No. 694,513. Patented Mar. 4, 1902.

C. C. WORTHINGTON.

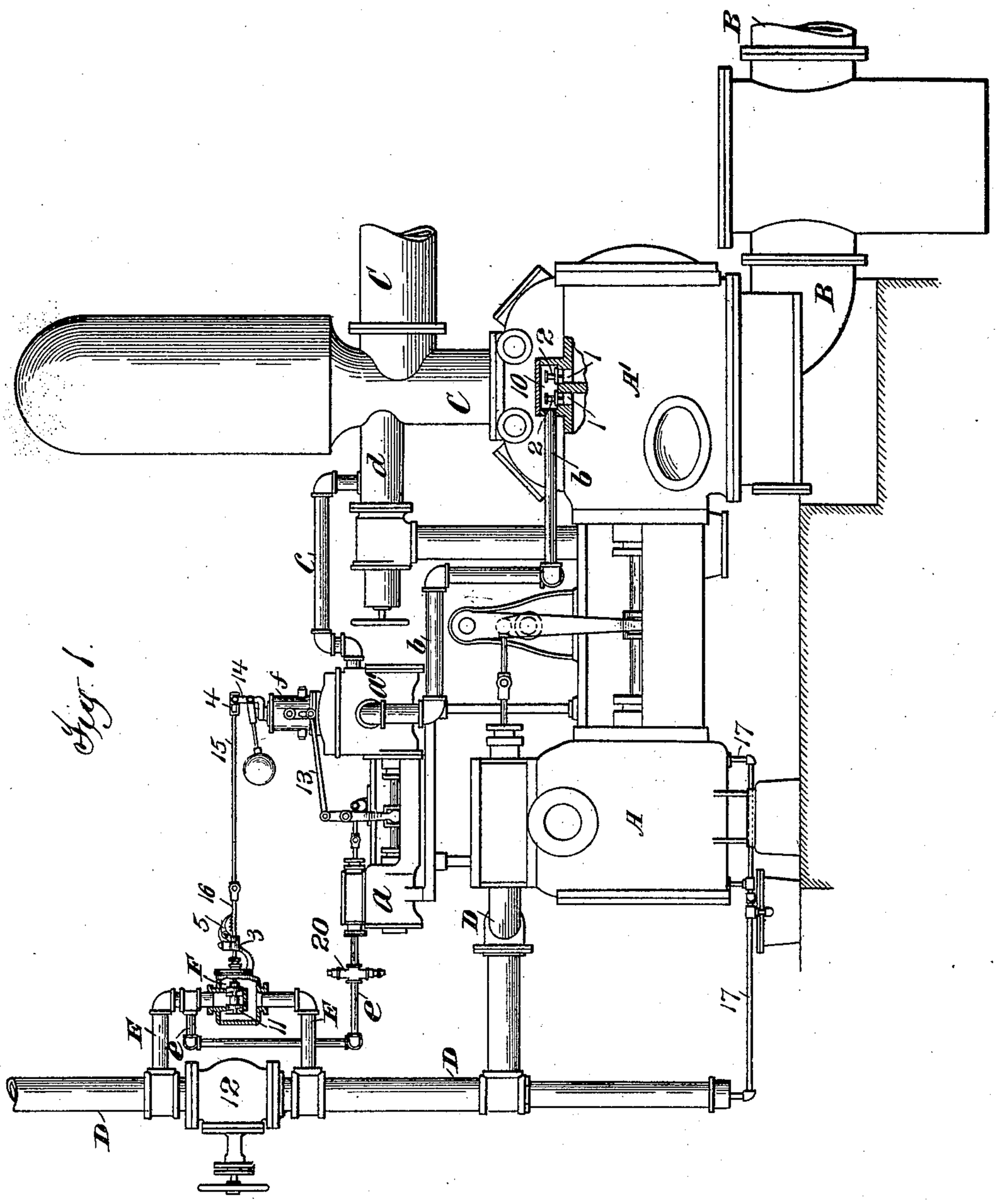
PUMPING APPARATUS.

(Application filed Nov. 4, 1898.)

(No Model.)

3 Sheets—Sheet 1.

Fig. 1.



Witnesses:
J. F. Kehoe.
J. A. Graves.

Inventor:
Charles C. Worthington
By Philip P. Phelps & Sawyer
Attys

No. 694,513. Patented Mar. 4, 1902.

