having a head seated within a recess in a cap-plate 42, fitted upon the outer or right-hand end, looking at Fig. 9, of said frame 36. The shaft 30 of the pump or motor 20 also extends into the casing of the variable motor or pump 21, as shown in Fig. 9, this result being permitted by reason of the fact that the pumps or motors 20 21 are arranged in end to end relation to each other. The impeller 34 cannot have any longitudinal movement and therefore is stationary, except for its capacity to rotate in about the central side portion of the casing of the variable motor or pump 21; but the impeller 33, being connected by the shaft 41 with the movable frame 36, may have a longitudinal motion imparted to it during its rotary motion, said impeller 33 being obliged to follow the movement of the frame 36. The frame 35 is formed with a substantially semicircular shoulder 43, Figs. 9, 13, and 14, which prevents the rotary envelop 37 from being drawn from its opening or seat 38 in the frame 35 during the outward movement of the frame 36, and the movable frame 36 is formed with a substantially semicircular shoulder 44, which prevents the rotary envelop 39 from losing its position from the seat or opening 40 when said frame is being drawn outwardly toward the right, looking at Fig. 9. The rotary envelop 37 for the impeller 33 rotates within the opening 38 and receives its rotary motion either from the impeller 33 or the shaft 30, as hereinafter explained, and in order that said envelop 37 may thus be rotated a portion of the impeller 33 always remains within said envelop and said shaft 30, adjacent to the outer end of said envelop 37, is formed with a head 45, Fig. 9, which is fastened to said envelop, whereby the shaft 30 becomes, in effect, during certain operations the shaft for transmitting power from the rotary motor 20 to the impeller 33. The impeller 34 receives its motion from or imparts motion to the shaft 31 in accordance with whether the device 21 is operating as a pump or as a motor, and said impeller 34 rotates the envelop 39.

The means for moving the frame 36 toward and from the stationary frame 35 comprise in the present instance a rack-bar 46, extending outwardly from the said frame 36, a pinion-wheel 47 in mesh with said rack-bar, and a wheel 48, secured upon the shaft 49 for said wheel 47, and the wheel 48 may be operated in any suitable manner, and in the case of elevator structures the said wheel may be operated by means of a usual control-cable within reach of the attendant in the car. By turning the wheel 48 in one direction the frame 36 will be caused to approach the stationary frame 35, and by turning the wheel 48 in an opposite direction the frame 36 will be caused to recede from said frame 35, the impellers 33 34 being entirely concealed when the frame 36 is moved close up to the frame 35 and being more or less exposed in the adjustment of said frame 36 from and toward said frame 35, thereby varying the capacity of the pump or motor 21 at will from nothing to the maximum.

The movable frame 36 has on opposite sides the shoulders 50, Figs. 12, 15, and 16, which guide on the longitudinal edges 51, Figs. 11, 13, of the stationary frame 35, and between the shoulders 50 the frame 36 is formed with a semicircular portion 52, which guides within the longitudinal semicircular portion 53 of the frame 35, and the frame 35 is formed with the shoulders 54, Figs. 10, 13, 14, against which the edges 55 of the longitudinal portion 56 of the frame 36 may guide, while between the said shoulders 54 the frame 35 is formed with the semicircular portion 57, against which said semicircular portion 56 of the frame 36 may guide, so that when the frame 36 is moved to its full inward position against the frame 35 the impellers 33 34 will be fully concealed within their envelops 37 39; but it is to be observed that although the impellers are at such time fully concealed and perform no duty their envelops 37 39 may continue in rotation under the power transmitted to them from the impellers 28 29 of the pump or motor 20.

The variable pump or motor 21 has been made the subject of a separate application for Letters Patent of the United States, filed by me on September 7, 1904, and bearing Serial No. 223,599, and therefore the said variable pump or motor is not separately claimed herein, but is illustrated herein for the purpose of disclosing the best means and method known to me for carrying out the present invention.

The impellers 33 34 of the motor or pump 21 are longer than the impellers 28 29 of the pump or motor 20, and the corresponding impellers in said pumps or motors 20 21 have their major axes on the same plane.

