No. 808,604.

PATENTED DEC. 26, 1905.

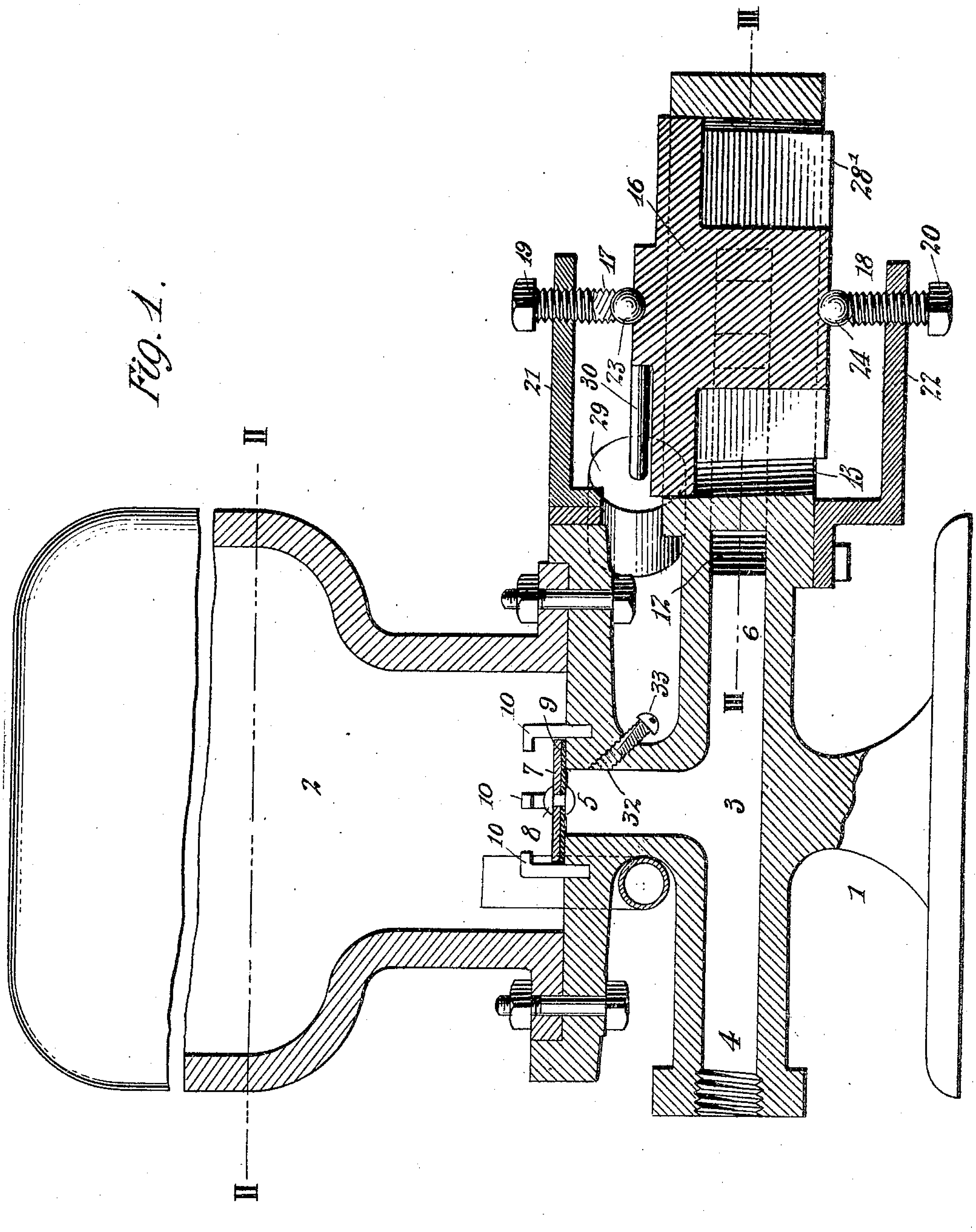
A. H. FRANCFORT.

HYDRAULIC RAM.

APPLICATION FILED JULY 30, 1903.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses
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4 SHEETS—SHEET 2.

