(No Model.) 2 Sheets—Sheet 1.

E. S. MATTHEWS.

HYDRAULIC VALVE.

No. 519,638. Patented May 8, 1894.

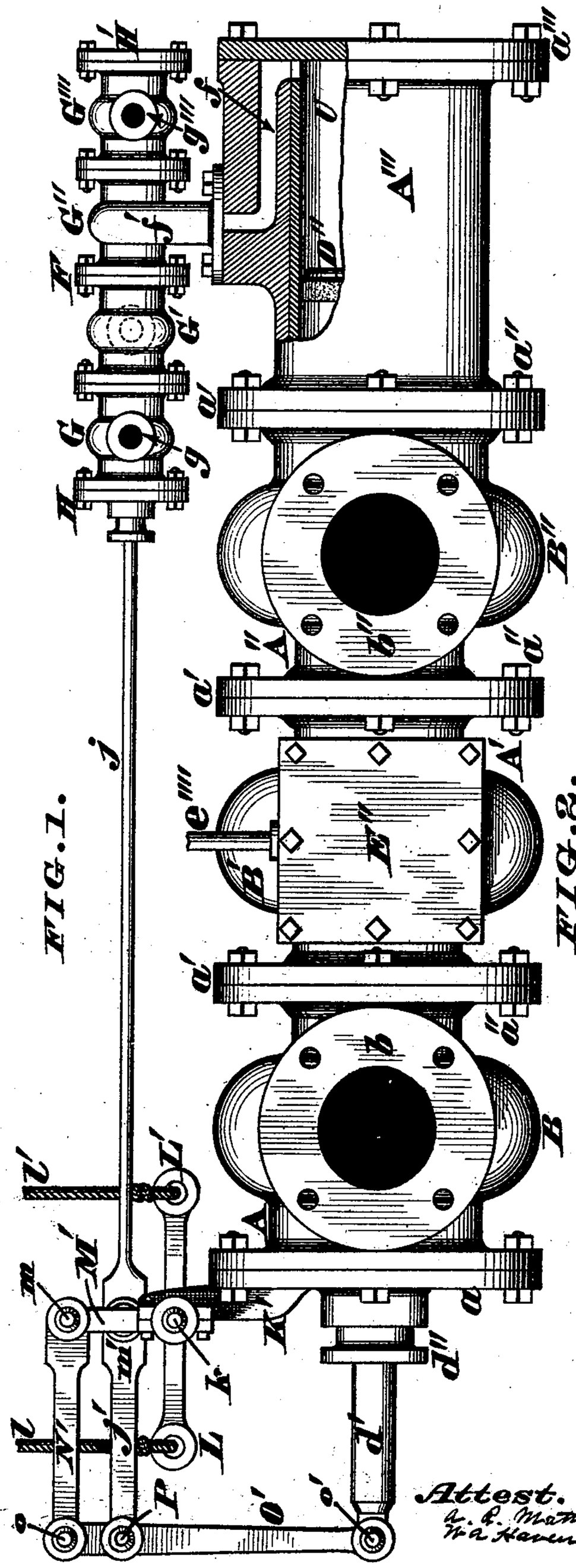

FIG. 1.

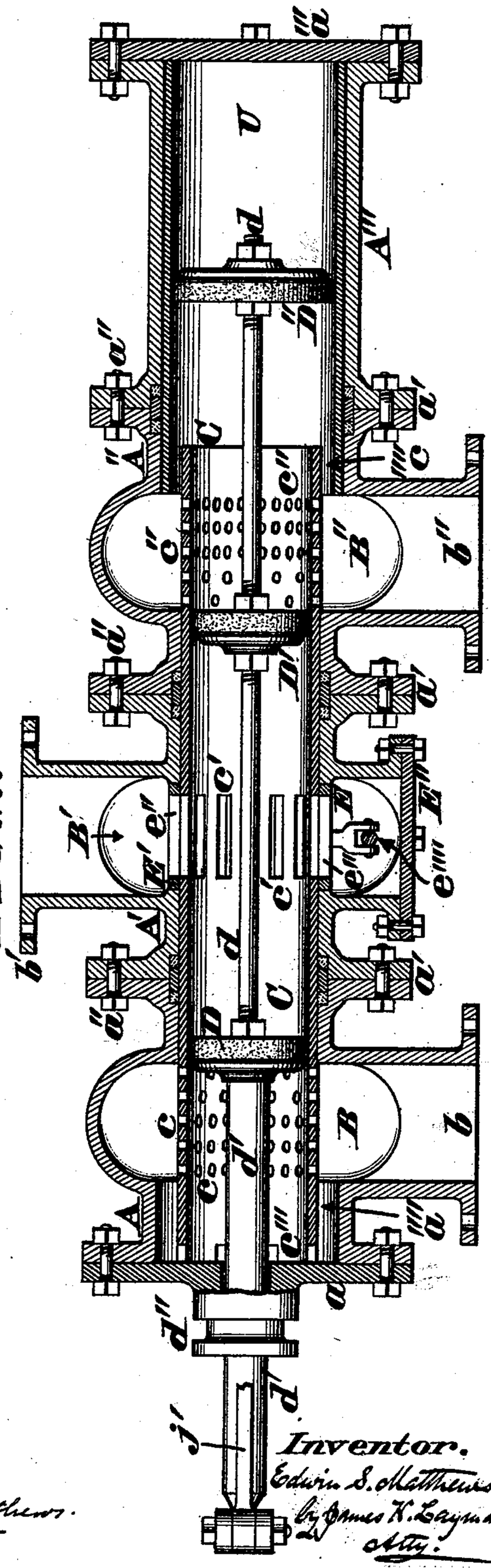

FIG. 2.

