(No Model.) 4 Sheets—Sheet 1.

C. C. WORTHINGTON.

PRESSURE ACCUMULATOR.

No. 524,013. Patented Aug. 7, 1894.

Fig. 1.

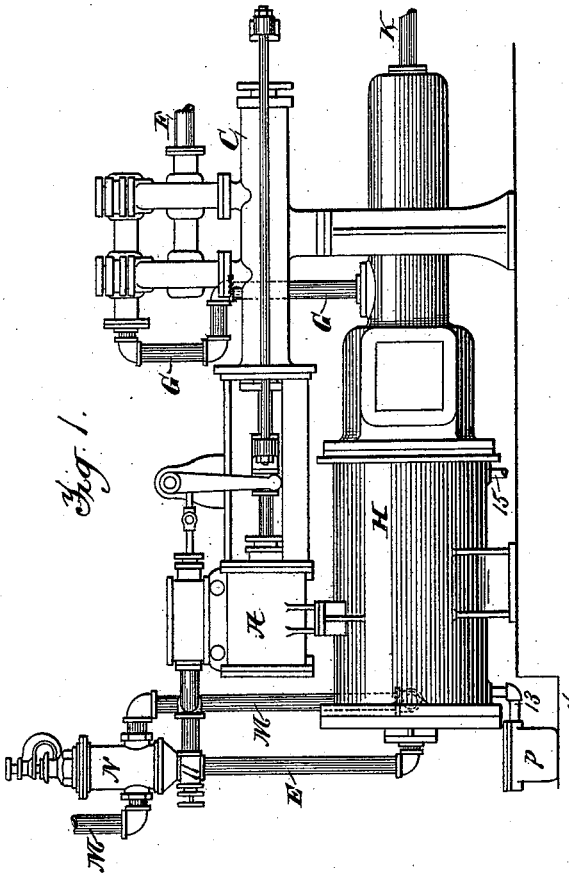


Fig. 2.

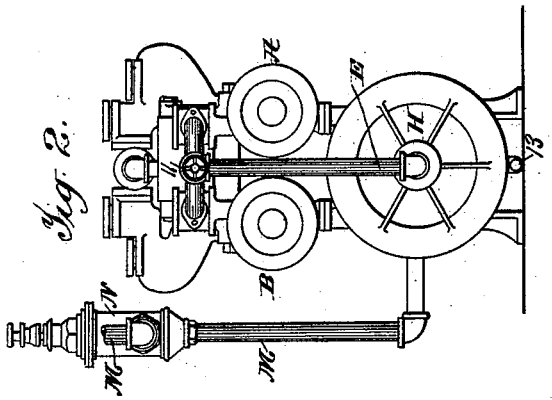
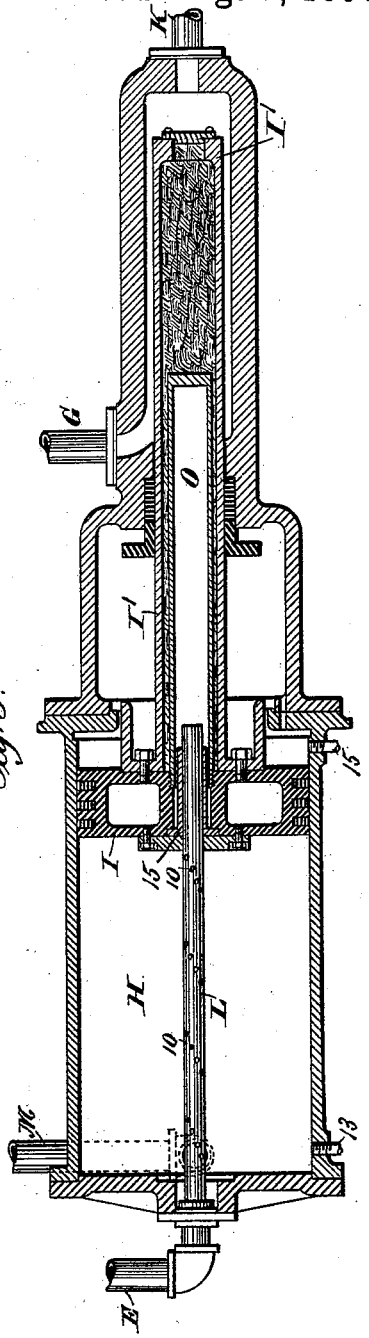


Fig. 3.



