

941,440.

Patented Nov. 30, 1909.

2 SHEETS—SHEET 1.

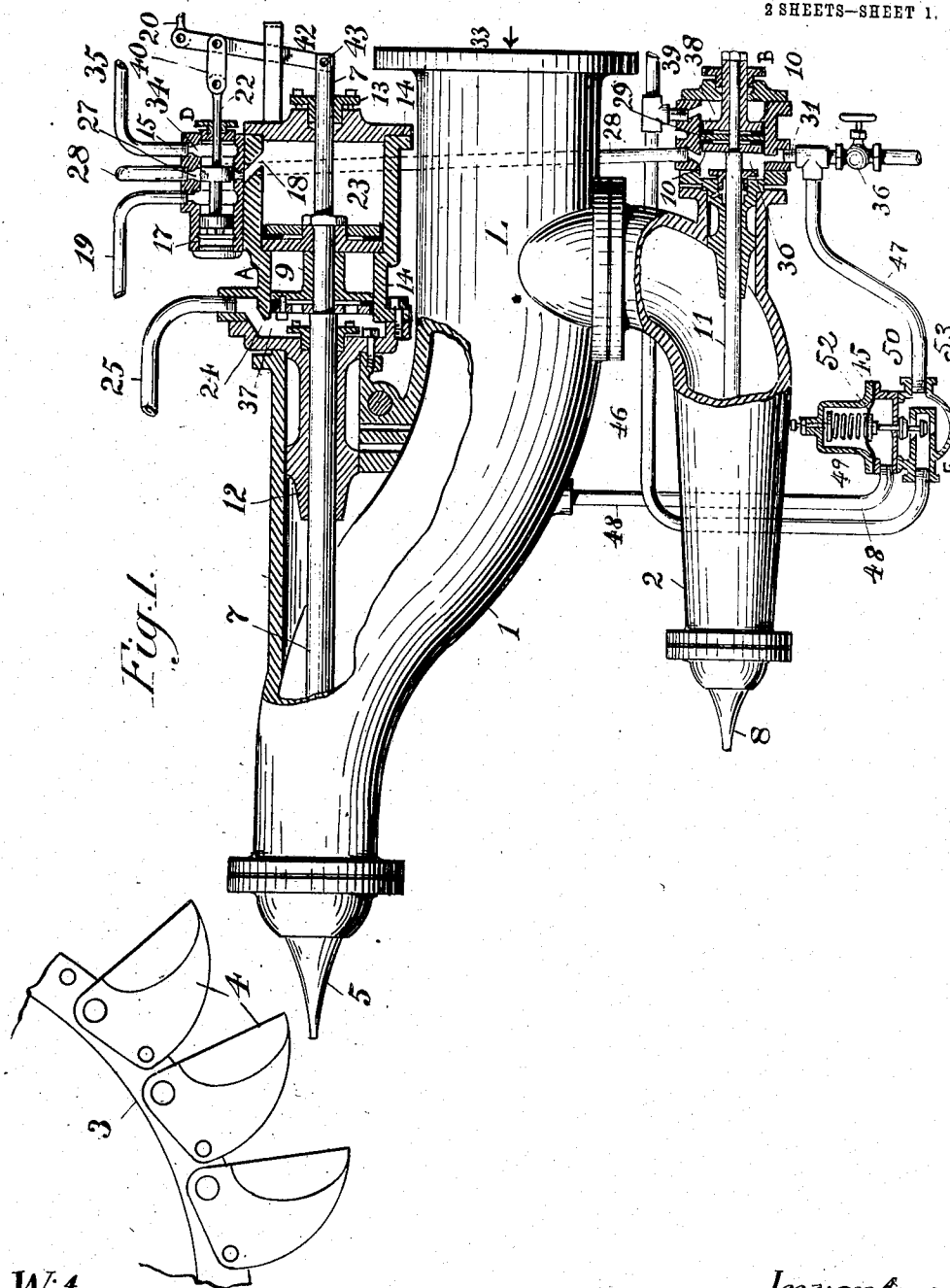


Fig. 1.