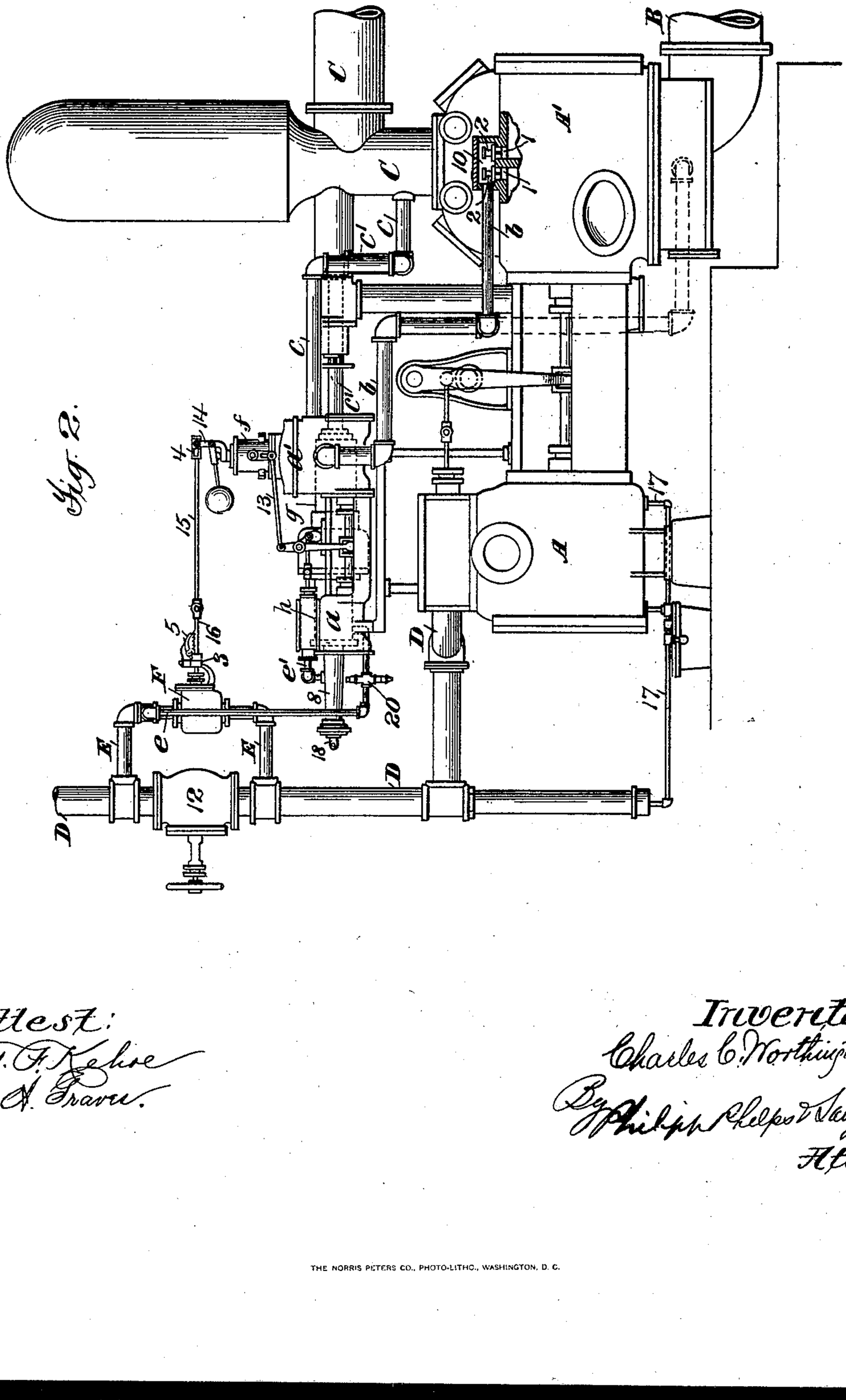
C. C. WORTHINGTON.

PUMPING APPARATUS.

(Application filed Nov. 4, 1898.)

(No Model.) 3 Sheets—Sheet 2.

Fig. 2.



Attest:
C. F. Kehoe
J. A. Graves.

Inventor
Charles C. Worthington.
By Philip P. Phelps & Sawyer
Attys

No. 694,513. Patented Mar. 4, 1902.

C. C. WORTHINGTON.

PUMPING APPARATUS.

(Application filed Nov. 4, 1898.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 6.