In arriving at an understanding of the operation of the invention it will be necessary to consider the action of the various parts of the apparatus under the varying conditions under which an elevator-car may be used, it being remembered that the purpose of the invention is to so regulate the water-supply that the water used from the main is directly proportioned to the load raised or lowered. In explaining the operation of the invention it may be assumed for purposes of illustration that the apparatus has been designed for an average load of fifteen hundred pounds and that the pressure of the water-supply is

one hundred pounds to the square inch. To start with, it may be assumed that the effective surface of the impellers in the motor or pump 21, which is exposed, equals the surface of the impellers in the pump or motor 20 and that the pressures are therefore balanced and the parts at rest, there being then the one hundred pounds pressure acting against one side of the pump or motor 20 and against the opposite side of the motor or pump 21. If the car is to ascend with its full or maximum load, the frame 36 of the variable motor or pump 21 will be moved inwardly to effect the concealment of both of the impellers 33 34, said frame 36 then closing the passage through the pump or motor 21 and said impellers 33 34 while rotating performing no duty whatever. Under this condition of the apparatus the water from the main will flow through the pipe 24, pump or motor 20, and pipe 25 into the cylinder 22 and effect the movement of the piston therein, whereby the rod 88 may be enabled, through its proper connections, to cause the car to ascend. Under such condition of the ascent of the car with the maximum load the apparatus constituting my invention performs practically no function during such ascent. To stop the ascending car carrying the maximum load, the attendant, by operating the wheel 48 through the ordinary cable, will move the frame 36 outwardly to a slight extent from the frame 35, thus exposing a narrow portion of the impeller 34 and effecting the exposure of a corresponding portion of the impeller 33 and bringing said exposed portion of the impeller 33 into coöperative relation with the exposed portion of the impeller 34, which will result in said impellers 33 34 acting as a pump pumping at one hundred pounds pressure until the inertia of the water flowing through the pipe 24 has been overcome and the pressures have become balanced, whereupon the car will stop. The slight friction of the moving parts of the apparatus will hold the impellers stationary when the pressures are balanced—that is, when there is the predetermined pressure of, say, one hundred pounds back pressure in the cylinder 22 and one hundred pounds impressed pressure on the main side of the motor or pump 20. It may be said, for the sake of illustration, that to stop the ascending car carrying a maximum load the frame 36 should be moved to expose about five per cent. of the length of the impellers 33 34. When it is desired that a car carrying the maximum load shall descend, the attendant in the car will by operating the wheel 48 move the frame 36 outwardly from the position last above indicated to expose about another five per cent., or a total of ten per cent. of the effective area of the impellers 33 34, this, assuming that the friction of the parts equals five per cent. of such area. Under this condition of the apparatus there would be the full impressed pressure of one hundred pounds on the main side of the pump or motor 20 and one hundred pounds back pressure from the cylinder 22 against the opposite side of the pump or motor 20 and one hundred pounds impressed pressure on one side of the motor or pump 21, with the-ten-per cent. area of the impellers 33 34 exposed to the said pressure, resulting in said impellers 33 34 being rotated reversely as a motor and driving the impellers 28 29 of the pump or motor 20 as a pump for pumping the water from the cylinder 22 and allowing the car to descend. The water which is at this time pumped from the cylinder 22 passes partly into the main through the pipe 24 and partly through the pipe 27 and motor 21 to the storage-tank 23, ninety per cent. of the said water passing to the main and ten per cent. thereof into the said storage-tank, whereby there is a saving of the said ninety per cent. of the water, the same being returned to the main instead of being wasted or allowed to escape into a sewer.

The operation of the apparatus may be further illustrated by stating the conditions which prevail during the ascent, stoppage, and descent of the car when the latter contains one-half of its maximum load. Under this condition, in causing the car to ascend, the attendant will through the wheel 48 and intermediate connections move the frame 36 outwardly until about but not quite one-half of the effective areas of the impellers 33 34 become exposed and placed into coöperative relation to each other, and at such time the variable pump or motor 21 will act as a pump and will be driven by the pump or motor 20 acting as a motor. Under this condition the pump 21 will pump about one-half of the quantity of water required for the cylinder 22 from the storage-tank 23, and the balance of the water required for said cylinder will come from the main. When the impellers 33 34 have thus become exposed throughout about but not quite one-half of their effective area we have during the ascent of the car with one-half of its maximum load fifty pounds back pressure in the cylinder 22, due to the load, and this acts against one side of the impellers in the pump or motor 20, and we also have one hundred pounds impressed pressure acting against the other side of the impellers in the pump or motor 20, leaving an effective pressure of fifty pounds to turn the impellers in said motor 20. The proportionate areas of the impellers in the pumps or motors 20 21 must be such that in the illustration given the fifty pounds excess of pressure on the main side of the pump or motor 20 may enable the said pump or motor to act as a motor and operate the pump or motor 21 as a pump, the latter pumping at a pressure of one hundred pounds and approximately