Attest:
Geo. H. Potts.
C. J. Sawyer

Inventor
Charles C. Worthington
by Philipp, Munson & Philipp.
Attys

(No Model.) 4 Sheets—Sheet 2.

C. C. WORTHINGTON.

PRESSURE ACCUMULATOR.

No. 524,013. Patented Aug. 7, 1894.

Fig. 4.

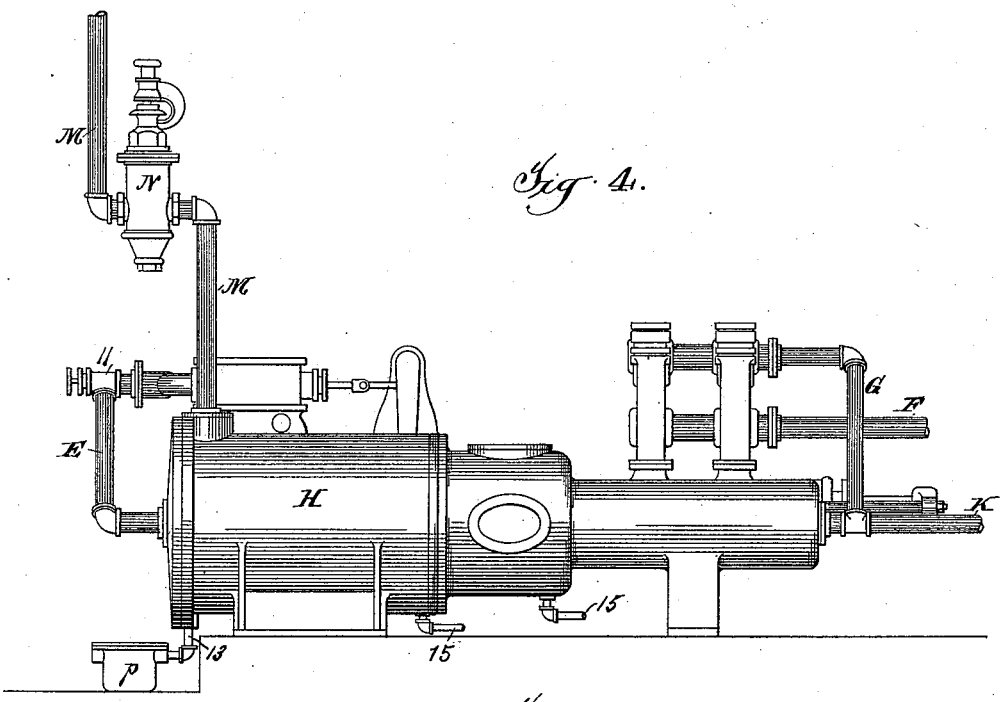
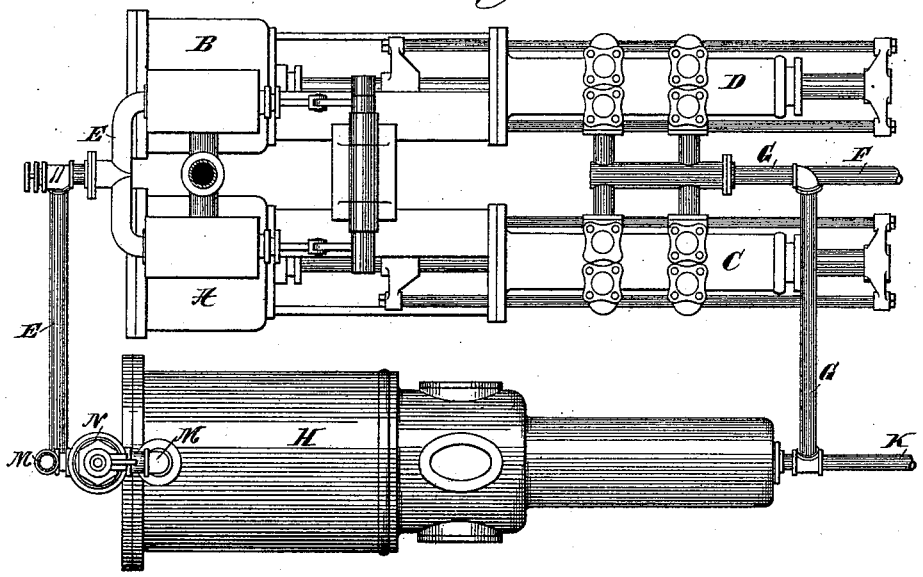


Fig. 5.