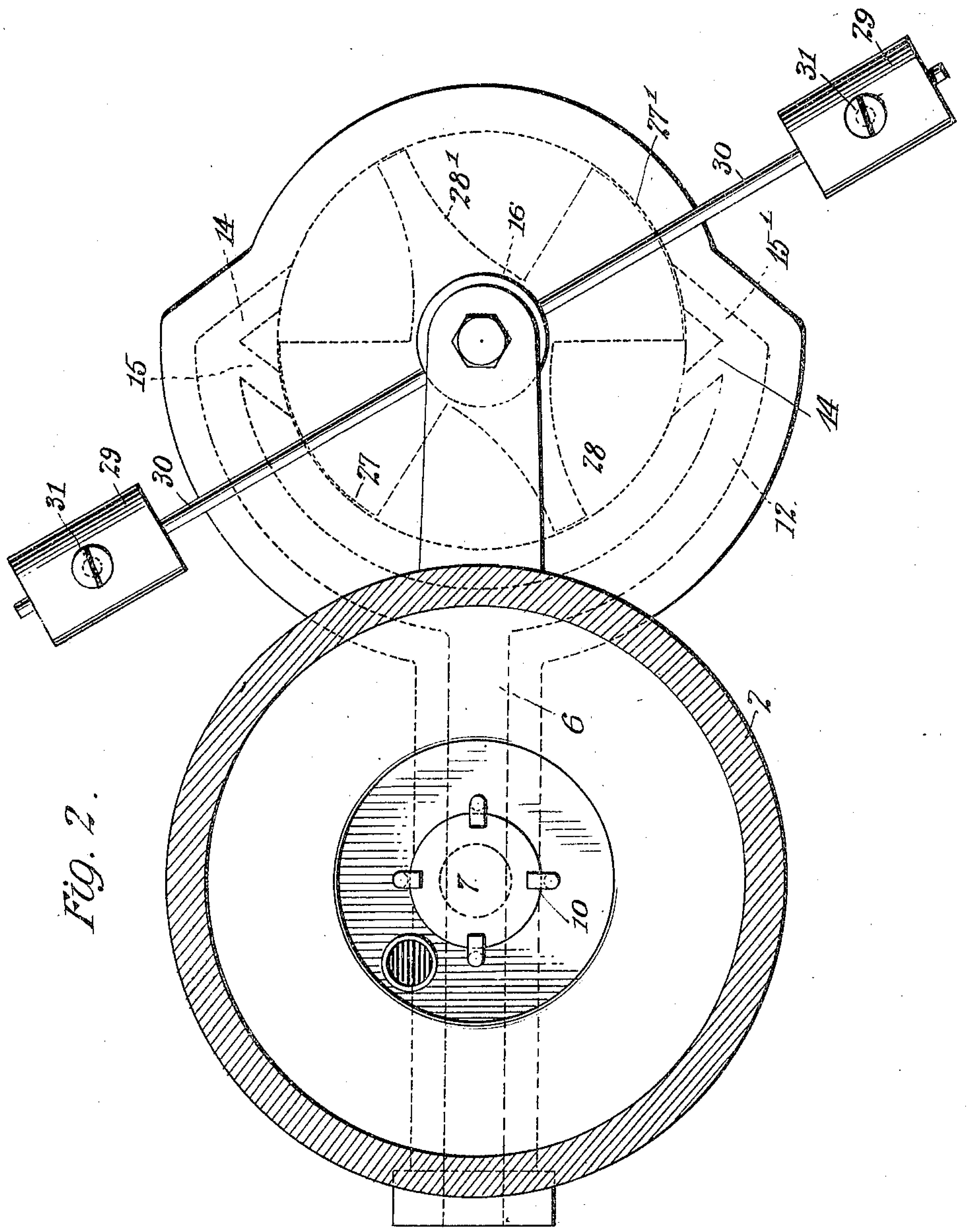

Fig. 2.

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4 SHEETS—SHEET 3.

Fig. 4.