pumping one-half of the quantity of water required for the cylinder 22. In this illustration of the action of the parts it is to be remembered that the effective area of the impellers 33 34 exposed for duty is less than the area of the impellers 28 29 in the motor 20. To stop the car, ascending with one-half its maximum load, the attendant will move the frame 36 slightly outwardly to a further extent, so that just one-half of the effective surface areas of the impellers 33 34 become exposed, and at such time there will be the fifty pounds back pressure in the cylinder 22 and one hundred pounds impressed pressure on the main side of the pump or motor 20 and on the discharge side of the pump or motor 21, which acting on the thus-exposed impellers 33 34 operates to enable the latter to hold the impellers 28 29 of the pump or motor 20 stationary. In this illustration the impellers in the pump or motor 21 do not turn under the impressed pressure against them, because of the fifty pounds of back pressure in the cylinder 22 and the fact that the one hundred pounds of impressed pressure on the impellers 33 34 is only acting against one-half of the effective area of said impellers. When the car is to descend with one-half of its maximum load, the attendant will pull the frame 36 outwardly to a slightly further extent, so that slightly more than one-half of the effective area of the impellers 33 34 will be exposed, and under sucn condition the impressed pressure from the main will drive the pump or motor 21 as a motor, which will drive the pump or motor 20 as a pump, the latter pumping the water out of the cylinder 22, fifty per cent. of said water going to the main and fifty per cent. through the motor 21 to the storage-tank 23.

A further illustration of the operation of the apparatus would be a consideration of the conditions which prevail during the ascent, stoppage, and descent of the car with no load. Under this illustration, leaving the question of friction out of account, there would be no back pressure in the cylinder 22, and the attendant would move the frame 36 inwardly until the exposed effective area of the impellers 33 34 is slightly less than the area of the impellers 28 29—that is, about five per cent. less—so as to overcome friction, under which condition there would be no back pressure, and the pump or motor 20 would act as a motor and drive the motor or pump 21 as a pump, the latter pumping from the storage-tank 23 and delivering to the motor 20 about ninety-five per cent. of the water required for the cylinder 22, the other five per cent. of the water coming from the main and being just sufficient to overcome the friction created by the moving parts. In this illustration the impellers 33 34 and 28 29 rotate in unison, and since the effective area of the impellers 33 34 was only reduced about five per cent. from a balancing condition and since the impellers 28 29 are consuming one hundred per cent. of water it follows that the impellers 33 34 pump from the storage-tank 23 ninety-five per cent. of the volume of water consumed. To stop the car ascending with no load, the attendant would simply move the frame 36 outwardly until the exposed effective area of the impellers 33 34 equals the area of the impellers 28 29 and the pressures become balanced on the main side of the pump or motor 20 and the discharge side of the pump or motor 21. To effect the descent of the car with no load, the attendant would move the frame 36 outwardly to an extent equal to about ten per cent. of the length of the impellers 33 34 beyond the degree of exposure of said impellers during the upward travel of the car with no load, and then the pump or motor 21 would act as a motor and drive the pump or motor 20 as a pump. The water from the cylinder 22 will then pass through the pump 20 and motor 21 to the tank 23, and at such time a volume of water from the main equal to about five per cent. of the volume of the water from the cylinder 22 would also pass through the motor 21 to the said tank 23, this five per cent. of water from the main passing to the tank 23 being due to the extra five per cent. of exposure of the impellers 33 34 for moving the car downwardly. In other words, during the descent of the car with no load the pump or motor 21, acting as a motor, consumes five per cent. more water than the pump 20 withdraws from the cylinder 22.

It is thought that the foregoing illustrations of the operation of the apparatus will be sufficient to indicate the utility of the invention. The saving of water during the ascent of the car is due to the fact that only a part of the water is taken from the main, while the other part is pumped from the storage-tank, and that the portion taken from the main is directly proportional to the load and during the descent of the car the water is put back into the main in direct proportion to the load on the car, necessary fixed friction losses excepted.

It is to be understood that my invention is not limited to the special details of mechanism above described, nor to any special hydraulic cylinder or actuating-motor 22, nor to the nature of the work the rod of said cylinder is to perform, whether it be for actuating an elevator-car or other body or device, the main object being that water used from the main shall be directly proportional to the load raised or lowered in the elevator or in other apparatus to the amount of work done. I regard the invention, however, as of very great utility in hydraulic-elevator apparatus.

I designate the parts 20 21 as "pumps" or "motors" because each acts at times as a pump and at other times as a motor, the part

20 acting as a pump when driven by the part 21 acting as a motor and acting as a motor when driving the part 21 as a pump.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In hydraulic apparatus, an actuating-motor for converting hydraulic into mechanical power, a pump or motor connected with a source of liquid supply under pressure and with said actuating-motor, a storage-tank for liquid, a variable pump or motor connected with said tank and with said liquid-supply, and means for regulating said variable pump or motor, said pumps or motors having co-operative action; substantially as set forth.