Witnesses:

Elmer Wickes
Elmer Wickes.

Inventor:

William A. Doble
By *J. Richards & Co.*
Atys.

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2 SHEETS—SHEET 2.

Fig. 2.

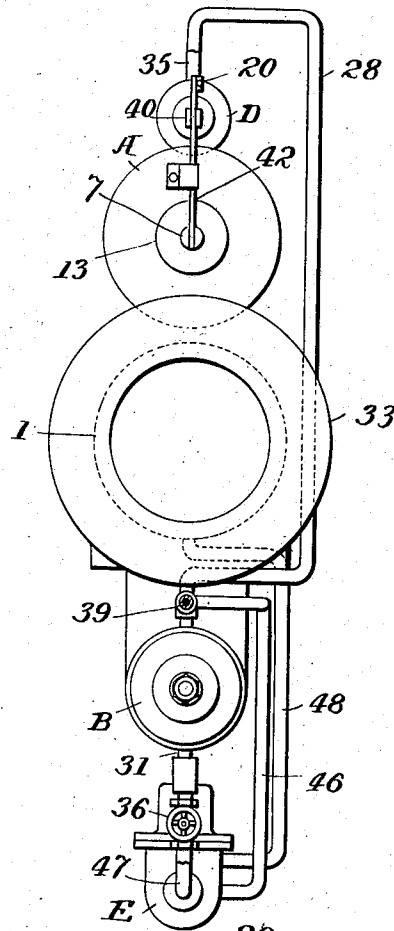
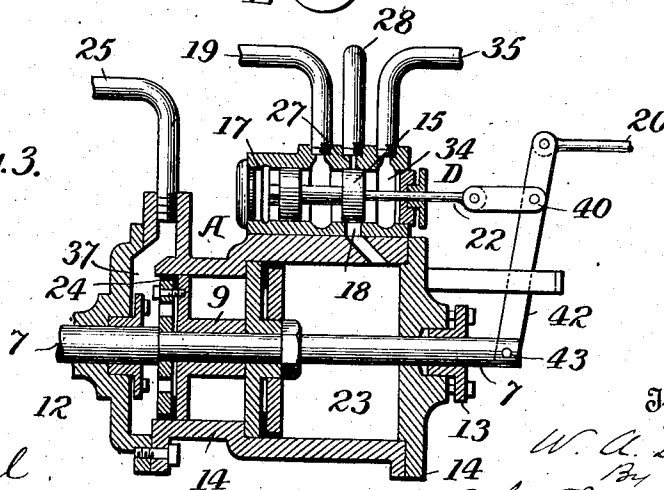


Fig. 3.



Witnesses
J. G. Hinkel
J. M. Gillman, Jr.

Inventor
W. A. Doble
By
Arthur Freeman Watson
Attorneys

UNITED STATES PATENT OFFICE.

WILLIAM A. DOBLE, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR TO MAY E. DOBLE.

REGULATING-NOZZLE.

941,440.

Specification of Letters Patent.

Patented Nov. 30, 1909.

Application filed April 29, 1904. Serial No. 205,606.

To all whom it may concern:

Be it known that I, WILLIAM A. DOBLE, a citizen of the United States of America, residing at San Francisco, county of San Francisco, and State of California, have invented certain new and useful Improvements in Regulating-Nozzles; and I hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates to that class of apparatus in which an impact wheel is combined with a nozzle through which a jet is projected against the buckets of the wheel, and this invention consists of means whereby to avoid waste of water, and to reduce to as great an extent as possible such changes of pressure within the apparatus as are detrimental to the same, and to this end my invention consists in a construction and arrangement of parts whereby to secure such results, as fully set forth hereinafter and as illustrated in the accompanying drawing, in which—

Figure 1 is a side elevation in part section of sufficient of a hydraulic impact apparatus to illustrate one means for carrying out the invention; Fig. 2 is a rear view of the part shown in Fig. 1; Fig. 3 is an enlarged view in section of the control valve of the main or nozzle valve motor.