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(No Model.) 2 Sheets—Sheet 2.

E. S. MATTHEWS.

HYDRAULIC VALVE.

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FIG. 3.

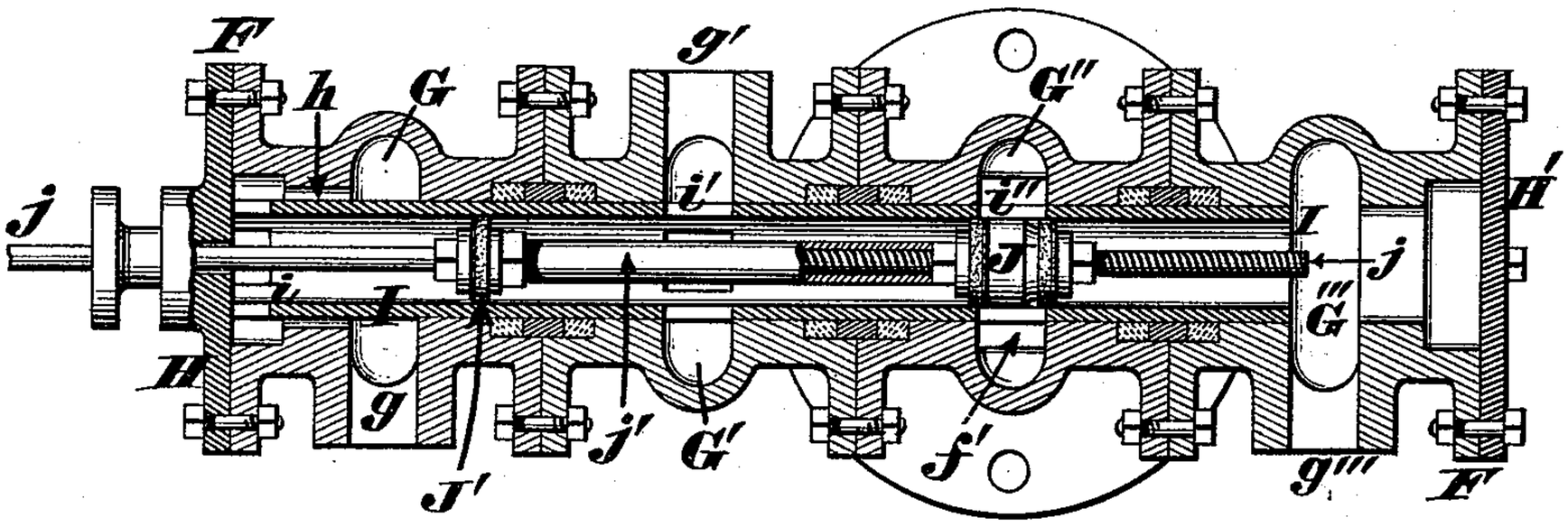


FIG. 4.