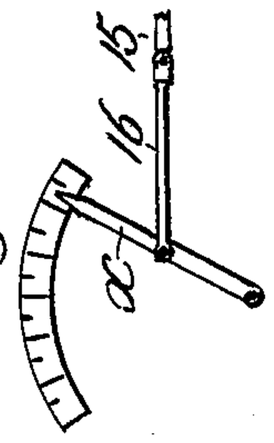


Fig. 4.

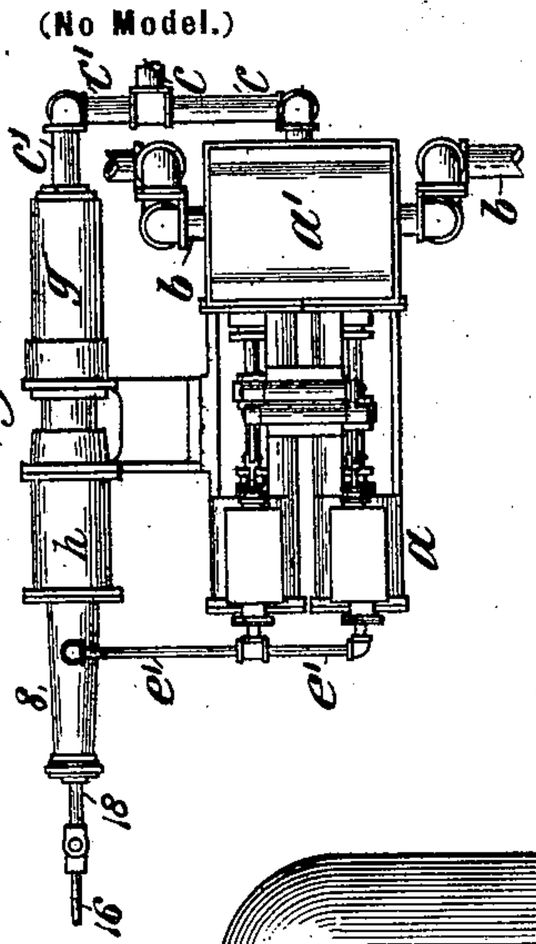


Fig. 3.