In the form of apparatus shown, there is a casing L adapted to be bolted by a flange 33 to a supply pipe (not shown) and having a nozzle 1, which is provided with a movable core piece or needle valve 5 controlling the jet which operates on the buckets 4 of the impact wheel 3, and a supplemental discharge port in a branch 2 has a needle valve 8, the said branch communicating with the nozzle 1 so that both are supplied with water from the main. The valves 5 and 8 are combined with means to secure independent or co-acting adjustments as required.

As thus constructed, it will be seen that the casing with its branches constitutes in effect a bifurcated nozzle with an outlet opening in one branch for discharging the jet against the wheel, and an overflow outlet in the other branch, with valves controlling the two outlets to preserve the relations of flow hereinafter set forth.

As shown, with the valve 5 is combined a motor or engine A, and with the valve 8 is

combined a motor or engine B, and with these parts is combined means whereby the motor B is put into operation to open the valve 8 as the valve 5 approaches the limit of its position in closing. As shown, the motor A of the valve 5 is a differential engine, the cylinder 14 of which contains the differential piston 9, having a rod 7 which also constitutes the stem of the valve 5. The motor B is an engine having a cylinder 10, in which works a differential piston 29, the rod 11 of which is the stem of the valve 8. The flow of motor fluid to the motor A is governed by a control device D, shown as a piston valve 15 in a cylinder 17, with which communicate the inlet pipe 19, discharge pipe 35, and the conducting pipe 28 which leads to, and constitutes the supply pipe of, the motor, B.

Between the valve casing 17 and the cylinder 14 of the motor A is a passage or port 18, and with the forward end of said cylinder communicates a supply pipe 25. The piston rod 7 is prolonged through the head of the cylinder 14, and with said rod and with the stem 22 of the valve 15 of the control device are combined devices whereby, while the valve 15 can be shifted by a suitable governor (not shown), or otherwise, it is also automatically shifted by the movement of the rod 7. As shown, a lever 42 is pivoted to the stem or rod 7 at 43 and is connected by a link 40 with the stem of the control valve, the governor-controlled rod 20 being connected to the upper end of the lever.

The parts are so arranged that in case of an excess of speed the valve 15 is carried by the action of the governor, to the right to uncover the port 18, when the motor fluid will flow from the pipe 19 into the chamber 23 of the engine and carry the piston 9 and valve 7 to the left, reducing the area of discharge from the nozzle 1. This forward movement of the piston 9, however, carries the lever 42 and valve 15 to the left and closes the port 18 unless the continued increase in speed of the governor further moves the valve 15 to the right, but when the movement of the governor ceases, the valve 5 will finally reach a position in which the area of the jet will act on the impact wheel 3 to secure the speed of operation determined by the governor, when the movement of the parts will be arrested. If the governor, from a reduction in speed of the apparatus, carries the valve 15, from the po-

sition shown in Fig. 1, to the left, a discharge port 34 leading to the pipe 35 will be put into communication with the port 18, and the fluid from the chamber 23 will escape as the motor fluid, which is under constant pressure on the reduced end of the piston 9, forces it to the right. This enlarges the area of the jet and applies increased power to the wheel and would carry the valve 15 to the right and close the port 18 so that the parts retain their new position.

These operations are the result of what may be termed the minor changes of speed which are continuously but slowly effected or are never such as to reduce the area of the discharge over a predetermined amount, say, seventy-five per cent.; but when there is a sudden and greater variation which would result in quickly closing or nearly closing the port of the valve 5, the valve 15 is carried to the right to a greater or less extent but so as to uncover the port 27 communicating with the pipe 28, when the action of the motor fluid on the piston 29 of the motor B will carry it back with the valve 8 and open the discharge port to an extent to compensate for the reduction of volume escaping from the nozzle, thus avoiding all sudden or excessive pressures and danger of rupture of any of the parts of the apparatus.