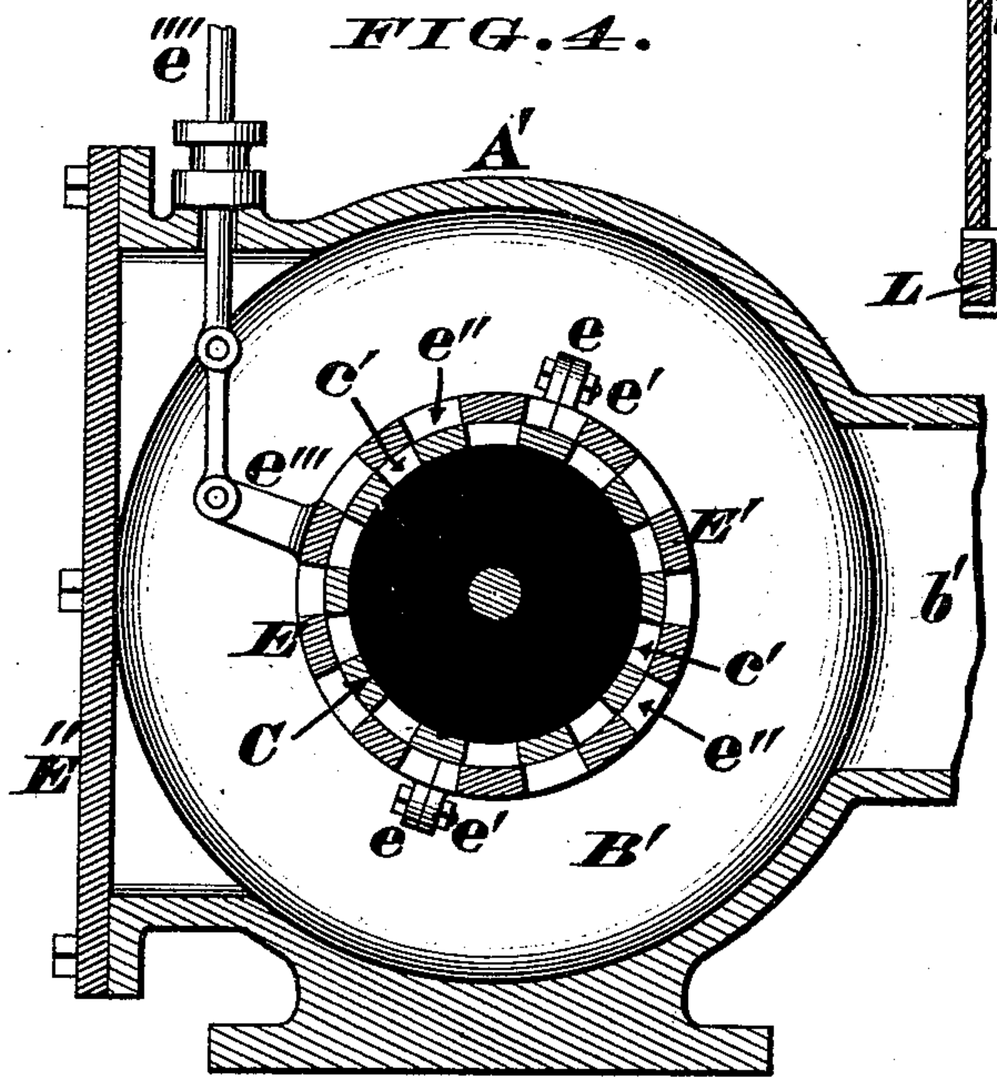


FIG. 5.

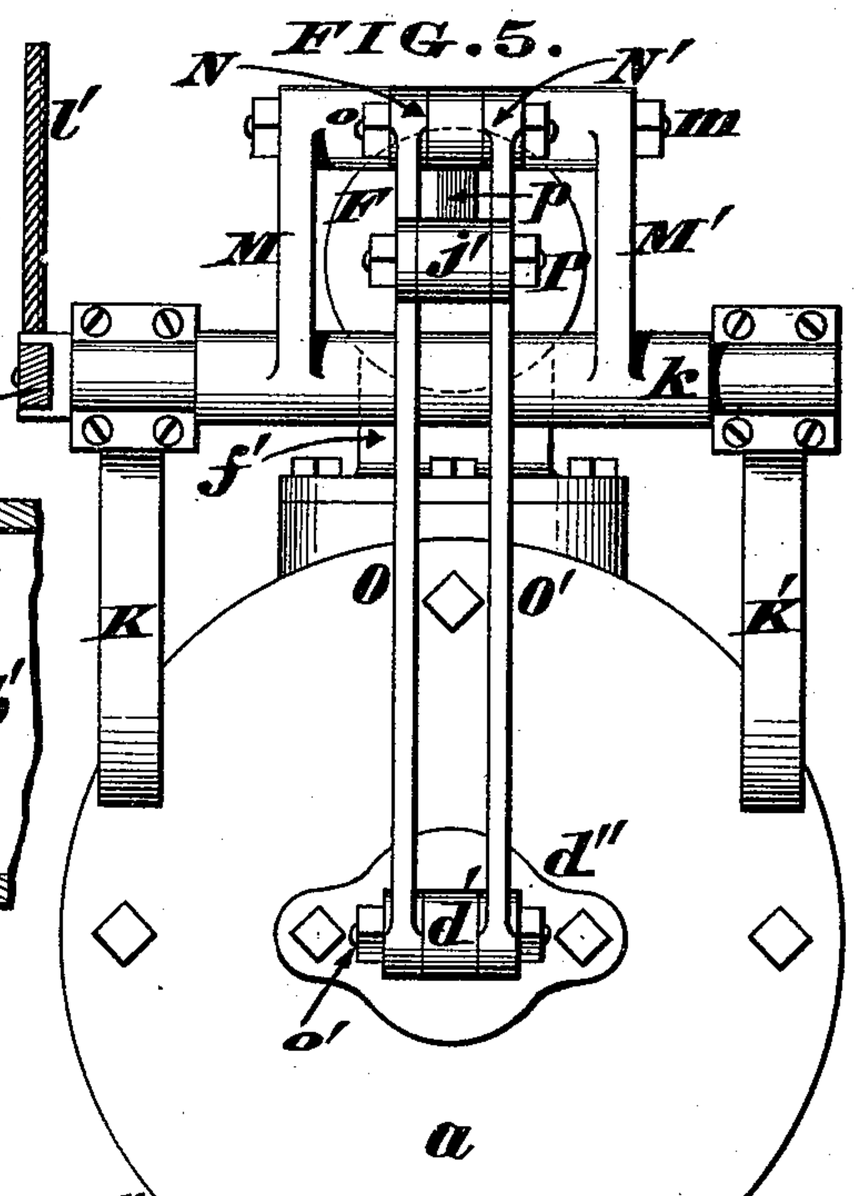


FIG. 6.