Attest:
Geo. H. Botts.
C. J. Sawyer

Inventor
Charles C. Worthington
by
Philip Thurston & Phelps
Attys

(No Model.) 4 Sheets—Sheet 3.

C. C. WORTHINGTON.

PRESSURE ACCUMULATOR.

No. 524,013. Patented Aug. 7, 1894.

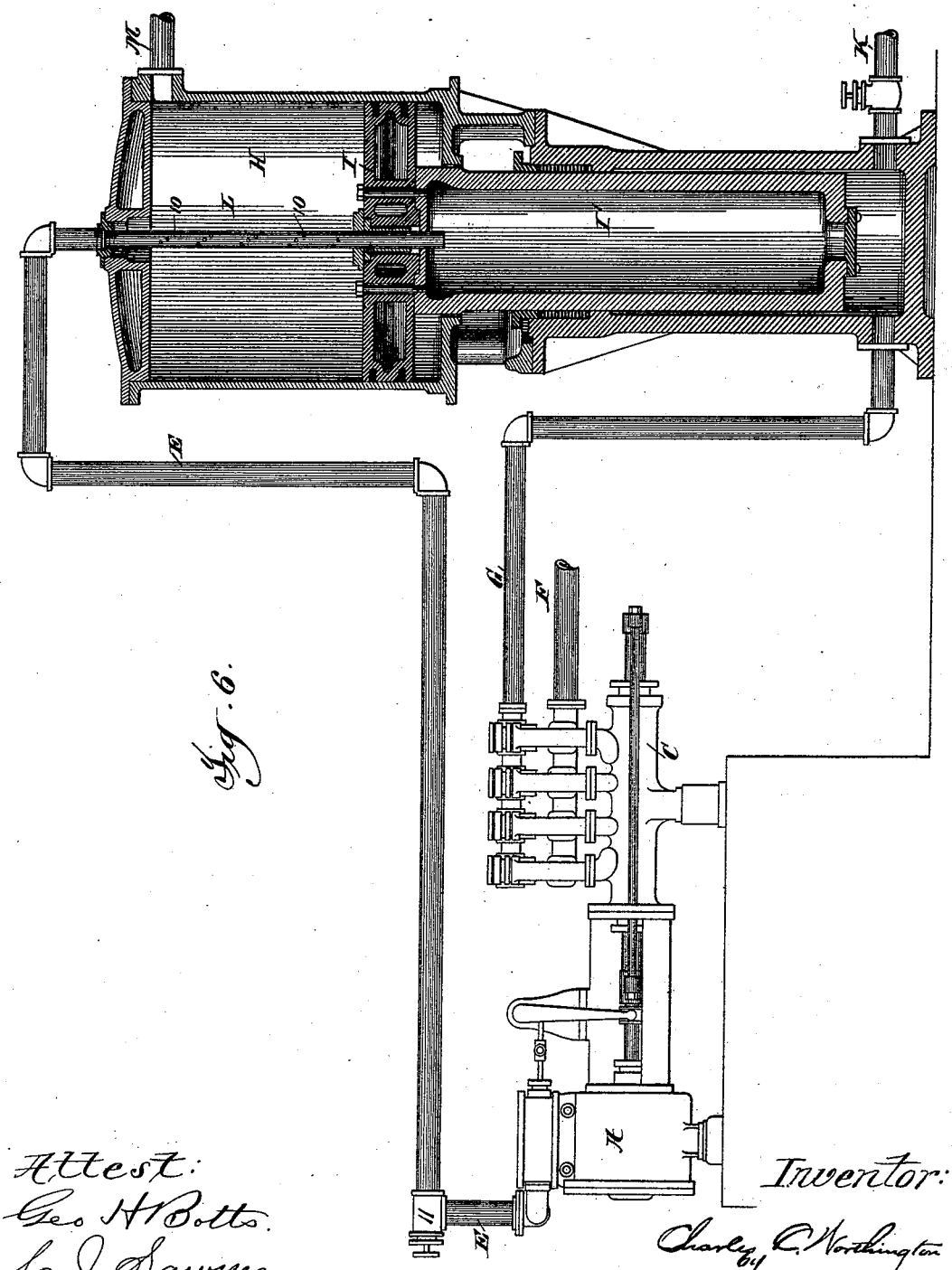


Fig. 6.

Attest:
Geo. H. Botts.
C. J. Sawyer

Inventor:
Charles C. Worthington
by
Philipp Thomas & Philipp.
Attys

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C. C. WORTHINGTON.