The discharge from the discharge port, however, is not continuous for when the machinery slows down, the valve 15 if carried sufficiently to the left, puts the port 18 in communication with the discharge pipe 35, relieving the chambers 23 and 30 of pressure and then opens the port 27 permitting the fluid to escape from the left end of the cylinder 10, so that the valve 5 is opened and the valve 8 at once closed.

A drip cock 36 in a pipe 31 communicating with the chamber 30 at the forward end of the cylinder 10 is so set that if the communication is cut off through the pipe 28, the motor fluid can escape from this chamber allowing the piston 29 to move to the left under fluid pressure from a supply pipe 39 acting on the reduced face of the piston and thus closing the escape port.

To compensate for a sudden obstruction of the main outlet, by debris of any kind, there is a relief device E of any desired character suitably arranged. As shown, this device has a casing 45, with a partition having ports closed by relief valves 53 loaded by a spring adjustable and bearing on a flexible diaphragm 52, as usual.

A pipe 48 constitutes a communication between the chamber below the diaphragm and the interior of the nozzle casing so that on any sudden increase of pressure in the latter, the valves 53 will be lifted and motor fluid supplied from the pipe 39 will flow

through the ports thus opened, through a pipe 47, to the pipe 31 and to the chamber 30 at the left hand end of the cylinder 10 of the motor B, and as the pressure thus brought on the larger face of the piston 29 overbalances that on the face of smaller area, the said piston will at once move to the right with the valve 8, open the discharge port and relieve the pressure in the nozzle casing. As this pressure is reduced, the valves 53 will be seated by their springs, and the pressure from the pipe 39 on the reduced face of the piston will force the latter to the left as the fluid escapes from the chamber 30 through the drip cock 36. The discharge port is thus closed.

It will be seen that the relief device does not, of itself, constitute the means of discharge from excessive pressure which would require a valve of great size and less sensitive than is needed, but it serves as a control device for the motor which actuates the valve of the discharge port. It will be evident that the fluid for operating the motors will depend on the character of the latter and may be a liquid, gas or electricity. Further, it will be seen that the discharge port valve is not controlled directly by the pressure like the relief valve, but depends more directly upon the position of the valve 5 controlled by the governor, and serves to compensate for the changes in volume of discharge which result after the nozzle has been closed to such an extent that increased velocity of discharge will not compensate for the reduced area of the outlet port. The operation of the compensating device is not therefore to relieve a pressure already existing, as in the case of a relief valve, but to prevent such increase as would otherwise result from closing or nearly closing the main valve.

It will be seen that the compensating device does not operate at all during the normal movements of the main valve, but operates only in case of a sudden increase of speed, as distinguished from a slow increase, or after the main valve is nearly closed, to prevent sudden excess of pressure in the nozzle casing; therefore, the discharge port of the compensating device may be of much less area than that of the nozzle outlet. Further, the compensating device is not called into operation except the closure of the valve 5 is sudden, thereby creating an undue pressure in the casing 1 and shifting the valve 15 to an extreme degree. It will be seen that if the speed of the apparatus increases gradually carrying the valve 15 to the right, pressure is admitted to the chamber 23 and the piston 9 moves to the left and would shift the valve 15 to close the port 18 if the increase in speed did not carry the valve 15 farther to the right and keep the port open, and if this gradual increase of

speed of the governor is slow, the port 18 is kept open to a slight extent and the valve 5 may be gradually shifted until nearly closed without any undue pressure in the casing 1 in consequence of the gradual character of the movement. When, however, the movement is sudden, the valve 15 is carried so far to the right as to uncover the port 27 and is held in this position until the compensating device secures the desired relief. It will be seen that this last named action is one which may depend on an increase of speed only, the compensating valve being then opened as a result of the action of the governor to thereby prevent an undue pressure in the casing and an increased discharge of water from the main nozzle.