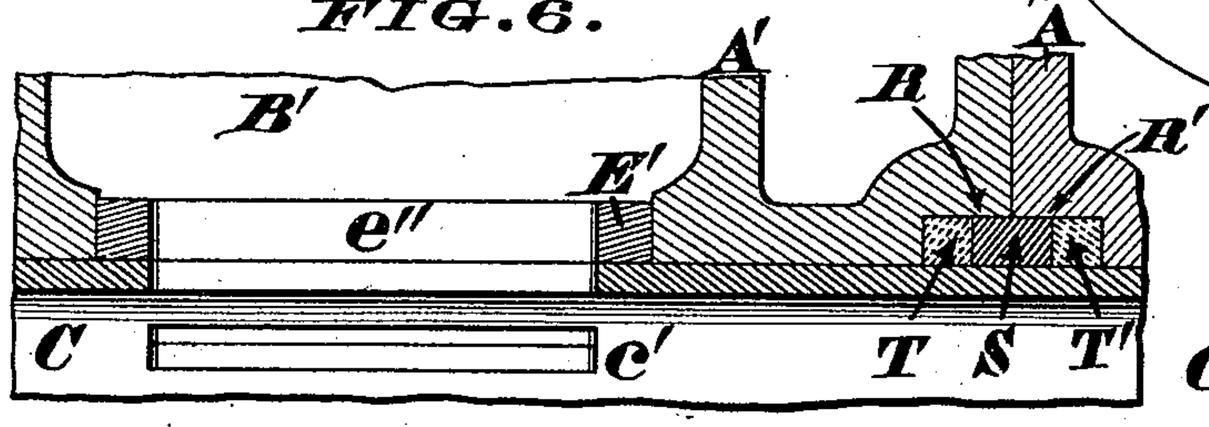
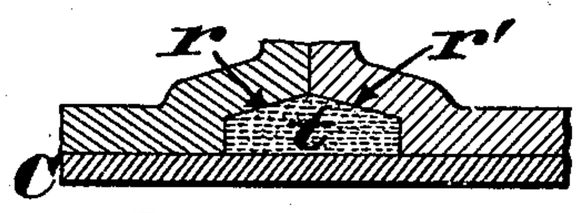


FIG. 7.



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UNITED STATES PATENT OFFICE.

EDWIN S. MATTHEWS, OF CINCINNATI, ASSIGNOR OF ONE-HALF TO JAMES L. HAVEN, OF AVONDALE, OHIO.

HYDRAULIC VALVE.

SPECIFICATION forming part of Letters Patent No. 519,638, dated May 8, 1894.

Application filed January 7, 1891. Serial No. 376,948. (No model.)

To all whom it may concern:

Be it known that I, EDWIN S. MATTHEWS, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Hydraulic Valves; and I do hereby declare the following to be a full, clear, and exact description of the invention, reference being had to the annexed drawings, which form part of this specification.

In hydraulic elevators and other apparatus for utilizing power from hydraulic, or other liquid, or gaseous pressure, it is customary to make use of a cylinder to which the fluid under pressure is conducted, and in which a piston, plunger, or equivalent, is moved by this fluid under pressure, which occupies the space thus vacated; thus rendering it necessary that this fluid be discharged from the cylinder when the reverse motion of said piston or plunger is desired, or, if it is desired to hold the piston or plunger stationary, necessitating that the fluid in the cylinder be securely locked within it at such a time.

My invention relates to an improved form of valve for controlling the supply of fluid to such a cylinder; and since such a cylinder is a well known mechanical device and my valve is equally applicable to all forms of the same, I have not shown it in drawings, but shall allude to it as the motor cylinder, or main motor.

My hydraulic valve is designed to give an operator a more positive and accurate control of the hydraulic, or fluid apparatus than has heretofore been afforded, to prevent all jar or sudden transition from rest to motion, or vice-versa; to prevent the possibility of the piston of the main motor traveling beyond its proper and predetermined limit, to prevent the possibility of the valve being accidentally, wholly, or partially shifted by any leakages, even if such leakages should exist, such occurrences being a not uncommon source of danger in many forms of hydraulic apparatus. This insures that when the hydraulic apparatus is brought to rest, it shall remain at rest until the valve is shifted by the operator, and when in motion that it shall retain the desired rate of motion until the valve is shifted by the operator, or the piston of the main motor terminates its stroke. Furthermore, the form of this valve is such as to be readily adapted to all the various conditions and arrangements necessary in practical application of hydraulic power, and such that its parts are readily accessible in case renewal or repair is necessary, all of which foregoing points will be hereinafter made evident in detailed description of the valve and its operation. In general it will be noticed that this valve has three sets of ports, two of which are opened and closed by the motion of pistons actuated by water pressure controlled by a pilot valve, while the third set of ports is opened and closed by a sleeve stop called the safety stop, moved automatically by the piston of the main motor as it reaches the termination of its stroke; this stop being always automatically operative and wholly without the power of the operator to effect or control motion of the same. Although this arrangement of ports is considered the best for efficient operation of the hydraulic valve the invention is not considered as restricted to the exact arrangement as shown, inasmuch as the valve would be operative, though less efficient, if only one set of ports namely, the center ones, were used for all purposes of water control or safety stop ports were otherwise arranged.

In the annexed drawings Figure 1 is a side elevation of my improved hydraulic valve. Fig. 2 is a horizontal section of the same, the safety stop being open so that it presents no obstruction to the flow of water through the valve, which is, however, prevented in the position shown, by the pistons which are represented in mid-position, thus allowing no water to enter or leave the motor cylinder. Fig. 3 is an enlarged horizontal section through the pilot valve. Fig. 4 is an enlarged transverse section of the safety stop and its accessories, which stop is here shown in its closed position. Fig. 5 is an enlarged end elevation of the hydraulic valve casing and connecting gear to pilot valve. Fig. 6 is a greatly enlarged horizontal section of a portion of the valve cylinder, showing flange and packing, also safety stop and ports. Fig. 7 is a section of a modified form of the joint packing.