PRESSURE ACCUMULATOR.

No. 524,013. Patented Aug. 7, 1894.

Fig. 7.

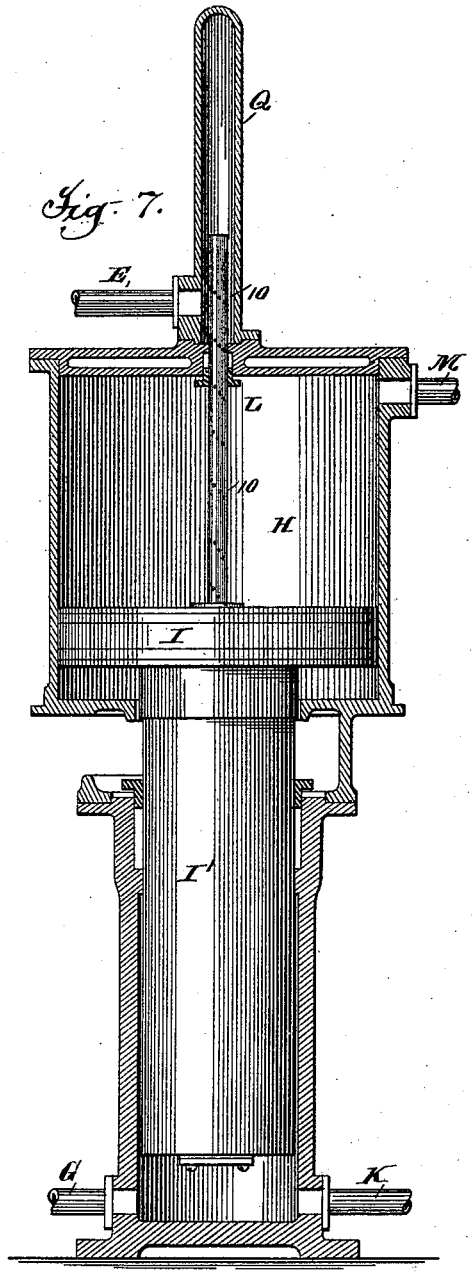
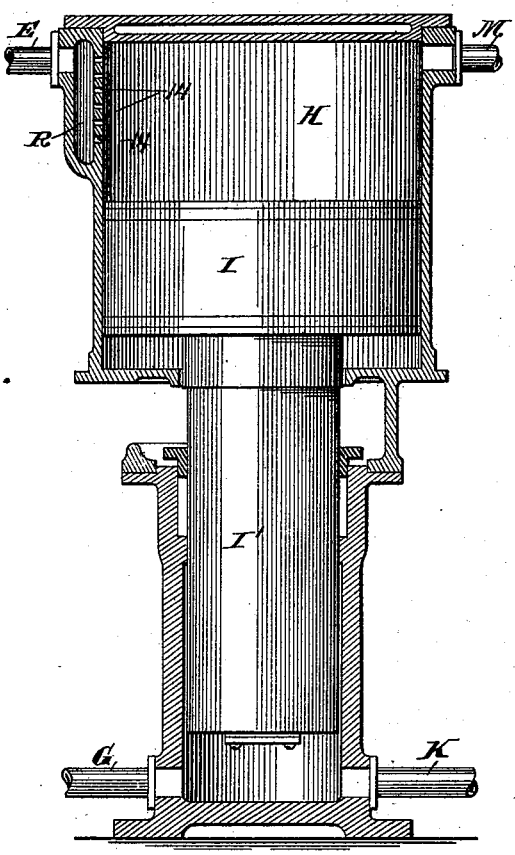


Fig. 8.



Attest:
Geo. H. Bolte
C. J. Sawyer

Inventor:
Charles C. Worthington
by
Philipp Thomson & Sheeps
Attys

UNITED STATES PATENT OFFICE.

CHARLES C. WORTHINGTON, OF IRVINGTON, NEW YORK.

PRESSURE-ACCUMULATOR.

SPECIFICATION forming part of Letters Patent No. 524,013, dated August 7, 1894.