If the governor shifts the valve 15 to the right and opens the port 18 so as to close the valve 5, the action of the parts would be to carry the valve 15 with the valve 5 without opening the valve 8. But if owing to the increase of speed, the governor further shifts the valve 15 to the right, the port 27 is opened and the valve 8 will therefore be opened by the pressure admitted through the pipe 28 so that there is an opening of the port of the nozzle 2 before the valve 5 can fully close. When the main valve is fully closed and it begins to open from the valve 15 moving to the left to open the port 18 to the discharge while the port 27 is yet closed, the leakage at 31 will tend to start the closing of the valve 8, but, as the valve 15 is farther moved to the left by the action of the governor, the further reduction in the chamber 30 insures a full pressure to close the valve 8.

It will be seen therefore that while the two valves may move simultaneously there is no such connection between them as to cause one inevitably to move with the other and their movements are therefore independent.

Having thus described one construction and operation embodying my improvement, I will now refer more particularly to the purposes intended to be accomplished by the combination of the two independent but co-acting valves, one controlling the jet which operates upon the impact wheel, and the other controlling the discharge from the casing.

In apparatus heretofore employed, the compensations for fluctuations in the load or in the water supply have resulted in waste of water, that is, the governing action has been secured without practically changing the velocity of flow through the supply or pipe line so that the same quantity of water is used whether the impact wheel be fully or partially loaded and a large portion of water in many instances goes to waste. Efforts have been made to remedy this difficulty by connecting the needle valve of the jet

nozzle and the governor as to control the position of the said valve according to the speed. Where the valve is thus connected with the governor, it has been found that the constant change of position of the valve results in what has been termed "water ram", but which is not in fact a water ram action but consists of certain wave-like variations of pressure within the pipe which are attended by a rupture of the latter, and the efforts to prevent this effect by relief valves of different characters have not proved effective. It may be stated, however, that the sudden shifting of the position of the valve will not result in such waves or pulsations to any detrimental extent where the valve does not close the discharge orifice to a much greater extent than one half its area and any increase of pressure resulting from such limited movement may be compensated for in the construction of the apparatus and in some instances a reduction of the orifice to the extent of 75 per cent. of its effective area may be permitted without setting up any detrimental wave-like movement of the particles of the water.

It will be seen therefore that in the above described apparatus the valve controlling the jet is operable by the governor within certain limits, which will not set up any detrimental pulsations, and that beyond these limits the compensating device so co-acts with the valve controlling the jet that there can be no material changes of pressure.

The effect of this combination of elements is to secure the prime object of the invention, to wit, economy in the use of water, because a plant provided with the jet valve and compensating device operating as set forth will not only use water almost strictly proportional to the power output of the station but will also eliminate any element of danger to the pressure pipe line. It will be seen that during the periods when there is but a small load upon the plant, a relatively small amount of water is discharged so that it is retained for use when upon increase in the load a greater supply is required; and that the changes in the position of the parts of the apparatus to secure this result are automatically made and regulated according to the variations of the load.

While reference has been made to operating the main valve so as to close the discharge to from one half to three fourths of its area, it will be understood that it might be found desirable under certain conditions to increase or decrease the extent of closure by the action of the governor, it being required that the valve of the compensating device shall be so opened in advance of the complete closure of the main nozzle as to prevent any detrimental increase of pressure in the casing.

It will be seen that if the fluctuations in

power output are not sudden or do not go beyond the limits predetermined upon, the auxiliary nozzle is not opened at all so that with a load fluctuating between full load and, say, one-half load the water used would be strictly proportioned to that required from the wheel, the compensating device coming into operation only when the fluctuations are such as to carry the main valve beyond the predetermined point.

Without limiting myself to the construction and arrangement of parts shown, I claim—

1. The combination in an impact hydraulic motor and with an impact wheel, nozzle and main valve, of a compensating device having a discharge port and valve, and means including a motor and connections constructed and arranged to cause the valve of the said device to be shifted to open its port only on an undue increase of speed of the apparatus or if the nozzle valve suddenly approaches its closed position, substantially as set forth.