Referring to Fig. 2, A A′ A″ and A‴, rep-

resent four separate and distinct sections composing the external shell, casing, or jacket of my valve, the outer end of the sections A and A''' being closed by heads *a* and *a'''* respectively, the sections A, A' and A'' are provided with annular passages B B B' B'' and these passages have pipe ends *b*, *b' b''* or other connections to couple to certain parts of the apparatus, to wit.—the opening *b''* to the source of fluid supplying motive power to the apparatus; the opening *b'* to the motor cylinder where said pressure is utilized and the opening, *b*, to the discharge where the fluid is emptied after having accomplished its work; while all sections are so united by flanges, *a*, and bolts, *a''*, as to allow every possible adjustment which may be required for arrangement of connections of pipe openings *b b'' b'''* and when so arranged to be tightened by bolts *a''* so as to constitute a long rigid cylinder of the proper length to afford the desired stroke of valve. Securely fitted within the casing is a non-corrosive tube, C which will be hereinafter designated as the "main valve cylinder," inasmuch as it is traversed by the pistons that regulate the flow of water to and from the motor cylinder, whatever the latter may be. This main valve cylinder has near its mid length a series of slotted ports, *c'* communicating with the water passage, B' and near its opposite ends a series of perforations, *c* and *c''* which lead, respectively, into the other water passages, B and B''.

c''' are ports at the extreme end of cylinder, C which ports communicate with an annular passage *a''''* of shell section A. This passage, *a''''* leads directly into the passage B. The opposite end of cylinder C, is entirely open to admit the ready insertion of the valve appliances after the head *a'''* of section A''' has been detached, and to allow the pressure of fluid supply in passage B'' to take effect on the outside surface of piston D' in whatever position said piston may be.

D, D' D'' represent three pistons attached rigidly though adjustably, to a common piston rod, *d*, which terminates in a plunger, *d'*, passing through a stuffing box in head, *a*, and of sufficient rigidity and strength to impart accurate motion to the connecting gear shown attached thereto, as will be hereinafter more fully explained. The piston D'' it will be noted, is of larger diameter than the pistons D and D' which reciprocate in cylinder C, and itself reciprocates in a larger cylinder U, which will be designated as the "actuating cylinder," which cylinder is fully supplied with water on its inner side from the annular passage B'' through the passage *c''''*, thus allowing an unbalanced pressure of water to exist between the piston D'' and either piston D or D' causing these said pistons D or D' to act not only to control the flow of water to the main motor by their passage across the ports, *c*, and *c''*, but also in conjunction with the piston D'' to furnish by means of the unbalanced pressure alluded to, the power required to move themselves in response to movements of the pilot valve which controls the balancing of pressure as will be hereinafter more fully explained. Adapted to revolve freely around cylinder, C, is a sleeve stop, preferably composed of a pair of semi-cylindrical halves, E and E' as seen in Fig. 4, which halves are secured together by lugs, *e*, and bolts *e'*, and have slotted ports, *e''* that coincide with the central ports, *c'* of said cylinder when this sleeve stop is open. As valve E E' is intended to operate only in certain contingencies, it will be hereinafter designated as the safety stop. Projecting laterally from this safety stop is a lug *e'''* suitably coupled to a rod *e''''* which rod may be operated by any convenient attachment to the piston or cross head or other moving part of the main motor of the apparatus.

E'' is a cap the removal of which affords ready access to this safety device, E, E'. The actuating cylinder U of the main valve, is constructed of non-corrosive material inclosed in section A''' and has a channel *f* communicating with a hollow pedestal *f'* that supports the pilot valve casing, or shell F, which casing is composed of a number of sections fitted together in practically the same manner as the sections of the main valve shell. This pilot valve casing has four annular passages, G, G' G'', G''' and three pipe ends *g*, *g'*, *g'''* communicating with said passages G G' and G''' but the other passage G'' communicates with the hollow pedestal, *f'* above alluded to. (See Fig. 3.) The pipe ends, *g* and *g'''* are connected to a waste tank or sewer or other receptacle for discharge water, while the other pipe end, *g'* communicates either directly or indirectly with the main or primary source of hydraulic or pneumatic power of the entire apparatus; such, for example, as an aqueduct or roof tank or pressure tank, &c.

H and H' are heads that close the extreme ends of the outer sections of the pilot valve casing within which casing is secured a tube, I of non-corrosive material that will be hereinafter alluded to as the "pilot valve cylinder," because it is traversed by the pistons or plungers wherewith the flow of water through the pilot valve and to and from the actuating cylinder of the main valve is controlled. This pilot valve cylinder has at one end a series of openings, *i*, near its center a set of slotted ports, *i'*, and near its other end a similar set of ports, *i''*. These openings, *i'*, lead into an annular passage, H, communicating with the passage, G, and from thence through the pipe end, *g*, to the receptacle of discharge fluid, while the ports, *i''*, open into passage G' and thence through the pipe end *g'* communicate with the supply of fluid under pressure. The other ports, *i''*, lead into the passage, G'', and thence through the passages *f'* and *f* to the actuating cylinder of the main valve through which passages and aforesaid ports, *i''*, the water or other fluid

passes to and from the actuating cylinder, U, of the main valve, as will be hereinafter more fully described in explaining the operation of the valve. Furthermore, this cylinder extends from the head, H, to passage, G‴, into which latter it opens directly, and from this passage through the pipe end, g''', it communicates with the receptacle for waste fluid from the apparatus. This pilot valve cylinder, I, is traversed by a piston valve, J, a counterbalancing piston, J′, said members, J, J′, being adjustably but firmly secured upon a stem, j, and being kept at proper distance by a bushing, j', applied to said stem. It will be noted that both the openings, G, and, G‴, of the pilot valve communicate with the receptacle of discharge water which is for the purpose of balancing this pilot valve against any back pressure on the discharge, and so securing its free and easy movement under all circumstances. The discharge of the pilot valve passes to the receptacle for discharged fluid through the passage, G‴, as will be hereinafter more fully noted, while the passage, G, not only causes a counterbalance against back pressure, but serves to collect any accidental leakage that might occur around piston, J′, which is under the pressure of supply fluid.

