No. 720,261.

PATENTED FEB. 10, 1903.

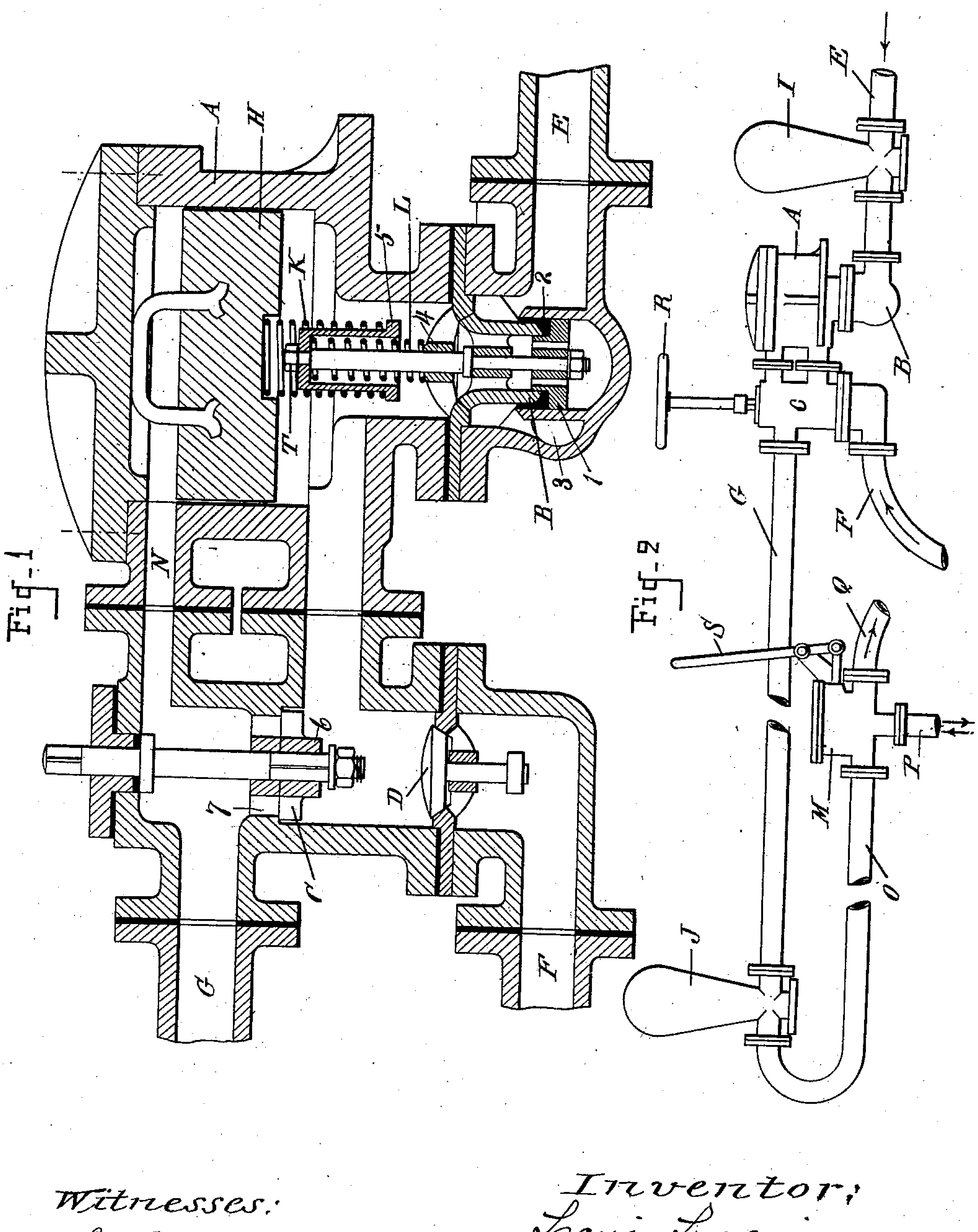
L. LACOIN.

APPARATUS FOR AUTOMATICALLY REGULATING THE SUPPLY OF WATER UNDER PRESSURE TO HYDRAULIC MACHINERY.

APPLICATION FILED JUNE 21, 1898.

NO MODEL.