2. The combination in an impact hydraulic motor and with an impact wheel, nozzle and its valve, of a compensating device having a discharge port communicating with the nozzle and means adapted to be operated from a speed governor constructed and arranged to cause the valve of the said device to be shifted to open its port only on an undue increase of speed of the apparatus or if the nozzle valve suddenly approaches its closed position, substantially as set forth.

3. In an impact motor, a casing provided with a nozzle and an independent discharge port, an impact wheel, arranged outside of the casing to receive a jet from the nozzle, valves controlling the discharge of fluid from the casing through the nozzle and port, and means constructed and arranged to cause the said port to be opened only when the nozzle valve moves beyond a predetermined speed and limit in closing, substantially as set forth.

4. The combination in an impact hydraulic motor and with an impact wheel, nozzle and its valve, of a compensating device having a discharge port and valve, means adapted to be operated from a speed governor constructed and arranged to cause the valve of the said device to be shifted to open its port as the nozzle valve suddenly approaches its closed position, and a relief device connected to open the discharge from the nozzle casing on a sudden increase of pressure with the nozzle valve in any position, substantially as set forth.

5. In an impact motor, a casing provided with a nozzle, a discharge port, and valves therefor controlling the flow from the casing, an impact wheel arranged outside the casing to receive the jet from the nozzle, means to actuate the nozzle valve, and means

constructed and arranged to cause the valve controlling the discharge port to be shifted to open said port only when the nozzle valve suddenly approaches its closing position, substantially as set forth.

6. In an impact motor, a casing provided with a nozzle, a discharge port, and valve therefor controlling the flow from the casing, an impact wheel arranged outside the casing to receive the jet from the nozzle, means to actuate the nozzle valve, and means including a motor controlled upon the movements of the nozzle valve constructed and arranged to cause the valve controlling the discharge port to be shifted to open said port only when the nozzle valve suddenly approaches its closing position, substantially as set forth.

7. In an impact motor, a casing provided with a nozzle, a discharge port, and valves therefor controlling the flow from the casing, an impact wheel arranged outside the casing to receive the jet from the nozzle, means for operating the nozzle valve, and means constructed and arranged to cause the valve controlling the discharge port to be shifted independently of the pressure in the casing to open said port only when the nozzle valve suddenly approaches its closing position, substantially as set forth.

8. In an impact water wheel apparatus, the combination with a nozzle and its valve, of a compensating device having a discharge port communicating with said nozzle, a supplemental valve controlling the said port, means constructed and arranged to cause the supplemental valve to be shifted independently of the pressure in the casing, and a relief device arranged to put the supplemental valve operating means into operation on an abnormal increase of pressure in the casing, substantially as described.

9. The combination with the valve of an hydraulic impact apparatus, of a motor for moving said valve, a control device for controlling the movements of the motor adapted to be actuated by a governor, connections between the valve and said control device for shifting the latter to arrest the motor as the valve assumes its proper position, a compensating device having a discharge port and valve, and means for operating said valve only if the nozzle valve suddenly approaches the limits of its closing movement, substantially as set forth.

10. The combination with the valve of an hydraulic impact apparatus, of a motor for moving the valve, a control device for controlling the movements of the motor adapted to be actuated by a governor, connections between the valve and said control device for shifting the latter to arrest the motor as the valve assumes its proper position, a compensating device having a discharge port and valve, a motor therefor, and means for

putting said motor in operation to open the discharge port only if the nozzle valve suddenly approaches its closed position, substantially as set forth.

11. The combination with the nozzle and valve of an hydraulic impact apparatus, of a motor for said valve, a compensating device having a discharge port, valve, and motor, and means whereby the motor of the compensating device is put in operation only if the nozzle valve suddenly approaches its closed position, substantially as set forth.