Application filed February 26, 1894. Serial No. 501,464. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. WORTHINGTON, a citizen of the United States, residing at Irvington, county of Westchester, and State of New York, have invented certain new and useful Improvements in Pressure-Accumulators, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The especial object of the present invention is to provide an improved pump and accumulator construction combining an accumulator with a pump in such a manner that a smooth, uniform and properly regulated action of the apparatus shall be secured. The result is attained by the present invention in its preferred form by combining with a pump an accumulator receiving the force pressure on one side of its piston, as usual in such constructions, but receiving its working pressure on the opposite side of the piston from the steam supply to the pump motor and so arranged that the accumulator piston controls and automatically varies the supply of steam to the pump in accordance with the position of the piston, gradually increasing the supply as the piston moves against the force pressure and decreasing the supply as the piston moves in the opposite direction under the action of the force pressure. This gradual adjustment of the steam supply is preferably constant throughout the stroke of the accumulator piston, as the most perfect adjustment of the steam in accordance with the work performed is thus provided, and the highest economy in the operation of the apparatus secured. While this combination of accumulator and controlled pump forms an important part of the invention, such a steam accumulator may be used also in systems in which the exhaust steam from the accumulator is applied to driving an engine other than the pump motor or to doing other work, and the invention includes such a combination. The invention includes also an elastic fluid accumulator with certain regulative features designed to secure its proper action and various special features of construction in accumulators and in combined accumulator and pump constructions, all as will be fully described and claimed hereinafter.

As the invention relates especially to combined pump and accumulator constructions, it will be illustrated as thus applied and from a description of such construction the use of the accumulator alone or with other apparatus for utilizing the exhaust therefrom will be readily understood. It is obvious that many different pump and accumulator constructions embodying the broad features of the invention may readily be devised by those skilled in the art, and that the size of the accumulator cylinder and piston and the arrangements for controlling the steam supply in accordance with its movement may be varied in accordance with the size and steam pressure of the pump, and the results desired. In the accompanying drawings, however, there are shown constructions of some of the preferred forms embodying the invention, and a detailed description of these constructions will now be given, and the features forming the invention specifically pointed out in the claims.

In the drawings:—Figure 1 is a side elevation of a pump and accumulator apparatus embodying the invention in one of the preferred forms, the engine being shown as of the common form known as the "Worthington duplex pumping engine," although it will be understood that the invention is applicable in connection with pumping engines of other forms. Fig. 2 is an end elevation looking to the right in Fig. 1. Fig. 3 is an enlarged central longitudinal section of the accumulator. Figs. 4 and 5 are respectively a side elevation and a plan of a construction with the accumulator placed beside the pump, the accumulator being of substantially the same construction as in Figs. 1 to 3, but the connection of the force main being changed. Fig. 6 is a view partly in elevation and partly in section employing a vertical accumulator, the accumulator and connections with the force main being slightly modified. Figs. 7 and 8 show modified forms of accumulator, which are shown as vertical, although it will be understood that they may be either vertical or horizontal.

Referring now to Figs. 1 to 3, the pumping engine is of the common form of the ordinary Worthington duplex pumping engine having steam cylinders A, B, and water cylinders C, D, on opposite sides, the steam cylinders

being supplied with steam through the usual supply or induction pipe E and the water cylinders having the usual suction main F and force main G. Below and in the same vertical plane with the pump is the accumulator H made as usual in hydraulic accumulator constructions with chambers of different sizes at opposite ends, and a differential piston having its larger and smaller portions I, I′ in respectively the larger and smaller chambers of the accumulator.

With the smaller chamber the force main G connects, preferably at the side, and some little distance from the end, as shown, and from the end of the smaller chamber extends the delivery pipe K, this construction being preferred to the usual arrangement of the force main connection with the delivery pipe, as it prevents opposing currents in the pipe, the water passing into and out of the accumulator cylinder in the direction of the current.

The steam supply pipe E of the pump connects at the larger end of the accumulator with the pipe L which extends through the accumulator chamber and the larger piston I, this pipe being provided with openings arranged in the line of movement of the piston, a series of perforations 10 sufficient to furnish the greatest amount of steam ever required for the pump being shown. It will be understood, however, that slots extending longitudinally of the cylinder may be used in place of the perforations, or any other suitable openings.

The pipe M from the boiler connects with the larger chamber of the accumulator H so as to supply steam thereto for the pressure upon piston I, and for the supply of steam to the pump motor through the perforated pipe L and supply pipe E, and this pipe M is controlled preferably by an automatic pressure regulator N, which may be of any suitable form to insure the desired pressure in the accumulator. It is preferably a pressure reducing and regulating valve of some suitable construction, and preferably adjustable to vary the pressure according to the work desired. A common Mason regulating valve construction, which answers all these requirements, is shown. Upon the pipe E between the accumulator and steam supply is preferably placed also an adjustable valve 11 which may be automatically adjustable to control and vary or maintain constant the steam supply, but which preferably is a common throttle valve by which the supply of steam may be adjusted as desired, it being understood that when this valve is once adjusted to secure the desired relative supply, the control of the steam thereafter is automatic by the accumulator piston I. It is not essential in all constructions, however, that a valve be placed between the accumulator and pump.