2 SHEETS—SHEET 1.



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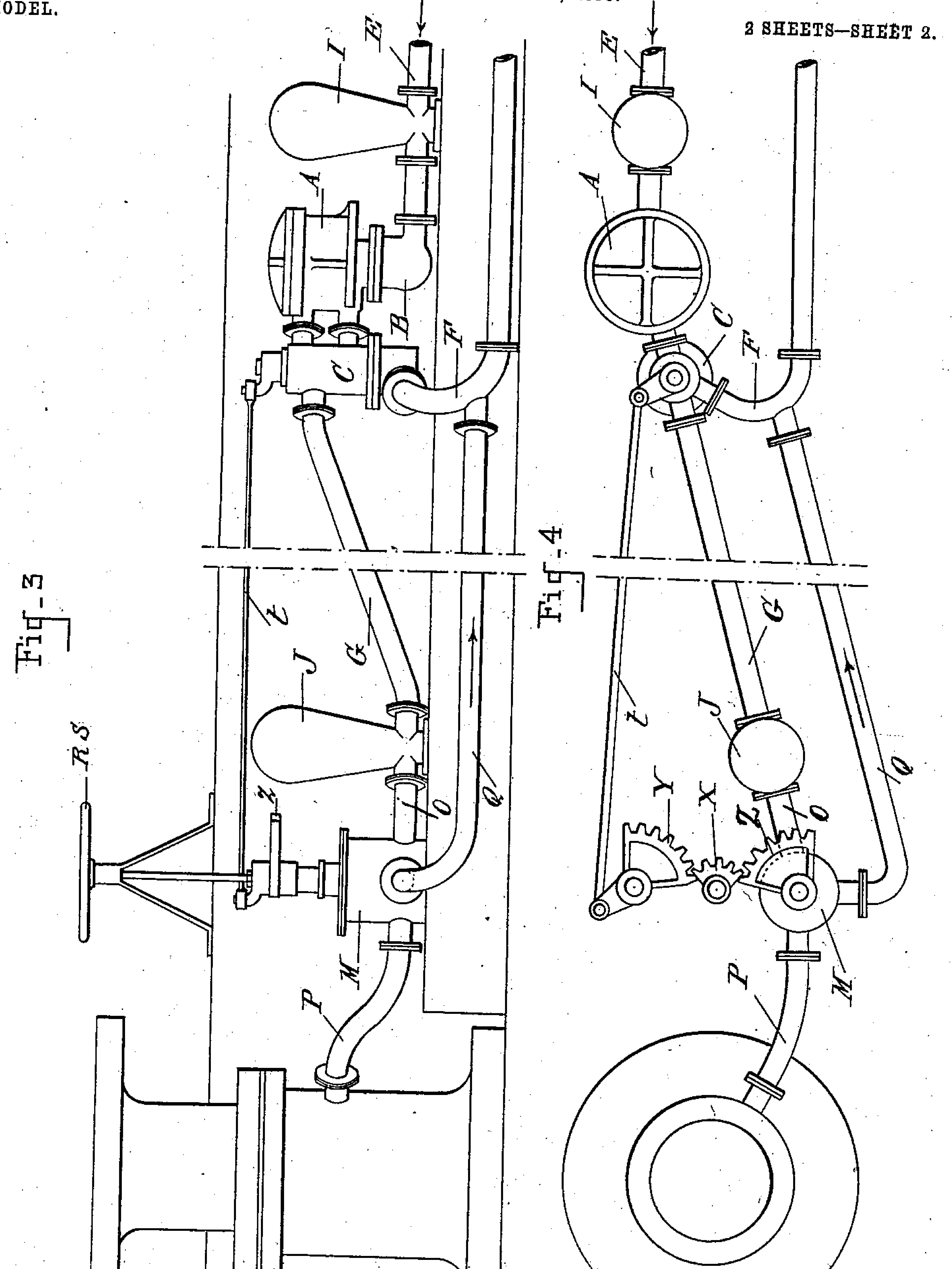

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UNITED STATES PATENT OFFICE.

LOUIS LACOIN, OF PARIS, FRANCE.

APPARATUS FOR AUTOMATICALLY REGULATING THE SUPPLY OF WATER UNDER PRESSURE TO HYDRAULIC MACHINERY.

SPECIFICATION forming part of Letters Patent No. 720,261, dated February 10, 1903.