The stem, j, traverses a stuffing box attached to the head H and is then coupled to the pilot valve actuating devices, the latter being arranged as follows:—projecting either from the section, A, of the main valve, or from the head, a, of said section, as seen in Fig. 5, are a pair of brackets—K, K′, that afford journal bearing for a rock shaft, k, to one end of which levers, L, L′, are secured. Attached to these levers are ropes or other couplings, l, l', leading to proper appliances wherewith the conductor or other attendant of the apparatus can control the action of the valves and thus regulate the speed, or start and stop the main motor. Projecting upward from rock shaft, k, are arms, M, M′, carrying a short shaft, m, to which are coupled the right ends of horizontal rods N, N′, the opposite end of the same being attached at, o, to the upper ends of a pair of vertical levers, O, O′, also from this shaft, m, a pendent link, p, hangs, carrying a pin, m', joining the pilot valve stem, j, to the horizontal link, j'. The lower ends of the levers, O, O′, are coupled at, o', to the stem of the main valve, d', in order that said ends may have the same motion as the valve.

P, is a pin uniting the pilot valve stem, j, through the pin, m', and the horizontal link, j', to the vertical levers, O, O′, at any suitable point between their ends; thus securing to the pilot valve stem, motion from the main valve by means of the pin, o', and also motion from the rock shaft, k, through the upper pin, o. These pins, o, o', at the ends of the levers alternately serve as fulcrums, each for the other, for said levers, O, O′, to swing on, as motion is imparted to them, either from the rock shaft, k, or from the main valve.

The joints at the various sections, both of the main and pilot valve casings, are constructed as seen in Fig. 6, reference to which illustration shows that the abutting ends of the contiguous sections are counter-bored, respectively, at, R, R′, and that a ring, S, and a pair of annular packings, T, T′, are inserted within said counter-bores, the ring S, being applied between the yielding packings. Consequently, when the sections are bolted together, said packings are expanded outwardly and forced so tightly against the cylinder C, as to produce a water tight joint, and to hold the latter centrally in the shell and without employing other fastenings. But, as seen in Fig. 7, a single flexible packing, T, is used, and the counterbores, r, r', are so shaped as to exercise a wedging action against said packing.

In arranging my valve mechanism, it will be recalled that the connection, B, has a pipe coupled to it and leading to a sewer or tank or other receptacle for the waste water from the apparatus, while the connection, B′, has a pipe attached to it and communicating with the cylinder of the fluid motor. The other connection, B″, has a pipe attached to it and leading to the street main or pressure tank or other sources for obtaining the proper head of water.

The operation of my hydraulic valve is as follows:—Reference being had now more particularly to Figs. 1, 2, and 3, which illustrations show the main valve and the pilot valve in such positions as to prevent the flow of water through their respective cylinders. It is evident from an inspection of Fig. 2, that the annular channel, B″, and that portion of the shell and cylinder included between the pistons, D′, D″, will be filled with water at the same pressure as the street main, or tank, or other source of supply. It is also evident that there is now a tendency for these members to move toward the head, a''', on account of the piston, D″, being of somewhat greater diameter than the piston D′, but such a movement cannot take place because the water contained between the piston, D″, and said head together with the water collected in channel, f, and hollow pedestal, f', is securely imprisoned by the pilot valve, J, closing the ports, i'', that lead from said pedestal into the cylinder, I′, of said valve. To start the main motor, the rope, l', is pulled, either directly or indirectly by the attendant of the apparatus, the result being to rock the shaft, k, in such a manner as to advance the piston, J, of the pilot valve to the left, thereby uncovering the inlet and outlet ports i'' and opening communication between the confined body of water imprisoned in the actuating cylinder, U, of the main valve, and the receptacle for discharge water of the apparatus through discharge pipe, g''', of the pilot

valve. The unbalanced pressure between the pistons, D′, D″, now moves the pistons and connecting stem of the main valve to the right, and the water in the actuating cylinder, U, of the main valve is discharged through the opening, G‴, of the pilot valve. This motion causes piston D′ in passing to the right to uncover a portion of the ports formed by the holes, *c″*, and allows the water or other fluid under pressure from the source of supply to flow through the openings, *c″*, from annular passages, B″, and enter the cylinder, C, of the main valve, the escape of water from the opposite end of the latter being prevented by the other piston, D. Consequently, the water supply can now pass through the cylinder, C, ports, *c′*, annular passage, B′, and thence out at the pipe attached to the connection, *b′*, and as this pipe communicates with the main motor, it is evident the latter is at once set in motion.