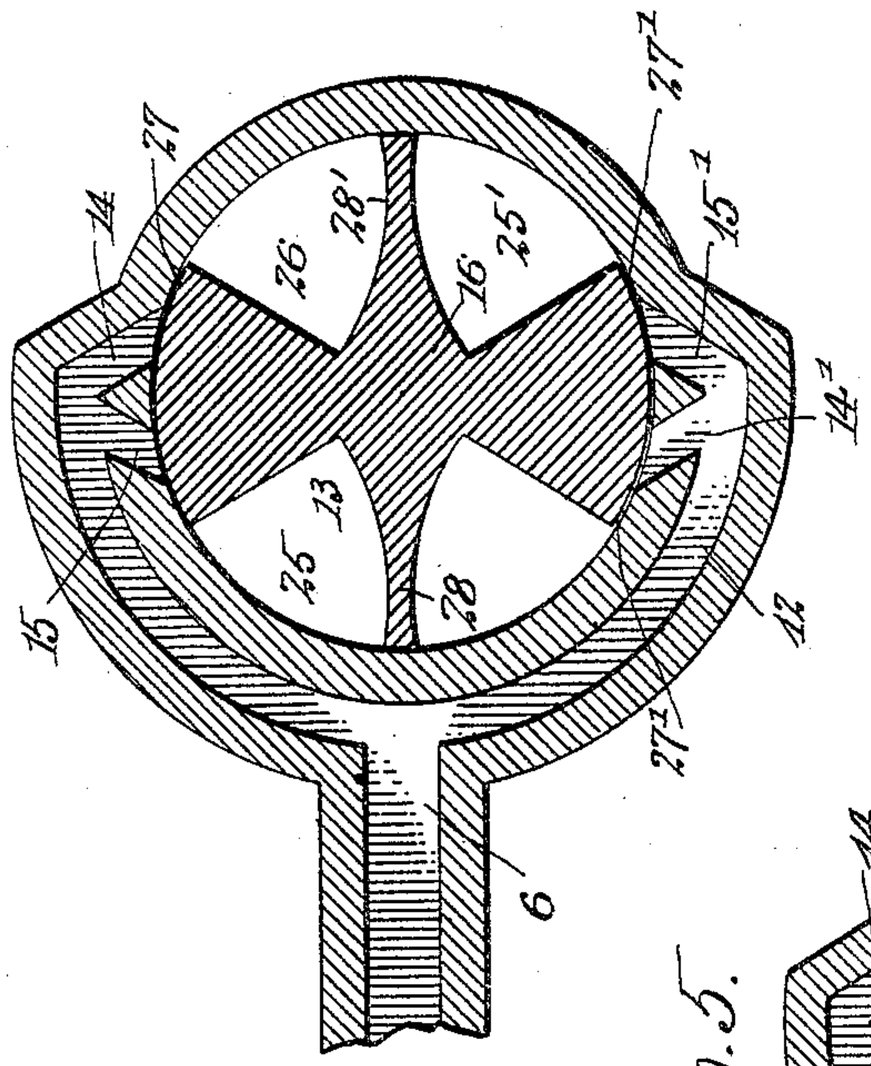


Fig. 5.