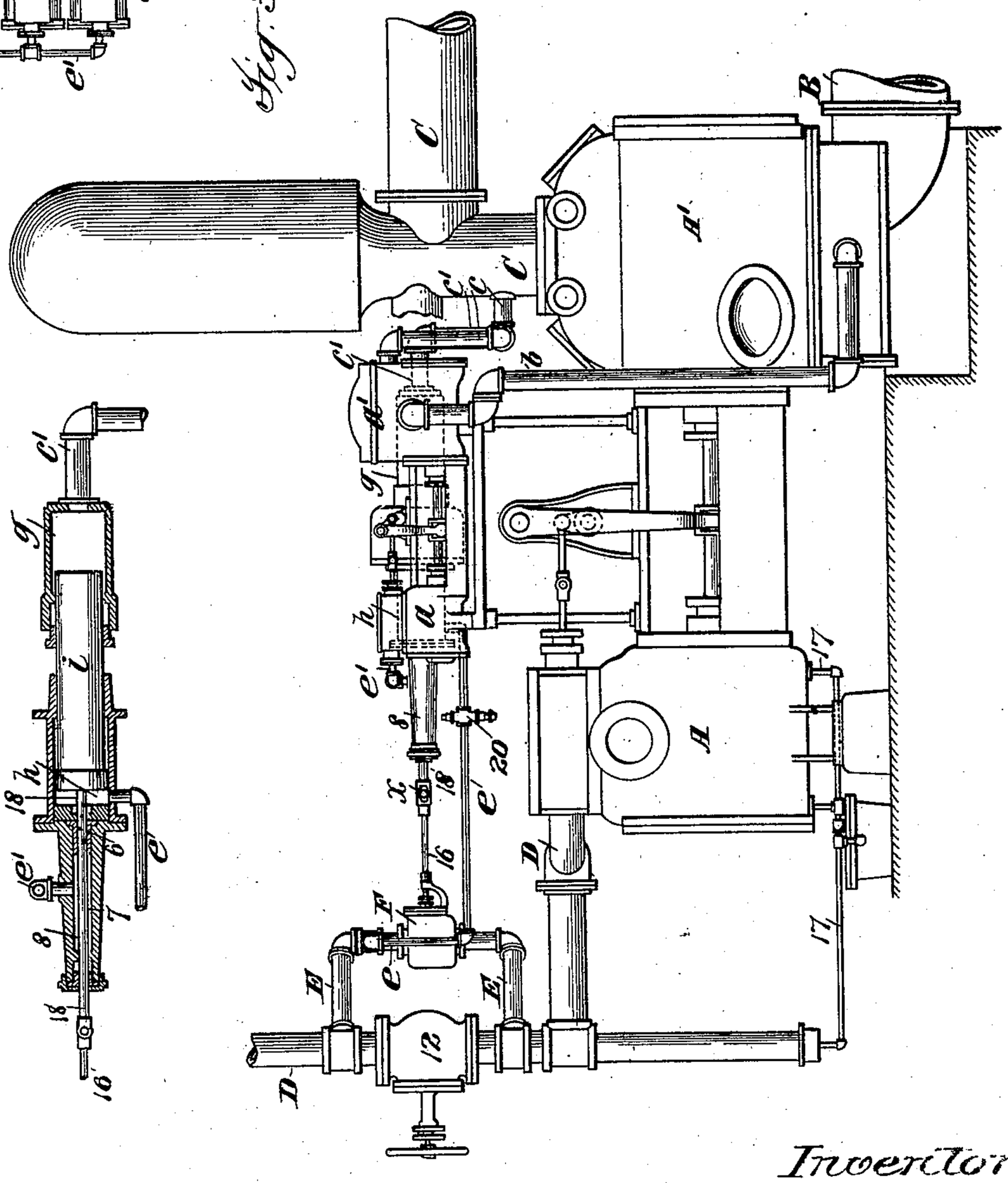


Fig. 5.

Inventor:
Charles C. Worthington
By Philip Phelps & Lawyer
Attys

Attest:
T. F. Kehoe.
J. A. Graves.

UNITED STATES PATENT OFFICE.

CHARLES C. WORTHINGTON, OF IRVINGTON, NEW YORK.

PUMPING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 694,513, dated March 4, 1902.

Application filed November 4, 1898. Serial No. 695,446. (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 Pumping Apparatus, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to an improved pumping apparatus designed especially for use in connection with automatic sprinkler and other fire systems, but which may be used also in connection with any system in which it is desired to maintain a fluid-supply under pressure and which is liable to constant or frequent slight withdrawal of fluid by leakage or otherwise, such that the required pressure in the system may be restored or maintained against such slight withdrawal by a small auxiliary pump, so that the main pump operates only when the system is called upon for fire or other service involving a larger withdrawal of fluid.

The object of the present invention is to provide an improved pumping apparatus of this class in which the main pump shall be controlled from the auxiliary pump through simple and positively-acting means, so as to secure the proper operation of the latter when required, and I secure this result by the use of means controlling the supply of steam, the electric current, or other source of power to the main pump and actuated by a member controlled by the auxiliary pump through suitable devices, so as to supply power for the operation of the main pump when the latter is to be called into action.

The invention, broadly considered, may be embodied in many different forms and various means be used for operating the pumps and securing the desired control of the main pump by the auxiliary pump; but I preferably control the main pump directly by the speed of the auxiliary pump, so that the device controlling the supply of power to the main pump is actuated for the operation of the main pump by the increase of speed of the auxiliary pump, which results from the reduction of pressure in the system caused by a withdrawal of fluid in excess of the quantity that the auxiliary pump is constructed or arranged to supply. This result is best obtained by the use of a speed-governor actuated by the auxiliary pump and having suitable connections to the valve controlling the steam-supply to a steam-operated main pump or to a switch controlling an electrically-driven main pump or other device controlling the operation of the main pump in any other suitable manner. I prefer also to provide means for regulating the supply of power to the auxiliary pump in accordance with the amount of fluid to be pumped thereby, so that instead of the auxiliary pump operating constantly or at a uniform rate of speed it is operated intermittently or at varying speeds by controlling the supply of power thereto in accordance with the withdrawal of fluid from the system at a rate less than the rate of withdrawal at which the main pump is to be called into operation. This result may best be attained in steam-operated pumps by the use of a steam-accumulator, which also acts to maintain a uniform pressure within the system and secure the smooth, uniform, and properly-regulated action of the apparatus desired. With such an accumulator also it is possible to dispense with the speed-governor by which the device controlling the power-supply of the main pump is actuated and actuate this device by connections to the accumulator-piston, and such a construction is within the broader features of my invention. The construction may be such that the action of the auxiliary pump controls both the starting and stopping of the main pump, but preferably the main pump when called into action continues in operation until the power is again shut off by hand or by means operating independently of the auxiliary pump, the action of the auxiliary pump operating only to start the main pump and operating to stop or control the stopping of the main pump. In such a construction also I preferably provide means for positively holding the device controlling the power-supply to the main pump in position for the operation of the main pump when the latter is called into action, so as to avoid accidental stopping of the main pump. The auxiliary pump may operate, however, to both start and stop the main pump, and such a construction is within the broader features of my invention.