Application filed June 21, 1898. Serial No. 684,103. (No model.)

To all whom it may concern:

Be it known that I, LOUIS LACOIN, a citizen of the French Republic, residing in the city of Paris, department of the Seine, France, have invented a new and useful Apparatus for Automatically Regulating the Supply of Water Under Pressure to Hydraulic Machinery and Motors, of which the following is a specification.

This apparatus is intended to govern and regulate the speed of hydraulic engines and to utilize to the best possible advantage the energy contained in the water under pressure; to govern speed means to obtain a regular and constant speed for any performance of work required of the machine within the limits of its power; to regulate the speed means to modify or vary the speed in such a manner that the governor may be placed in analogy with the governors of steam-engines which act upon the expansion-gear, but offering the advantage that the running speed of this new apparatus can be changed very easily and speedily. Its principle is entirely different from the principle of steam governors or regulators. It can be used in connection with all kinds of hydraulic engines just as well for engines with rectilinear displacement, as for elevators, and also for hydraulic engines with continuous rotary movement, as in capstans.

In the drawings, Figure 1 is a sectional view through the casing containing the valves. Figs. 2 and 3 are side views of different forms of the apparatus, and Fig. 4 is a plan view of Fig. 3.

The invention consists, first, of a cylinder A, in which a piston H moves with the least possible friction. At one of the extremities of this cylinder are provided necks for the admission of water under pressure through the valve B, for the admission of supplementary water through valve D, and the passage of water by the regulating-valve C. At the other extremity of the cylinder A is a neck N, which communicates with the outlet of the regulating-valve C and the start of the stroke-pipe G. Thus it becomes readily apparent that the piston H receives at each surface the same pressure as exercised on each of the sides of the valve C and that whatever loss in pressure occurs at the passage from this valve the loss will bear upon the piston H.

Second. The invention consists, further, of a valve B, controlled by the piston H and the springs K and L, the water under pressure arriving through said valve.

Third. Further, there is a piston H, which ordinarily has neither segment-packing nor other packing to avoid friction in the cylinder A. This piston may be formed, as in Fig. 1, of a heavy casting turned on the outside and of sufficient weight to open the valve B when the difference in water-pressure on the two sides of the piston H is not in the way.

The drawing represents a connection between piston H and valve B, established by means of two springs K L. This arrangement is specially applicable when the piston operates by its own weight. One of the springs L tends constantly to hold the valve on its seat. For that purpose it presses, on the one hand, on the guide 4 of the rod of the valve and, on the other hand, on the interior bottom of a brass top fixed behind that rod. A second spring K passes around the brass top or lid 5 and presses, on the one hand, on the lower rim of this lid and, on the other hand, on the piston H. As the latter presses on the spring K it compresses it, and so can open the valve B by means of the lid or cap, as will be set forth when the operation of the apparatus is described.

Fourth. Then there is another valve D, through which the supplementary water arrives. This is an ordinary valve which opens and shuts automatically. It plays very freely, so as to allow easy passage for the water which arrives through the pipe F and then passes through the valve C after having communicated, as above stated, with the extremity of the cylinder A, where the valve B is already provided.

Fifth. There is a regulating-valve C, through which the water arriving from B or D passes. This valve can be closed by a disk 6, having openings to correspond to the perforations of the seat 7, on which it is applied, said disk closing them when it is turned around its axis. This device is represented in Fig. 1. The size of this opening is regulated by means of the fly R, as shown in the view of the total combination in Fig. 2, or by means of the rod t, as shown in the modifications of the apparatus shown in elevation and plan in Figs. 3 and 4 of the drawings herewith or by any other arrangement. The water passing through this valve undergoes a very slight loss in pressure. The intensity of the loss depends upon the size of the opening and varies in the same sense as the speed of the water—that is, for a certain size given to the port the loss of pressure is so much greater as the speed of the water rush is enhanced. I will state here that in no case will this loss of pressure be as much as two per cent. of the total water-pressure. Hence it is very slight. The loss of pressure, as we have seen, acts upon the piston H in the opposite sense of the weight of this piston or such elements which substitute this weight. These explanations show that with a given speed of the water in the valve C the piston H is balanced and will not move. When the speed is greater, the effect of the loss in pressure carries it on, and when the speed, on the other hand, is lower than the given speed the weight of the piston or the elements taking its place are, to the contrary, greater than the effect produced by the loss of pressure on the piston.