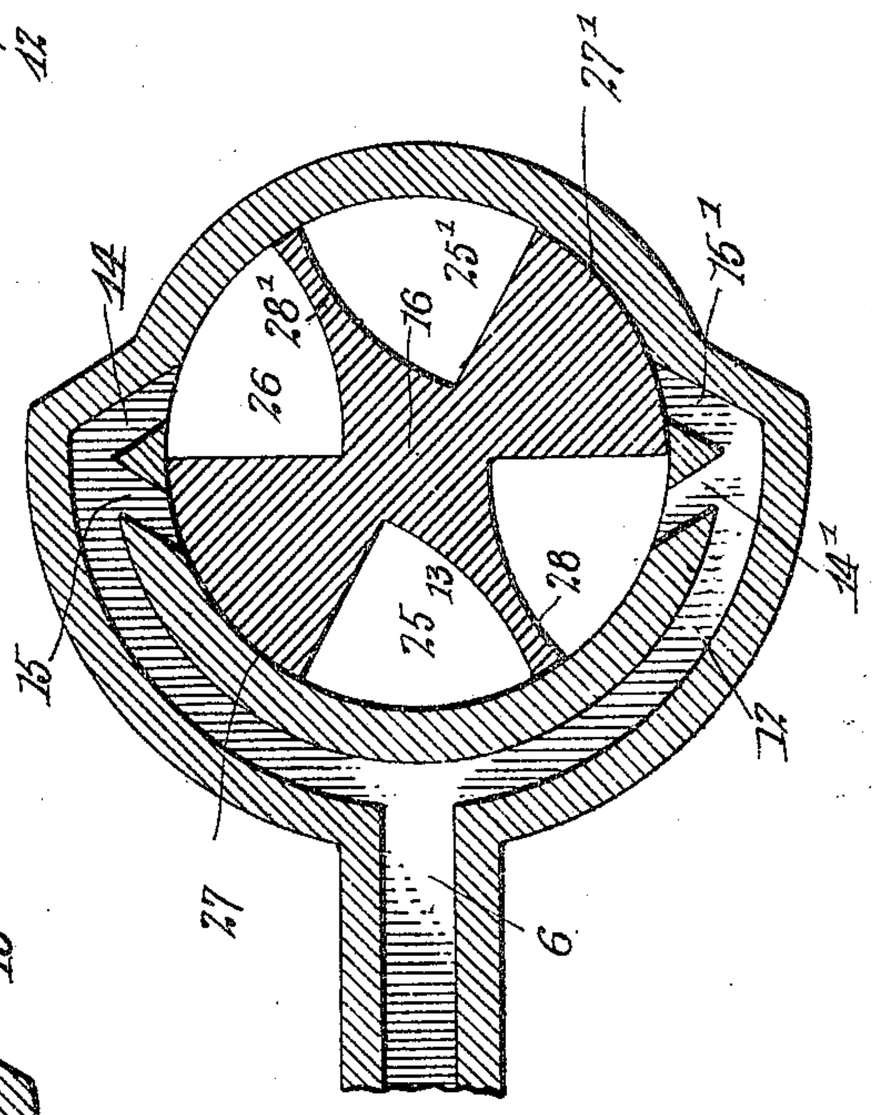
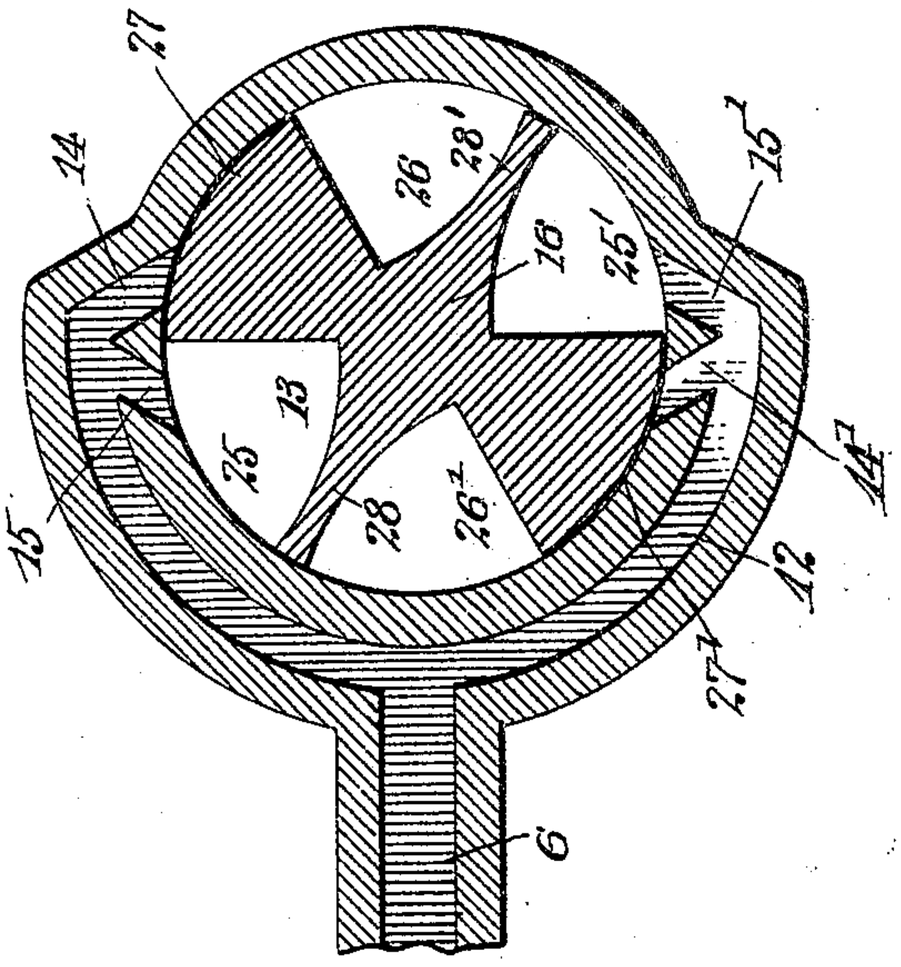


Fig. 3.



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4 SHEETS—SHEET 4.