By referring to Fig. 2, it will be noticed that the openings, *c″*, first uncovered by the piston, D′, are few in number but increase in number toward the right, the object of this arrangement being to gradually let the water on to the motor, and thereby to prevent any sudden jerk when it starts, which is quite a common and dangerous occurrence with elevators and other hydraulic apparatus driven with a high head or pressure. Simultaneously with the shifting of the main valve to the right, the pilot valve, J, is advanced in the same direction, through the medium of the link mechanism, thereby closing the ports, *i″*, of cylinder, I, and preventing further travel of the main valve. To stop the main motor, the other rope, *l*, is pulled so as to bring the rock shaft, *k*, to its primary position, seen in Fig. 1, thus causing the pilot valve stem, J, to move to the right, and uncover the ports, *i″*, establishing communication between the body of water in the actuating cylinder, U, of the main valve, and the source of supply through the inlet, *g′*, of the pilot valve, which, as previously stated, connects with the source of supply. As soon as this communication is established, the piston, D″, becomes balanced, having the pressure of the primary supply on both sides, but the unbalanced pressure against the piston, D, now moves the main valve to the left and brings it to the position seen in Figs. 1 and 2. Evidently when the main valve has reached this point, the pilot valve will also, through the link mschanism, as heretofore explained, have come to the central position shown in Figs. 1 and 3, thus bringing the main valve to a positive stop in the central position seen in Figs. 1 and 2. Consequently the main motor is isolated from all connection either of supply or discharge, and is at once arrested and will remain at rest until these valves are again intentionally shifted either to the right or left. When it is desired to reverse the motion of the main motor, as, for example, to allow an elevator car to descend, the rope, *l*, is pulled, thus again uncovering the ports, *i″*, to the main supply, and causing additional motion of the main valve to the left in exactly the same manner as just previously described; said motion being terminated when by means of the link work the pilot valve, J, is again brought to cover the ports, *i″*, which motion as is evident, takes place in the same manner as heretofore noted, and causes its attached pistons, D, D′, to move toward the head, *a*, of the casing, which movement continues until the valve, D has uncovered all or a portion of the ports, *c*, and occupies a position between said uncovered ports and the openings, *c‴*; evidently, the water used in effecting the above described stroke of the main motor will now be discharged from the latter through the pipe attached to connection, *b′*, thence into the annular passage, B′, thence through the ports, *c′*, into cylinder, C, and then along this cylinder to the ports, *c*. The water finally escapes through these ports into the annular passage, B, and out at the discharge, *b*. It will be noticed that the first of the series of holes, *c*, uncovered by piston valve, D, are comparatively few in number, but increase toward the left, by which arrangement an enlarged area of opening is afforded in proportion as said valve advances, consequently, the discharge of water is gradually effected, and, on this account, the descent of the car is not initiated with a sudden drop. The openings, *c‴*, at the end of cylinder, C, prevents any imprisoning of water within said cylinder as the piston, D, approaches the head, *a*. Since the efficiency of this valve depends largely upon certain relations between main and pilot valves, it is necessary to consider these relations somewhat in detail and I will note, first:—that since the proportions of the lever arms, *o* P, and, *o o′*, are to each other as the stroke of the pilot valve is to the stroke of the main valve, or practically so, if the pilot valve be opened to its full stroke or extent of movement by the operator—the main valve must move its full stroke before it can close the pilot valve and come to rest; or, if the pilot valve be opened a fractional part of its stroke, it will be closed when the main valve has accomplished the same fractional part of its stroke, and the main valve be brought to rest at such a point. Hence, it is seen that the direction of the motion of the pilot valve of my hydraulic valve, as imparted to it by the operator, not only governs the direction of stroke, of the main valve, but the extent of motion imparted to the pilot valve by the operator governs the extent of stroke of the main valve and holds it immovably water locked in any position that may be signified by the particular direction and extent of motion imparted to the pilot valve by the operator. Furthermore, in my hydraulic valve it will be noted that the "lap" of the main valve in proportion to its stroke is relatively greater than the "lap" of the pilot valve in proportion to its stroke, or that the "lap" of the main valve

bears a greater proportion to the lever arm of the main valve represented by *o o'*, in the drawings (Fig. 2) than the lap of the pilot valve bears to the lever arm of the pilot valve represented by *o* P in Fig. 1. It will be noted that the lap of these valves is determined by the position of their respective pistons on their respective piston rods, and with the adjustable but rigid manner of securing the same in this valve, the lap may be set and maintained accurately at any desired ratio. The operation of this feature of my invention is as follows:—Suppose the main and pilot valves to be in mid-position as shown in Figs. 1, 2, and 3, and the main motor consequently at rest and desired for the present to remain so. In the ordinary forms of hydraulic valves, leakage to or from an actuating cylinder gradually shifts the main valve, and sets the main motor in motion, which motion would in some cases be slow or a "creep", as it is technically termed, while in other cases the main motor finally acquires full velocity, either of these is a source of danger and annoyance, and is entirely obviated by my invention, as follows: Suppose a considerable leakage to exist around the pilot valve, J, so as to allow the main supply to pass by this valve, though in mid position where such supply should be cut off; and find its way to the actuating cylinder U of the main valve. This will gradually move the main valve toward the left, but before the "lap" of the main valve can be taken up and a port uncovered, the pilot valve "lap" being proportionately less, as has been stated, will have been taken up by motion toward the left transmitted to the pilot valve from the main valve through the lever, O', and a port uncovered to discharge which absorbs the leakage without causing any additional motion of the main valve. It will be remembered in the meantime that the main valve, owing to its greater lap, has not uncovered any port to the main motor which, consequently, remains at rest. A similar and complete analysis would show that no leak in the pilot valve or around the piston, D'', of the actuating cylinder can cause the shipment of the main valve so as to cause motion of the main motor when the conditions of the relative "lap" and leverage connections are properly provided for as aforesaid by my invention. And it has been found in actual practice that a mere plug of brass, making no pretentions to a water tight valve, may be substituted for the pilot valve, J, and the main motor perfectly controlled by the automatic adjustment of leakages, as has been explained. As this feature of my invention is independent of the exact form of pilot and main valves, it is to be considered as applicable to any form of main and pilot valves, or actuating cylinder and pilot valve. In further analysis of the lever motion, it will be noted that since the point, *o'*, travels in a straight line, any change of position from its central one, as shown in Fig. 1, will cause the point, *o*, to descend a distance practically equal to the versed sine of the angle of vibration multiplied by the length of the lever, O', and the link, N', will deviate from the horizontal position as shown in Fig. 1, by the descent of one end, the point, *o*, while the other end, the point, *m*, remains stationary. But it will be noted that the link, *j'*, also has an exactly similar motion, and that from the nature of the articulation shown, the pendent link, *p*, being equal in length to the distance between, *o*, and, P, the links, N', and, *j'*, which are equal to each other in length are always parallel with each other, and the lever, O', is always parallel with the pendent link, *p*. Thus it is readily seen that the motion of the point, *o'*, is imparted in strict proportion, as governed by length of lever arms, to the point, *m'*, without any variation whatever from foreshortening of links or deviation due to variation of circular and rectilinear motion, as is common in some forms of this apparatus. In addition to this it will be noted that any motion to the right or left of the point, *m'*, due to the rocking of the rock shaft, *k*, by the attendant in the car which would tend to cause this point, *m'*, to descend slightly and so destroy the parallel relation of the two valve stems, *j*, and, *d'*, is instantly compensated for by the motion imparted to the pendent link by the action of the point, *o'*, in the lever, O', due to the shifting of the main valve, as already noted. Hence the point, *m'*, has, in any case, but a minute variation in its vertical position, and the valve stems, *j*, and, *d'*, are always kept practically parallel in position under any and all circumstances.