I call "normal speed" such given speed for which the piston H is at equilibrium, and I call "normal delivery" such quantity of water as passes each second through the valve C when this quantity of water therein has normal speed. The normal speed varies somewhat with the size of the port, but follows the same relation. The normal delivery, to the contrary, varies much and also in the same relation, as it is proportionate to the product of the speed multiplied by the section of the opening, said speed and section varying both in the same relation. Hence it results that the normal delivery can be changed at will by modifying the section, which means the size of the opening.

Sixth. There is a pressure-pipe G running from the valve C and running into the dome J, Fig. 2. This pipe consists of a long tube with small diameter. It is as straight and smooth inside as possible, so as to facilitate the rapid movement of the water in its path notwithstanding its length and slight diameter.

Seventh. There is a dome or equalizing apparatus J, into which the water arrives from G by rapid pulsations and running from there continuously to the hydraulic engine which it actuates. Fig. 2 repsesents an equalizer consisting of a simple air bell or chamber, as in the ordinary pumps.

Eighth. Then there is a series of pipes E F O P Q, which connect the regulator with the supply of the water under pressure and the supplementary water, on the one hand, and, on the other hand, with the hydraulic engine and the exhaust. On the admission-pipe E for the water under pressure a dome or equalizer I, like the dome or equalizer J, may be arranged so as to take up any shocks or jars and prevent them from affecting any other apparatus controlled by the same hydraulic plant. This dome should give as constant a pressure as possible. The function of these domes or equalizers is as follows: The dome J tends to render more uniform the pressure in pipe O, and the dome I tends to similarly equalize the pressure in the supply-pipe behind it. The conduit F carries the feed-water. Under ordinary circumstances this water comes from the exhaust of the engine. In that case, as shown in Figs. 3 and 4, the exhaust-pipe Q need only be connected with the pipe F, which will deliver the necessary water.

Figs. 2, 3, and 4 represent at M the distributer of the hydraulic apparatus, on which the regulator or meter is arranged. This distributer receives through the pipe G O the water coming from the regulator. It communicates by the pipe P with the hydraulic engine and lets off the exhaust-water by the pipe Q. This distributer is operated either by a lever S, Fig. 2, or by a fly, Fig. 3, or in any other manner; but, as will be set forth, it is advantageous that the distributer should be either entirely open or entirely closed, so as not to interfere with the passage of the water, and if it is desired to change the speed of the machine it should be done by means of the valve C. This valve is operated in Fig. 2 by the fly R. To facilitate the operation of R and S, Fig. 2, they may be connected with a single fly-wheel, as shown in Figs. 3 and 4.

The drawings show a fly R S, by means of which a toothed sector X is actuated. This sector gears, on one hand, with another sector Y, which actuates the valve C by means of a rod t, and, on the other hand, it gears with a sector Z, which actuates the distributer M. The number of teeth of the pinion X, as shown in Fig. 4, is so arranged that this sector operates the sector Y, and consequently opens the valve C only when the sector Z has been guided to the end of its run and has consequently opened entirely the distributer M. In the opposite direction the distributer M is only closed by actuating the sector Z after having closed the valve C, while guiding the sector Y to the end of its run. The drawings represent the sectors in position at the moment when the distributer M is wide open and the valve C closed. As shown, by turning the sector X in one direction the distributer M would be closed, while the valve C remains unmoved, and when the same sector is turned the other way the valve C would be opened and the distributer M would remain unmoved. This position is assumed at low speed. When the sector X is turned in the direction as followed by the hands of a clock, the machine would stop. If it is turned in the opposite direction, the speed would be continuously increased. When the valve C is closed, the machine runs along slowly, because the piston H is not tight, and the water passes around it, though in exceedingly small volume. Nevertheless it was necessary on this account to use the distributer M in the manner as it exists in the hydraulic machines which are not provided with this regulator. The valve B is not closed, so as to prevent any operation of the driven machine when the valve C is closed, because the piston H is not tight, and even if the valve C is closed water passes around H and comes back to the pipe G by the conduit N.