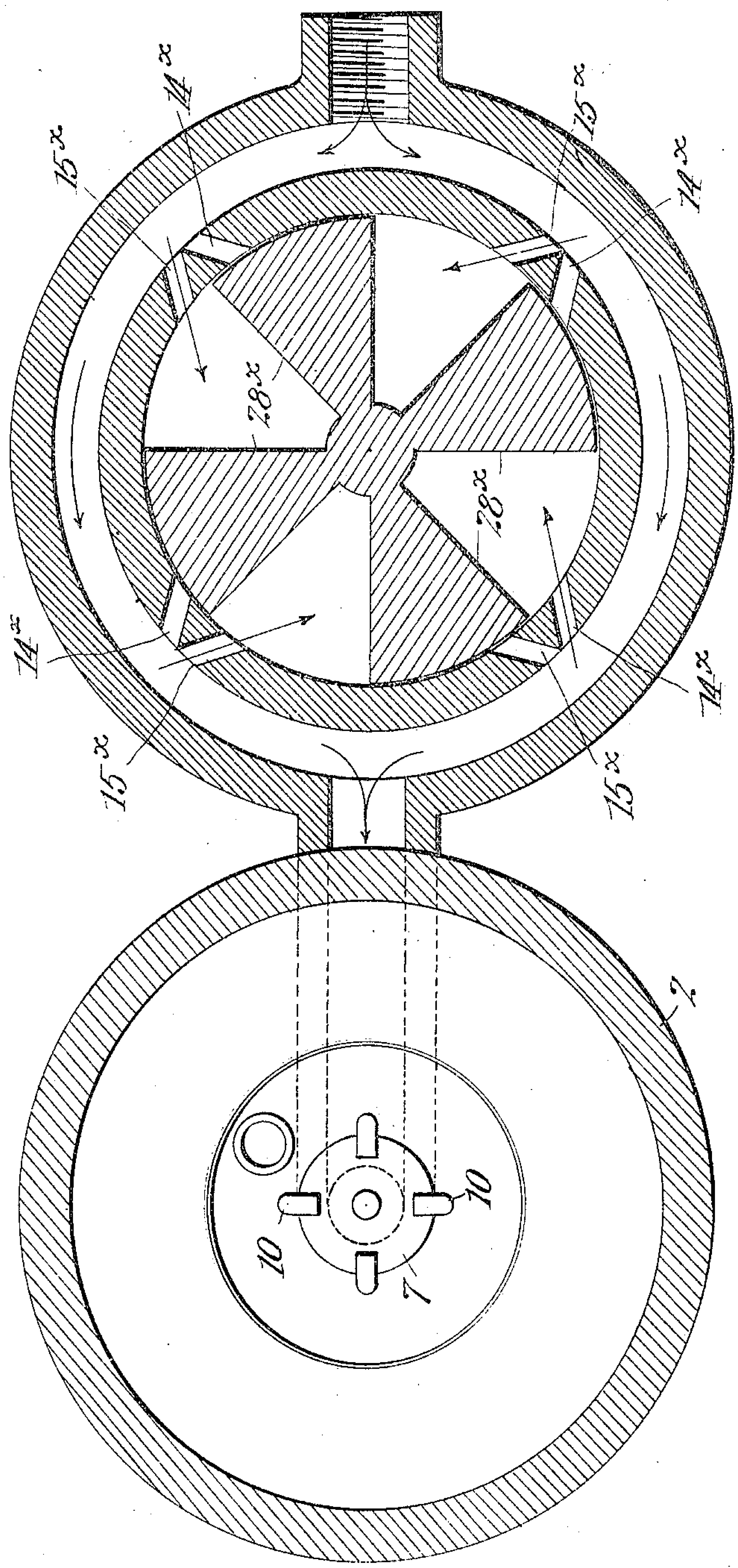

Fig. 6.

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UNITED STATES PATENT OFFICE.

ALFRED HENRY FRANCFORT, OF JERSEY CITY, NEW JERSEY.

HYDRAULIC RAM.

No. 808,604. Specification of Letters Patent. Patented Dec. 26, 1905.

Application filed July 30, 1903. Serial No. 167,558.

To all whom it may concern:

Be it known that I, ALFRED HENRY FRANCFORT, a citizen of the United States, and a resident of Jersey City, in the county of Hudson and State of New Jersey, have invented a certain new and useful Hydraulic Ram, of which the following is a specification.

This invention relates to hydraulic rams. In apparatus of this class the kinetic energy of a moving body of liquid is transformed into potential energy either by storing the liquid in a reservoir under pressure or by raising it to an elevation. The principle which is utilized in such apparatus is the sudden development of pressure which accompanies any sudden arrest of a moving column of liquid. So far as I am aware this arrest of the liquid column has always been accomplished by a species of check-valve, against which the liquid column impinges until a pressure is produced sufficient to close the valve.