The arrangement shown in the construction now being described, in which the pump and accumulator are placed in the same vertical plane, is desirable, and in itself forms a part of the invention, as the floor space is thus much reduced and a single bed of the width required for one of these members serves also for the other. Moreover, it permits short and convenient connections between the pump and accumulator to be used. The placing of the pump above the accumulator is preferable over the opposite arrangement with the pump below the accumulator, as the pump is thus brought on top where its working parts are more convenient of access, while the working parts of less convenient access are those of the accumulator which are inclosed and protected within the accumulator casing and therefore require but slight and infrequent attention.

The interior arrangement of the accumulator and packing, so as to avoid the escape of steam from the pipe L may be of any suitable form, but the construction shown in Fig. 3 will be found very efficient. In this construction, the smaller piston I′ is made hollow so as to accommodate a closed pipe O which is screwed or otherwise secured into the piston I so as to move therewith, this pipe inclosing the end of perforated pipe L. The space within the piston I′ around this pipe O is preferably filled with non-conducting material, such as asbestus, to prevent the condensation of the steam by the water surrounding the piston I′. The pipe L is surrounded within the piston by a metallic sleeve 15 which slides upon the pipe, and with the construction shown no other steam packing is required. The larger accumulator chamber is preferably connected by a pipe 13 with a trap p so as to trap off the water of condensation from the chamber, and drain pipes 15 for other parts of the accumulator are preferably provided, as shown. It will be seen that the accumulator in this construction receives the condensation from the steam in the supply pipe E for the pump motor. This is a desirable feature, as in the case of pumps called upon to pump intermittently, as is generally the case when accumulators are used, difficulty results from the water of condensation collecting in the supply pipe during the time that the pump is not in action, to be delivered into the steam cylinder on the sudden opening of the throttle.

While, as above stated, it is preferable that the accumulator and pump be placed in the same vertical plane, it will be understood that this is not essential, but that they may be placed otherwise. In Figs. 4 and 5, the pump, accumulator and connections are shown of substantially the same construction as previously described, but the pump and accumulator are placed side by side, and the force main G is shown as connecting with the delivery pipe K outside the accumulator. The accumulator also may be placed vertically, if desired, as usual in the case of weighted and hydraulic pressure accumulators, such a construction being shown in Fig.

6. In this construction, the pipe O is omitted, and the pipe L passes directly into the closed hollow smaller piston I', the force main G and delivery K connecting at opposite sides of the base of the accumulator.

In all the constructions thus far shown, the control of the steam supply to the pump is secured by the accumulator piston moving over a perforated pipe, so that, as the accumulator piston rises, it closes to the steam more or less of the perforations 10, and thus reduces the supply of steam, the reverse action occurring as the piston falls. It is obvious that this result may be secured in other ways, and of the many modifications which may readily be made by those skilled in the art, while retaining this feature of the gradual variation of the steam supply to the pump through the stroke of the accumulator piston, two are shown in Figs. 7 and 8.

In Fig. 7, the perforated pipe L is attached to and moves with the piston, passing through the head of the accumulator into a closed chamber Q with which the steam supply pipe E connects. The pipe L is packed in the head of the accumulator so that the only steam passing to the chamber Q is that admitted through the openings 10. As the pipe L rises with the piston the number of perforations 10 within the accumulator cylinder is reduced, and thus the supply of steam lessened, and on the descent of the piston and pipe the reverse occurs.

In Fig. 8, a chamber R is formed in the side of the accumulator cylinder with which chamber the steam pipe E connects, and this chamber R connects with the accumulator cylinder through a series of perforations 14, so that some or all of these perforations are cut off and closed by the rising piston, and as the piston falls the perforations are opened.

From the above description and illustration the embodiment of that part of the invention relating to the combined pump and accumulator with other forms of devices and with other arrangments of the pump, accumulator and connections, and the application of the accumulator on other systems where the steam from the accumulator performs other work than actuating the pump motor, or the the accumulator is used alone on a steam or other elastic fluid supply, may readily be made by those skilled in the art.