For an understanding of the operation of the regulator we will now examine Fig. 2. In the ordinary arrangement without the regulator the water under pressure would flow directly from E into O, and the distributer M would constantly receive water under high pressure. When the hydraulic engine, being connected by the pipe P with the distributer M, acts with full power, the water should have full pressure; but when the strain which the hydraulic engine must overcome grows weaker it is no more necessary that the water in the pipe P should have as high a pressure, as otherwise the engine would clog. As a rule the pressure is reduced by choking or narrowing the water admission by closing more or less the distributer M—by means of the lever S, for instance. In this manner the water-pressure is reduced as much as required; but nevertheless water under pressure passes in the same volume. I have aimed at reducing the pressure at P to a given volume; but to this end I would only use for this purpose a quantity of water under pressure in better proportion to the work to perform. As a given volume of water must be supplied for this purpose, the necessary volume to make up the quantity should be taken from another source, and I call this water the "supplementary water," which is fed in by the valve D. This total quantity of water, as can be readily understood, is in absolute proportion with the speed of the engine, and it will be sufficient to regulate the speed of the water arriving through the pipe O to obtain regulating of the run of the engine. Hence I set my regulator on the water-admission pipe so that all water coming to the hydraulic machine is compelled to pass through the same and to pass thereafter specially through the regulating-valve C, and I regulate the opening of the valve so that the output, which I call the "normal supply" of C, should agree with the speed which I intend to give to the hydraulic engine.

The regulator receives water under high pressure at E, low-pressure water at F, and supplies it at O at any desired pressure to impart to the machine such pressure as may be intended. To examine into the action how this effect is brought about, I take in illustration the regulator represented by Figs. 1 and 2, although I do not limit my invention to this model alone, as the varying conditions of pressure and water-supply call for slight changes in shape and arrangement, which do not interfere in any way with the underlying principle of the apparatus. The water arrives through the conduit E and strikes against the valve B. We will assume this valve to be open. The water penetrates into the cylinder A, communicates its pressure to one of the sides of the piston H, passes through the valve C, and there undergoes the loss in pressure referred to. Then it communicates its reduced pressure through the conduit N to the other side of the piston and thereupon runs through the pipe G into the equalizer J.

If the hydraulic engine works at its full power, the speed will be normal, the supply at C will be up to normal rate, the piston H will be in place and will hold the valve B open. The water will therefore pass freely from E to J and from J to the machine, just as if there were no regulator. The only difference arising is derived from the very slight decrease in pressure from the insertion of the regulator, and these are scarcely greater than the losses in pressure arising from the pipes, elbows, and ordinary distributers, in which the port's sections are generally so very reduced. Hence the hydraulic engine will run at whatever speed is required.

Assuming that the resistance to the engine becomes less, the necessary consequence will be that the water-pressure in the engine decreases, and as the distributer M is left wide open the pressure in the equalizer J will also fall off as it communicates freely with the engine. As the pressure is very low in the equalizer J and as all its strength issues from the starting-point of the pipe G, the water in this pipe will rush into the equalizer J with increasing speed; but this water must of necessity pass first through the valve C. Consequently there is a gradually-increasing speed in this valve. The loss in pressure grows gradually as the speed increases. The two sides of the piston H are subjected to pressures varying gradually, so that at a given time these forces are sufficient to overcome the weight of the piston, which ascends and allows the valve B to close. The water does not arrive any more by B; but into G it has a certain speed which it cannot loose so suddenly, and as a consequence a certain relative vacuum results behind this pipe—that is, in the whole cylinder A around the valve C and under the valve D—said vacuum being sufficient to allow the water in the pipe F to pass through the latter valve. To increase the intensity of this vacuum, the conduit G must be long, so as to hold a great volume of water, and it must also be narrow, so that the water should run at great speed, and consequently with great active power. The conduit should be straight and smooth, so that the movement of the water be unimpeded, and, on the other hand, a quick cut-off or closing must be produced at B, because the water which arrives through B while this valve is half closed is not at full pressure, because it passes with difficulty only through this reduced opening, and as soon as it arrives through B the valve D cannot open, and there is no saving of the water under pressure. To obtain this quick cut-off, the springs K and L have been arranged conveniently. When the piston H is at the bottom of its stroke and the valve B is open, the springs K and L are both pressed down. When the piston H ascends, the spring K begins to distend; but it still presses sufficiently upon the hood or cap, and consequently upon the spring L, to prevent the valve from rising. When the piston H has almost reached the end of its travel, the pressure of K on L becomes weaker still. The spring L is thus enabled to raise the valve B. The water arriving through E begins to be choked off when passing into B, and the decrease in pressure resulting therefrom acts with gradually-growing intenseness to the influence of the spring L. It closes the valve B suddenly, notwithstanding the growing resistance of the spring K, provided that the piston H has been removed far enough from the extremity T of the rod of the valve B. This distancing can be easily obtained by calculating appropriately the dimensions of the springs K and L.