A very serious objection arises in practice from the use of hydraulic rams constructed in the manner above indicated, due to the destructive effect of the sudden closure of the usual form of valve upon its seat. It is apparent that a considerable amount of force must be exerted to close the valve, and the impact of the heavy piece of metal which is required in anything except the smallest sizes against its seat is a severe hammer-blow, which is very destructive.

The object of my present invention is to provide a hydraulic ram in which the above-mentioned defect is wholly overcome not only in the smaller sizes, but in the largest sizes of ram which it is desirable to construct.

A further object of my invention is to provide a hydraulic ram which shall be simple and easy to manufacture, convenient to use, and having a minimum number of parts.

Other objects of the invention will hereinafter appear, and the novel features thereof will be set forth in the claims.

In the drawings, Figure 1 is a vertical sectional view of a hydraulic ram embodying my invention. Fig. 2 is a horizontal sectional view on the line II II of Fig. 1. Fig. 3 is a sectional view on line III III of Fig. 1, showing the valve in one of its extreme positions. Fig. 4 is a similar view showing the valve at an intermediate position. Fig. 5 is an additional view showing the valve moved to its other extreme position, and Fig. 6 is a view showing a slightly-modified form of valve.

In order that the principles and operation of my invention may be clearly understood, it is necessary to consider the action of a hydraulic ram in which a supply of liquid falling through a moderate head is utilized to raise a small quantity to a greater height or pressure. It will be understood that when a supply of liquid is discharged through a pipe into the open air at a lower level the potential energy of the liquid in the reservoir is converted into kinetic energy in the moving liquid and that at the point where the liquid emerges into the atmosphere its energy is entirely kinetic and represented by the expression $1/2\ M\ V^2$, where M is the mass of the body of liquid in the pipe and V its velocity. This kinetic energy may be reconverted into potential energy, if desired, having a new relation of pressure and volume. In hydraulic rams the pressure factor is increased over that of the original reservoir, while the volume of liquid is necessarily less, accounting for the waste of water which always takes place in apparatus of this sort. The method of reconverting the kinetic energy of the moving liquid to potential energy is by arresting its momentum, and since the checking of a definite mass in a certain length of time develops twice the pressure that would be developed if checked in double that length of time it follows that a pressure of any required magnitude whatever may theoretically be developed in the liquid by arresting its momentum with a greater or less degree of suddenness. In my invention I employ a form of valve in which the checking action is accomplished with a maximum degree of suddenness to obtain any required degree of pressure, and I do this with a form of valve in which the destructive action of the hammer-blow, hitherto always incident to hydraulic rams, is entirely overcome.

Referring now to the accompanying drawings, 1 designates a chamber or casing having a pressure-reservoir 2 thereon.

3 indicates an internal cavity or recess within the chamber 1, having branch passages 4, 5, and 6 leading therefrom. The passage 4 leads to the inlet connection or drive-pipe of any desired sort. The passages 5 and 6 lead, respectively, into the pressure-reservoir 2 and into a specially-constructed gate or valve embodying the principles of my invention and which will be later more particularly described.

I employ a practical form of valve which I arrange between the passage 5 and the pres-

sure-reservoir 2, comprising a plate or disk 7, of metal or other material of sufficient strength and wearing qualities, and upon the face thereof I secure, by a rivet 8 or other suitable means, a packing-disk 9, which abuts against the bottom of the pressure-reservoir 2 and forms a check-valve between said reservoir and the passage 5.

10 designates a plurality of guiding-studs, which project from the bottom of the pressure-reservoir 2 and have hooked ends thereon, so as to permit a limited up-and-down movement of the valve 7 upon its seat.

The passage 6 above referred to terminates in a valve-chamber 12, and I provide a valve to coöperate therewith in the manner more particularly illustrated in Figs. 3, 4, and 5. In the form of my invention illustrated I form the valve-chamber 12 of annular shape, extending partially around a central cavity or opening 13, which may be cylindrical or slightly conical in form. Within this cavity or recess I arrange what I shall term the "impact gate or valve," which swings or oscillates or otherwise moves within the recess between certain predetermined limits or positions and tangentially to the ports of the valve-casing.

It is to be understood that while I show the valve-chamber 12 as annular in shape and the recess or cavity 13 of cylindrical or slightly conical form I do not desire to be limited or restricted thereto, since it is evident that many other shapes may be used, it being merely essential that the impact gate or valve shall swing or move tangentially to and fro, so as to alternately uncover certain ports of the valve-chamber.