The above is a description of the ordinary action of the valve when the main motor is performing its regular duty and never exceeding a certain pre-determined length of stroke; but if the piston should pass beyond this limit, the proper tappet or other instrumentality, will actuate the rod, *e''''* in such a manner as to cause the stop sleeve, E E', to revolve around the cylinder, C, as a bearing. This revolution is slight, but is sufficient to bring the solid portions of said sleeve directly over the ports, *c'*, of said cylinder, as seen in Fig. 4, thereby instantly cutting off the supply of water to the main motor and immediately arresting its motion. It will, of course, be understood that a pair of tappets—or equivalent devices, may be arranged to operate this safety stop, so as to control both the advancing and receding stroke of the main-motor piston. Finally, all the uses to which my invention can be put have not been described, but it is intended to employ it in every place where a hydraulic, fluid, or pneumatic motor can be controlled by a valve. And furthermore, while my hydraulic valve, as shown and described, is in shape, design and combination, as best adapted to practical use; it is

not intended to restrict the features of my invention to a hydraulic valve constructed in every or exact detail as here shown.

Independent and oppositely graduated supply and discharge ports; independent supply and discharge ports in conjunction with intermediate motor-ports and a double piston; the broad system by which the creep of the main valve is checked and reversed during the lap-travel of the valve; that system when executed by means of a pilot-valve movable on a seat; and the peculiar manner of joining the valve-case sections, is reserved as the subject matter of another application filed July 1, 1891, Serial No. 398,116.

I claim as my invention—

1. The combination, in a fluid controlling valve, of the cylinder, C, provided with ports, c', a reciprocating piston, D', within said cylinder, and a safety stop, E E', adapted to close the ports, c', of said cylinder, C, if the piston of the main motor exceeds a certain limit of stroke, substantially as described.

2. The combination, in a fluid controlling valve, of a cylinder provided with ports, a jacket around said cylinder and having an annular passage exterior to said ports, said passage having two outward openings, a pipe-connection at one of said openings, a cap at the other of said openings, and a sleeved stop encircling said cylinder within said passage.

3. The combination in a fluid controlling valve of a reciprocating piston within the same, a safety-stop, and a cylinder serving as the seat for said piston and safety-stop.

4. The combination, substantially as set forth, of a main valve, an actuating piston therefor, a pilot valve controlling said actuating piston and having a closing motion in the direction of the motion of the actuating piston as it opens the main valve, and a lever fulcrumed at one end and connected at its other end with said actuating piston, and connected intermediate of its length with the pilot valve.

5. In a fluid controlling valve the combination of an actuating cylinder, a pilot valve, a lever fulcrumed at its ends connecting at one end to the piston rod of the actuating cylinder and connected at the other end and intermediate point with two links equal in length or practically so, whose other ends are joined to another link equal in length to the distance separating their junction on the first mentioned lever, or practically so, and connections between the same and pilot valve and operating mechanism, for the purpose described.

6. In a fluid controlling valve the combination of an actuating cylinder, U, a pilot valve, F, a lever, O O', fulcrumed at its ends, o, o', connecting at one end, o', to the piston rod, d d', of the actuating cylinder, U, and connected at the other end, o, and intermediate point, P, with two links, N', and, j', equal in length or practically so, whose other ends, m, and, m', are joined to another link, p, equal in length to the distance between the points, o, and, P, or practically so, and connections, j, between the same and pilot valve and operating mechanism, M', k, L, L', l, and l', for the purpose described.

In testimony whereof I affix my signature in presence of two witnesses.

EDWIN S. MATTHEWS.

Witnesses:
JAMES H. LAYMAN,
SAMUEL M. QUINN.