We spoke last of the water of conduit G when by its *vis viva* it sucked up the supplementary water by the valve D; but the pressure of the supplementary water is very weak and insufficient to set the engine going. It is lower than the pressure in J, which is just apt to set the engine to work, and as a consequence the speed in the conduit G and in the valve C will necessarily decrease, and the loss in volume, which varies in the same manner as the speed, will also fall off. The piston H, which is subject to the effects of this loss in volume, is held above with gradually-decreasing power, and at a given time this power becomes insufficient to hold it raised, and the piston H descends and opens the valve B. It may be stated that the opening of this valve is also sudden, as a great effort is required to open the valve B, which is subjected on one side to the pressure of the water at E and on the other side it is influenced by the pressure of the water coming from F. This is not the case when the valve is open. The first water parts passing through B bring about the closing of the valve D and also the increase of pressure in the whole cylinder A. Thus the spring K, which was completely pressed down for the purpose of opening the valve B, needs only slight stress to push it to the end of its travel and to easily press down the spring L. This sudden opening is as serviceable as the quick closing above referred to and for the same reasons. When the valve B is open, the water under pressure rushes again through the valve C into the pipe G on its way to the equalizer J. The same events as described before are repeated. B is again closed by the ascent of H, owing to the decrease in pressure at C produced by the increase of speed and the admission of the supplementary water through D, &c. Finally I will show that my apparatus governs and regulates by these operations the speed of the hydraulic engine, while reducing to a minimum the consumption of water under pressure.

It is readily manifest how the speed of the hydraulic engine is governed and regulated, as the speed depends upon the medium supply at C, and if the water passes at C in rapid pulsations its supply is but very little at variance of the supply which I have called "normal" supply, which is regular and regulative, and the same holds good of the medium supply, which the damper converts into continuous supply, and consequently the speed of the hydraulic engine is regular and subject to regulation. Economy of the water under pressure is also shown, as a certain part of the supply required for the operation of the machine is furnished by the supplementary water, and without entering into consideration of a more theoretical character I will only state that the losses in supply between the hydraulic engine and the valve B are but very slight. The water under pressure acts always with full energy, which when in excess is employed to give *vis viva* to the water in the conduit G, the *vis viva* serving thereafter to introduce supplementary water, and consequently the yield of the apparatus must run very high. This is really the case.

In a steam-engine to decrease the discharge of steam its expansive force is utilized, and as the water cannot expand its energy is converted into *vis viva* to better advantage. In either case the motive fluid is introduced under full pressure and in small volume, and the apparatus supplies fluid at a medium lower pressure and with greater volume.

I claim—

1. In combination in a hydraulic regulator for apparatus actuated by water-pressure, a pipe G leading to said apparatus, a supply-pipe E, a cylinder or casing interposed between said pipes E and G, a valve C for reducing the pressure in the cylinder and regulating the flow of the water in the pipe G, a valve B regulating the admission of the water under pressure from the pipe E, a regulating apparatus controlling the movements of the valve B and controlled in turn by the difference in pressure of the water on each of the faces of the valve C, a supplemental supply-pipe entering the casing or cylinder between the valves B and C and a valve D controlling the water admission, substantially as described.

2. In an automatic regulator for hydraulic apparatus, the combination of a casing hav-

ing a pipe G leading therefrom to the engine, means for throttling the water passing to said pipe, a supply-pipe E leading to the casing, an inlet-valve controlling the water-supply from said pipe to the casing and means connected with the said valve for controlling the inlet-valve, said means consisting of a piston exposed also to the pressures on the opposite side of the throttle-valve from the conduit-pipe G, substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

LOUIS LACOIN.

Witnesses:

EDWARD P. MACLEAN,

JULES FAYOLLET.