14, 14′, 15, and 15′ indicate the ports which I employ in the structure shown in Figs. 3, 4, and 5. The diametrically opposite ports 14 14′ are inclined in one tangential direction, and the diametrically opposite ports 15 and 15′ are each directed in the opposite tangential direction to that of the ports 14 and 14′.

16 designates generally the swinging impact gate or valve, and I have illustrated a convenient form in which a generally cylindrical member is rotatably supported between pivoted bearings, broadly designated as 17 and 18, respectively. In the practical use of my invention I form the bearings 17 and 18 adjustable for wear, and for this purpose I provide screws 19 and 20, which are threaded into lateral arms 21 and 22, which project from the main frame or chamber 1. 23 and 24 indicate balls, preferably of hardened steel, which engage correspondingly-shaped cups or recesses on the screws 19 and 20 and also on the cylindrical member 16, which constitutes my impact gate or valve. By these means the impact-gate is journaled to permit a swinging or oscillatory movement within the valve-chamber 12, and in practice the screws 19 and 20 may be so adjusted as to leave an exceedingly minute clearance between the impact-gate 16 and the surrounding valve-chamber, which, as I have above stated, may both be made very slightly conical for this purpose.

The form of impact gate or valve illustrated in Figs. 3, 4, and 5 is recessed or cut away, so as to form valve-ports 25, 25′, 26, and 26′ around its peripheral edge. I prefer to leave these recesses entirely open at the bottom of the member 16, so that liquid entering the same may drop freely through the impact-gate and flow away without resistance. It is obvious, however, that these particular details may be widely modified to suit the convenience of any particular designer and the practical conditions under which my hydraulic ram is desired to operate. The form or the number of the valve-ports 25 25′ 26 26′ is also governed by convenience, it being merely essential to provide gate-surfaces 27 27′ and vane or impact surfaces 28 28′.

29 indicates a pair of weights, which are adjustably mounted upon arms 30, projecting from the swinging member 16, the same being adjustable on the arms 30 by means of screws 31.

The operation of the device is as follows: A supply of liquid is directed into the passage 4 of the chamber 1, being led thereto through a drive-pipe of any desired length and from a supply source of any obtainable pressure. Under normal conditions the liquid finds the valve 7 closed upon its seat; but the impact gate or valve 16 lies at such a position as to allow the liquid to pass freely therethrough, as shown in Fig. 3. Under these circumstances the liquid passes freely through the valve-chamber 12 and through the inclined or tangential ports 15 15′ therein, whence it escapes through the ports 25 25′. By reason of this free escape all of the available pressure in the supply-reservoir is effective to increase the momentum of the liquid, which tends to attain a kinetic energy at the issuing-ports 15 15′ corresponding to the potential energy of the same mass within the supply-reservoir. The liquid accordingly takes on a considerable velocity as it issues from the ports 15 15′ and impinges against the vanes 28 28′, which may be formed with curved faces like a Pelton water-wheel, if desired, so that a definite and ascertainable force is exerted against such vanes by the impact of the moving liquid. When this impact rises to a predetermined amount, the statical forces of friction or inertia or of any other desired character are overcome and the impact-gate swings to the left in Fig. 3 with a speed which can be controlled by the weights 31. As the gate-surfaces 27 27′ pass the ports 14 15 and 14′ 15′, as shown in Fig. 4, all egress of the liquid is temporarily cut off, the reaction checking the momentum of the liquid-body within the supply-pipe and developing a pressure which is directly proportional to the speed at which the cut-off is accomplished. In practice this

pressure is adjusted to an amount somewhat greater than the pressure within the pressure-reservoir 2, so that the check-valve 7 is opened and water passes into such reservoir until the forces are equalized, whereupon the valve again closes. In the meantime the impact-gate has swung into a still farther advanced position of its movement, as shown in Fig. 5, under the influence of its inertia-weights 31, and under these conditions a new set of passages 14 14′ are opened up, which direct the liquid against the vane-surfaces, tending to swing the impact-gate in a direction opposite to that it previously took. When the velocity of the liquid attains a sufficient amount under the new conditions, the impact-gate will be swung to its other limit of movement and the cycle of operation above described will be again gone through exactly as before.

By virtue of the way in which my form of oscillatory valve swings back and forth under the influence of jets of the liquid, there is no dependence or gravity or springs, or other devices to reopen the impact gate or valve after an actuation. This feature of my invention is of great importance, since it permits the use of a drive-pipe of any desired length whatever. The actuation of all hydraulic rams produces a reaction or "back kick" directly after the pumping action which varies in amount for different lengths of drive-pipe, and this back kick, which creates a reduction in internal pressure, is depended on to reopen the usual form of valve.