12. The combination with the nozzle and valve of an hydraulic apparatus, of a motor having a differential piston and cylinder therefor, a control device adapted to be actuated by a governor and connections between said device and the valve, a compensating device having a port, a valve and motor having a differential piston and cylinder therefor, and ports and connections arranged to permit a motor fluid to pass to the motor of the compensating device as the control device is shifted beyond normal limits, substantially as set forth.

13. The combination with the nozzle, valve and fluid motor of an hydraulic impact apparatus, of a compensating device having a port, valve and fluid motor, a control device for the main motor having a valve and ports arranged to control the operations of the motor under normal variations of speed, and a port arranged to control the flow of motor fluid to the secondary motor as the control device is shifted beyond normal limits to carry the main valve to its closing position, substantially as set forth.

14. The combination of the nozzle, valve, motor, control device adapted to be actuated by a governor and connected with said valve, a discharge port communicating with said nozzle, a valve therefor, a motor having a differential piston connected with the latter valve, and a communication between the two motors including a port in the control device arranged to be uncovered only as the control device is shifted beyond normal limits, substantially as set forth.

15. The combination of the nozzle, valve, motor, control device adapted to be actuated by a governor and connected with said valve, a discharge port communicating with said nozzle, a valve therefor, a motor having a differential piston connected with the latter valve, a communication between the two motors including a port in the control device arranged to be uncovered only as the control device is shifted beyond normal limits or if the main valve suddenly approaches its closing position, and a relief device arranged to put the latter motor in operation on an abnormal increase of pressure in the nozzle with the nozzle valve in any position, substantially as set forth.

16. The combination with the nozzle and

valve of an hydraulic impact apparatus, of a discharge port of smaller area and valve therefor, and means constructed and arranged to cause the discharge valve to be moved to open its port if the nozzle valve suddenly approaches its closed position, substantially as described.

17. The combination with the nozzle and valve of an hydraulic impact apparatus, of a discharge port of smaller area and valve therefor, and means constructed and arranged to cause the discharge valve to be moved to open its port on an undue increase of speed of the apparatus or if the nozzle valve suddenly approaches its closed position, substantially as set forth.

18. In an impact water wheel apparatus, the combination with a nozzle and its valve, of a compensating device having a discharge port communicating with said nozzle, a supplemental valve controlling the said port, and a motor, and means for controlling it constructed and arranged to cause the supplemental valve to be shifted independently of the pressure in the casing to open said port on a sudden increase of speed of the apparatus, substantially as set forth.

19. The combination with a nozzle and valve of an impact motor apparatus, of a supplemental nozzle and valve, a governor and connections whereby to shift the main valve according to load changes on the motor, means whereby the supplemental valve may be retained in a closed position while closing the main valve and for opening the supplemental valve independently of the main valve to prevent detrimental increase of pressure in the apparatus.

20. The combination with the nozzle and valve of an impact motor apparatus, of a supplemental nozzle and valve less in area than the main nozzle and valve, a governor and connections whereby to shift the main valve according to load changes on the motor, means whereby the supplemental valve may be retained in a closed position while closing the main valve and for opening the supplemental valve independently of the main valve to prevent detrimental increase of pressure in the apparatus.

21. The combination with the nozzle and valve of an impact motor apparatus, of a supplemental nozzle and valve, a governor connected to shift the main valve according to the load changes on the motor, and means for positively opening the supplemental valve upon a closing movement of the main valve only when the latter exceeds a predetermined speed.

22. The combination with an hydraulic motor provided with valve mechanism, of a compensating device having a discharge port and valve, and means adapted to be operated from a speed governor constructed and arranged to cause the said compensating

valve to be shifted to open its port only when the said valve mechanism is shifted beyond normal limits.

23. The combination with an hydraulic motor provided with valve mechanism, of a compensating device having a discharge port and valve, and means adapted to be operated from a speed governor constructed and arranged to cause the said compensating valve to be shifted to open its port only when the motor valve moves beyond a predetermined speed and limit in closing.