The pressure regulator for the accumulator performs an important function in that the pressure in the accumulator cylinder must never exceed even slightly what is necessary to balance the pressure on the water end of the accumulator, as in such case the entire construction will become ineffective. This pressure regulator is shown as an ordinary pressure reducing valve construction on the connections between the pressure accumulator and boiler, permitting the steam to flow toward the accumulator, but closing on the increase of back pressure so as to prevent a return flow, and with the usual boiler constructions this will be found preferable for the following reason:

It is important that the pressure on the accumulator shall be constant and independent of any fluctuations in the boiler or other supply. In the usual boiler constructions such fluctuations occur, and the maximum pressure on the accumulator must not exceed the lowest point to which the boiler pressure may fall. In order, therefore, to secure any range of regulating action, the valve controlling the maximum accumulator pressure must be a pressure reducing valve varying the accumulator pressure below the boiler pressure in accordance with the action of the apparatus. It will be understood, however, that any suitable means may be used for regulating the pressure upon the accumulator so as to secure a constant accumulator pressure of the required amount and insure that this pressure shall not pass the desired point. It is very desirable, also, that this regulator should be adjustable so as to vary the pressure in the accumulator when desired, as the accumulator may thus be applied to work requiring different pressures solely by adjusting this pressure regulator.

In the construction shown, in which the accumulator cylinder is provided with an escape or exhaust pipe, which function in the construction shown is subserved by the pipe E forming a supply pipe for the pump, the required flow of steam through the reducing valve is assured and its proper operation thus secured. In combination with the reducing valve which prevents a return flow, such an escape pipe is important also in preventing the compression of the steam in the upper part of the accumulator, which otherwise would result as the piston moves up under the water pressure from the pump, and this forms a feature of the invention in connection with the pressure reducing valve whether this escape pipe forms also an exhaust pipe for conducting away the surplus steam from the accumulator or forms simply an escape pipe through which the steam is allowed to escape to relieve the pressure, if the latter tends to rise too high.

It will be seen that the construction shown secures a gradual change of the steam supply to the pump and that this change is made practically continuous by very small variations throughout the stroke of the accumulator piston. While such small frequent variations are desirable and the constructions shown embody the invention in its preferred form, it is evident that the variations of the supply may be less frequent and consequently greater than shown, the perforations or other regulating details being varied. The gradual variation of the steam supply is a very important feature of the invention in that the pump is thus started and stopped without shock. Thus when the accumulator piston commences its downward movement, steam is supplied to the pump by the opening

of the perforations 10 as the piston passes over them, the supply being slight at first and gradually increased until the pressures upon the piston are balanced, when it remains stationary, and upon the stoppage or decrease of the withdrawal of fluid the piston will be reversed and raised by the force pressure without shock and the steam supply gradually cut off so as to stop the piston slowly and without shock.

It will be understood that, while the invention has been described as applied in connection with an ordinary steam motor and the term "steam" has been used throughout the specification and claims, the accumulator may be combined also with an expansion engine employing any other suitable motor fluid and that the term "steam" is intended to include such equivalents. If the accumulator be used independent of any expansion engine so that there is no supply of steam therefrom for any other work, it may be found preferable to use compressed air or other gas rather than steam.

What is claimed is—

1. The combination with a steam engine, of a steam accumulator forming part of the steam connections between the steam supply and engine, and means for varying the supply of steam to the engine in accordance with the movement of the accumulator piston, substantially as described.

2. The combination with a steam pump, of a steam accumulator on the force main forming part of the steam connections between the steam supply and pump motor, and means for varying the supply of steam to the pump motor in accordance with the movement of the accumulator piston, substantially as described.

3. The combination with a steam engine, of a steam accumulator, and an exhaust pipe from the steam chamber of the accumulator forming a steam supply pipe for the engine and controlled by the accumulator piston to vary the supply of steam to the engine in accordance with the movement of the accumulator piston, substantially as described.

4. The combination with a steam engine, of a steam accumulator, and an exhaust pipe from the steam chamber of the accumulator forming a steam supply pipe for the engine and communicating with the steam chamber by openings arranged in the line of movement of the accumulator piston and closed and opened by the latter, whereby the supply of steam to the engine is varied in accordance with the movement of the accumulator piston, substantially as described.

5. The combination with a steam engine, of a steam accumulator forming part of the steam connections between the steam supply and engine, and a pressure regulator between the steam supply and accumulator, substantially as described.