2. In hydraulic apparatus, an actuating-motor for converting hydraulic into mechanical power, a rotary pump or motor of the impeller type connected with a source of liquid-supply under pressure and with said actuating-motor, a storage-tank for liquid, a variable rotary motor or pump of the impeller type connected with said tank and with said liquid-supply, and means for regulating said variable pump or motor, said pumps or motors having coöperative action; substantially as set forth.

3. In hydraulic apparatus, an actuating-motor for converting hydraulic into mechanical power, a pump connected with a source of liquid-supply under pressure and with said motor, a storage-tank for liquid, a variable motor connected with said tank and with said liquid-supply, and means for regulating said variable motor, said pump and variable motor having coöperative action; substantially as set forth.

4. In hydraulic apparatus, an actuating-motor for converting hydraulic into mechanical power, a motor connected with a source of liquid-supply under pressure and with said actuating-motor, a storage-tank for liquid, a variable pump connected with said tank and with said liquid-supply, and means for regulating said pump, said pump and motor having coöperative action; substantially as set forth.

5. In hydraulic apparatus, an actuating-motor for converting hydraulic into mechanical power, a pump or motor connected with a source of liquid-supply and with said actuating-motor, a storage-tank for liquid, and a variable pump or motor coacting with said pump or motor and connected with said liquid-supply and said tank, said variable pump or motor comprising impellers and means for controlling the extent of area of said impellers which shall be permitted to act; substantially as set forth.

6. In hydraulic apparatus, an actuating-motor for converting hydraulic into mechanical power, a pump or motor connected with a source of liquid-supply and with said actuating-motor, a storage-tank for liquid, and a variable pump or motor coacting with said pump or motor and connected with said liquid-supply and said tank, said variable pump or motor comprising impellers one of which is movable with respect to the other impeller, and means for controlling the extent of area of said impellers which shall be permitted to act and placing the adjacent ends of said impellers into coöperative relation to each other; substantially as set forth.

7. In hydraulic apparatus, an actuating-motor for converting hydraulic into mechanical power, a pump or motor connected with a source of liquid-supply and with said actuating-motor, a storage-tank for liquid, and a variable pump or motor coacting with said pump or motor and connected with said liquid-supply and said tank, said variable pump or motor comprising the impellers, a rotary envelop having an opening to receive more or less of one of said impellers, a rotary envelop to receive more or less of the other impeller, and means for effecting the exposure to a greater or less extent of the adjoining ends of said impellers and placing said ends into co-operative relation to each other; substantially as set forth.

8. In hydraulic apparatus, an actuating-motor for converting hydraulic into mechanical power, a pump or motor connected with a source of liquid-supply and with said actuating-motor, a storage-tank for liquid, and a variable pump or motor coacting with said pump or motor and connected with said liquid-supply and said tank, said variable pump or motor comprising the impellers one of which is movable longitudinally with respect to the other impeller, means for moving said movable impeller to bring more or less of its area into coöperative relation with the other impeller, and means for concealing so much of the area of said impellers as it may be desired to keep out of action; substantially as set forth.

9. In hydraulic apparatus, an actuating-motor for converting hydraulic into mechanical power, a pump or motor connected with a source of liquid-supply and with said actuating-motor, a storage-tank for liquid, and a variable pump or motor coacting with said pump or motor and connected with said liquid-supply and said tank, said variable pump or motor comprising the impellers, a frame having an opening therein, a rotary envelop fitting said opening in said frame and containing an opening to receive more or less of one of said impellers, a movable frame containing an opening, a rotary envelop fitting the opening in said movable frame and having an opening in it to receive more or less of the other one of said impellers, means connecting said movable frame to the impeller of the first-mentioned frame, and means for moving said movable frame toward and from the other frame, whereby one of said impellers may be more or less forced into or withdrawn

from its rotary envelop and the envelop carried by said movable frame is caused to more or less conceal or expose its impeller and the adjacent ends of said impellers are brought into coöperative relation to each other; substantially as set forth.

10. In hydraulic apparatus, an actuating-motor, a rotary pump or motor of fixed capacity and a rotary pump or motor of variable capacity connected with the source of liquid-supply to said actuating-motor, an additional source of liquid-supply connected with the pump or motor of variable capacity, and means for adjusting the impellers of said pump or motor of variable capacity in accordance with the load, said rotary pumps or motors having their corresponding impellers connected for coöperative action; substantially as set forth.

Signed at New York city, in the county of New York and State of New York, this 10th day of September, A. D. 1904.

ETHELBERT M. FRASER.

Witnesses:

CHAS. C. GILL,

ARTHUR MARION.