24. The combination with an hydraulic motor provided with valve mechanism, of a supplemental discharge port and valve, a governor connected to shift the main valve according to the load changes on the motor, and means for positively opening said discharge port upon a closing movement of the main valve only when the latter exceeds predetermined speed.

25. The combination with an hydraulic motor, of mechanism for controlling the passage of water in said motor, a supplemental discharge port and valve connected to relieve the pressure of the water supplied to said motor, and a relief device connected to open the discharge port on a sudden increase of pressure with said controlling mechanism in any position.

26. The combination with an hydraulic motor, of mechanism for controlling the passage of water in said motor, a supplemental discharge port and valve connected to relieve the pressure of the water supplied to said motor, and a relief device connected to open the discharge port on an abnormal increase in pressure of water supplied to the motor.

27. In a hydraulic motor, the combination with mechanism for controlling the passage of water, of a compensating device having a discharge port communicating with the casing of said motor, a supplemental valve controlling the said port, means constructed and arranged to cause the supplemental valve to be shifted independently of the pressure in the casing, and a relief device arranged to put the supplemental valve into operation on an abnormal increase of pressure in the casing.

28. The combination with the water regulating means of an hydraulic motor, of a discharge port of smaller area and valve therefor, and means constructed and arranged to cause the discharge valve to be moved to open its port only if the water regulating means is shifted beyond normal limits.

29. The combination with the water regulating means of an hydraulic motor, of a discharge port of smaller area and valve thereof, and means constructed and arranged to cause the discharge valve to be moved to open its port on an undue increase

of speed of the apparatus or if the regulating means suddenly approaches its closed position.

30. The combination with an hydraulic motor provided with valve mechanism, of a compensating device having a discharge port and valve, and means adapted to be operated from a speed governor constructed and arranged to cause the valve of the said device to be shifted to open its port only on an undue increase of speed of the apparatus or if the valve mechanism suddenly approaches its closed position.

31. The combination with an hydraulic motor provided with valve mechanism, of a compensating device having a discharge port and valve, means adapted to be operated from a speed governor constructed and arranged to cause the valve of the said device to be shifted to open its port only on an undue increase of speed of the apparatus or if the valve mechanism suddenly approaches its closed position, and independent means for gradually closing said compensating valve.

32. The combination with an hydraulic motor provided with valve mechanism, of a compensating device having a discharge port and valve, means adapted to be operated from a speed governor to cause the valve of the said device to be shifted to open its port only on an undue increase of speed of the apparatus or if the valve mechanism suddenly approaches its closed position, and a relief device connected to open the discharge from the casing of the motor on a sudden increase of pressure with the valve mechanism in any position.

33. In an hydraulic motor, the combination with valve mechanism for regulating the passage of water, of a compensating device communicating therewith having a discharge port, a supplemental valve controlling the said port, means constructed and arranged to cause the supplemental valve to be shifted independently of the pressure in the casing, and a relief device arranged to put the supplemental valve operating means into operation on an abnormal increase of pressure in the casing.

34. The combination with an hydraulic motor provided with valve mechanism, of a supplemental discharge port and valve, a governor connected to shift the main valve according to the load changes on the motor, means for positively opening said discharge port upon a closing movement of the main valve only when the latter exceeds predetermined speed, and independent means for gradually closing the valve of said discharge port.

35. The combination with the water regulating means of an hydraulic motor, of a discharge port of smaller area and valve therefor, means constructed and arranged to

cause the discharge valve to be moved to open its port only if the water regulating means is shifted beyond normal limits, and independent means for gradually closing the discharge valve.

36. The combination in an impact hydraulic motor and with an impact wheel, nozzle and its valve, of a compensating device having a discharge port communicating with the nozzle, and means adapted to be operated from a speed governor constructed and arranged to cause the valve of

the said device to be shifted to open its port only on an undue increase of speed of the apparatus, or if the nozzle valve moves beyond a predetermined speed and limit in closing. 15

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM A. DOBLE.

Witnesses:

ALFRED A. ENQUIST,
ELMER WICKES.