6. The combination with a steam engine, of a steam accumulator forming part of the steam connections between the steam supply and engine, and a pressure regulator between the steam supply and accumulator adjustable to change the accumulator pressure in accordance with the work required, substantially as described.

7. The combination with a steam engine, of a steam accumulator forming part of the steam connections between the steam supply and engine, a pressure regulator between the steam supply and accumulator, and an adjustable valve between the accumulator and engine, substantially as described.

8. The combination with a steam pump, of a steam accumulator on the force main, connections between said accumulator and a steam supply, and an exhaust pipe from the steam chamber of the accumulator forming a steam supply pipe for the pump motor and controlled by the accumulator piston to vary the supply of steam to the pump motor in accordance with the movement of the accumulator piston, substantially as decribed.

9. The combination with a steam pump, of a steam accumulator on the force main, connections between said accumulator and a steam supply, and an exhaust pipe from the steam chamber of the accumulator forming a steam supply pipe for the pump motor and communicating with the steam chamber by openings arranged in the line of movement of the accumulator piston and closed and opened by the latter, whereby the supply of steam to the pump motor is varied in accordance with the movement of the accumulator piston, substantially as described.

10. The combination with a steam pump, of a steam accumulator on the force main, connections between said accumulator and a steam supply, an exhaust pipe from the steam chamber of the accumulator forming a steam supply pipe for the pump motor, and a pressure regulator between the steam supply and accumulator, substantially as described.

11. The combination with a steam pump, of a steam accumulator on the force main, connections between said accumulator and a steam supply, an exhaust pipe from the steam chamber of the accumulator forming a steam supply pipe for the pump motor, a pressure regulator between the steam supply and accumulator, and a throttle valve between the accumulator and pump motor, substantially as described.

12. The combination with a steam pump, of a steam accumulator on the force main arranged in line vertically with said pump and forming a part of the steam connections between the steam supply and pump motor, substantially as described.

13. The combination with a horizontal steam pump, of a horizontal steam accumulator on the force main arranged in line beneath said pump and forming a part of the steam connections between the steam supply and pump motor, substantially as described.

14. The combination with a steam engine, of a steam accumulator forming part of the

steam connections between the steam supply and steam engine, and arranged to form a trap for condensation in the steam connections between the accumulator and engine, substantially as described.

15. The combination with a pressure accumulator, of an elastic fluid supply for said accumulator and a pressure regulator for regulating the pressure in said accumulator relatively to the supply, substantially as described.

16. The combination with a pressure accumulator, of an elastic fluid supply for said accumulator, and a pressure regulator for regulating the pressure in the accumulator relatively to the supply and adjustable to change the accumulator pressure in accordance with the work required, substantially as described.

17. The combination with a pressure accumulator, of an elastic fluid supply for said accumulator, a pressure reducing valve mechanism between said supply and accumulator, and an escape pipe for the fluid from the accumulator cylinder, substantially as described.

18. The combination with a pressure accumulator having the differential piston I, I′, the piston I′ being hollow, of perforated exhaust pipe L passing through the piston I into the hollow piston I′, and supply pipe E, substantially as described.

19. The combination with a pressure accumulator having the differential piston I, I′, the piston I′ being hollow, of perforated exhaust pipe L passing through the piston I into the hollow piston I′, closed pipe O in said hollow piston I′, and supply pipe E, substantially as described.

20. The combination with a pressure accumulator having the differential piston I, I′, the piston I′ being hollow, of perforated exhaust pipe L passing through the piston I into the hollow piston I′, closed pipe O in said hollow piston I′, and a non-heat-conducting packing about said pipe O, substantially as described.

21. The combination with a pressure accumulator connected with an elastic fluid supply, of pipe E connecting with the accumulator chamber by a series of openings arranged in the line of movement of and opened and closed by the accumulator piston, substantially as described.

22. The combination with a pressure accumulator connected with an elastic fluid supply, of pipe E, and exhaust pipe L connecting the accumulator chamber with the pipe E and having a series of openings opened and closed by the movement of the accumulator piston, substantially as described.

23. The combination with a pressure accumulator connected with an elastic fluid supply, of pipe E, and perforated exhaust pipe L in the accumulator chamber connecting with the pipe E and passing through the accumulator piston, whereby the perforations in the pipe are opened and closed by the piston, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHARLES C. WORTHINGTON.

Witnesses:
LOUIS R. ALBERGER,
H. W. TILLINGHAST.