If the drive-pipe in ordinary rams is too long, this back kick is so reduced that the impact-valve will not open at all; but the operation of my device is altogether independent of the back kick, so that any length whatever of drive-pipe may be used.

As has been already stated, it is not essential to employ a swinging impact-gate having valves upon its peripheral faces, nor is it essential to use any particular number of valve-ports or form of vanes. In Fig. 6 I have illustrated a modification in which the valve-chamber extends entirely around the impact-gate and is provided with four pairs of ports $14^{\times}$ and $15^{\times}$. In this form of the device the impact-gate is correspondingly modified, being provided with vane-surfaces $28^{\times}$, which are merely lateral faces of the gate or valve members proper, as will be clearly seen from the drawings. In this form of my invention I have also arranged the impact-gate at a point in advance of the inlet to the pressure-reservoir 2, rather than beyond such inlet, it being of course obvious that either expedient may be used, as found desirable.

An additional and special feature of my invention relates to a method by which a supply of air is maintained in the pressure-reservoir 2 in order to obtain the usual air-cushion, the operation of which is well understood. In practice it is found that the water in the pressure-reservoir absorbs a certain amount of the air, so that the air therein soon becomes exhausted unless means are provided by which it can be resupplied.

32 indicates an inclined threaded aperture leading into the passage 5, and 33 indicates a screw, which may have one of its sides slightly cut or filed away and is inserted into the aperture 32, so as to form an adjustable plug therein. It is evident that after the flow of the liquid has been checked by the valve 7 and the reaction or back kick takes place there is a reduction in the pressure within the passage 5. This serves to draw or suck in through the aperture 32 a small quantity of air, which upon the next actuation of the device is forced up into the pressure-reservoir 2.

Having described my invention, I claim—

1. In an hydraulic ram, the combination of a drive-pipe, an air-chamber, a circular centrally-mounted oscillating valve and an air-feed for said chamber, substantially as described.

2. In an hydraulic ram, the combination of a drive-pipe having branches to opposite sides of an oscillating valve, and ports for delivering the liquid to opposite sides of the valve, substantially as set forth.

3. In an hydraulic ram, the combination of a drive-pipe having ports delivering water on opposite sides of the valve at a tangent to the valve, the acting ports delivering the water parallel to each other and in opposite directions.

4. In an hydraulic ram, the combination of a drive-pipe, an intermittently-oscillating valve adapted to produce the ramming action, and a casting circular in form inclosing the branches of the drive-pipe.

5. In an hydraulic ram, the combination of a drive-pipe, a valve-box whose outer shell incloses the branches of the drive-pipe, an oscillating valve operated by the branches of said drive-pipe, and angularly-directed ports in said branches adapted to produce the oscillatory movement of the valve, substantially as set forth.

6. In an hydraulic ram, the combination of a drive-pipe having branches provided with angularly-directed ports, and a valve having open and solid segments adapted to open and close the said ports, substantially as described.

7. In an hydraulic ram, a valve-chamber having ports, and an impact gate or valve mounted to move to and fro in front of said ports under the influence of liquid impelled alternately in different directions thereagainst.

8. In an hydraulic ram, a valve-chamber having ports, and an impact gate or valve actuated by the momentum of the liquid and mounted to move to and fro in front of said ports under the influence of liquid impelled alternately in different directions thereagainst.

9. In an hydraulic ram, the combination of

a drive-pipe, a circular oscillating valve having a closed and an open segment, and an air-chamber arranged in operative relation thereto, substantially as set forth.

10. In an hydraulic ram, the combination of a drive-pipe, a circular oscillating valve having a plurality of open and closed segments adapted to open and close the drive-pipe.

11. In an hydraulic ram, the combination of an oscillating valve having open and closed segments, a drive-pipe communicating therewith, a valve-box conically shaped, and means for compensating the wear of the valve and box substantially as set forth.

12. In an hydraulic ram, a swinging impact gate or valve having vane-surfaces and means for directing the liquid against said surfaces alternately in different directions.

13. In an hydraulic ram, a valve-chamber having ports extending in different directions, and an impact gate or valve mounted to move to and fro in front of said ports whereby the liquid is alternately directed therethrough against the gate.

Signed at New York, in the county of New York and State of New York, this 27th day of July, A. D. 1903.

ALFRED HENRY FRANCFORT.

Witnesses:
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