The invention includes, therefore, in addition to the broader features of the invention various specific features of construction and combinations of parts in pumping apparatus embodying such features and certain details of construction, many of which may be applied in pumping apparatus used for other purposes, all of which will be fully described hereinafter and specifically claimed.

As a full understanding of the invention can best be given by a description of a construction embodying the same, such a description will now be given in connection with the accompanying drawings, forming a part of this specification, and showing so much of steam-pump systems embodying the various features of the invention in some of the preferred forms as is necessary for the purpose of illustration.

In the drawings, Figure 1 is a diagrammatic side elevation, partly in section, showing an apparatus in which the steam-valve of the main pump is controlled directly by the speed of the auxiliary pump, so as to open the valve when the speed of the auxiliary pump becomes excessive on account of the withdrawal of water from the system in excess of the pumping capacity of the auxiliary pump. Fig. 2 is a similar view of a system in which the steam-valve of the main pump is controlled by the same means, but a steam-accumulator is combined with the auxiliary pump to control the supply of steam thereto. Fig. 3 shows a pumping apparatus similar to that shown in Fig. 2, except that the main steam-valve is opened and closed by the accumulator-piston, the speed-governor of Figs. 1 and 2 being omitted. Fig. 4 is a detail plan of the auxiliary pump and accumulator construction of Fig. 3, and Fig. 5 is a longitudinal central section of the accumulator. Fig. 6 is a detail of a modification.

In Fig. 1, A is the steam end, and A′ the water end, of the main pump, B the suction-main, and C the force-main, connected to an automatic sprinkler system or other system in which the water-supply is to be maintained at a certain pressure. *a a′* are respectively the steam and water ends of the auxiliary pump, and *b* the suction and *c* the delivery pipe of the same. The suction-pipe *b* connects with and takes its water from the water-cylinder of the main pump through a small chamber 10, mounted on top of the pump and connecting with the cylinder on opposite sides of the diaphragm through passages 1, controlled by check-valves 2, opening upward or toward the auxiliary pump, there being such a connection with the chamber 10 on the pump-cylinders A′ at each side of the pump. As shown in Fig. 4, two suction-pipes *b* are used, entering at opposite sides of the water end *a′* of the auxiliary pump. The delivery-pipe *c* connects with the force-main C through a pipe *d*, and thus to the system with which the pumping apparatus is employed, so that the auxiliary pump, as well as the main pump, delivers directly to the system.

While it is to be understood that the auxiliary pump can be connected to the suction-pipe of the main pump or elsewhere, it is preferable to connect it, as described, so that the cylinders of the main pump can be kept normally free from air and charged with water ready for the plunger to operate immediately on solid water when called upon to move. This arrangement dispenses with the necessity of charging or priming pipes for the cylinders of the main pump as ordinarily used for this purpose. The valves 2 are used, so that communication will be shut off between the two ends of the water-cylinders of the main pump when the pump is in operation, thus preventing the water from pulsating from one side of the main-pump piston to the other through the passages 1 and chamber 10.

The steam end A of the main pump receives its supply of steam from the induction-pipe D, the steam passing to the main pump in the usual operation of the apparatus through a by-pass pipe E, having thereon a valve-chamber F, through which the passage of the steam is controlled by a valve 11, which may be of any suitable form, being shown as a common form of balanced piston-valve. The induction-pipe D is provided with a throttle 12 between the ends of the by-pass pipe E, by which steam may be supplied to the main pump directly through the induction-pipe without control by the valve 11, if desired, and a small amount of steam may be allowed to pass constantly to the main pump independently of the valve 11 to keep the pump in condition for immediate use. The valve 11 is normally closed, so that the main pump is out of operation, the auxiliary pump being in action and being arranged to supply the system with water sufficient to offset the loss by leakage or other causes producing such a small withdrawal of water that it is not desired that the main pump shall act, the pressure in the system thus being maintained by the auxiliary pump, which receives a constant supply of steam from the induction-pipe D or, as shown, from the by-pass pipe E on the inlet side of the valve-chamber F through steam-pipe *e*. An automatic pressure-reducing valve 20 of any common or suitable form is used upon the pipe *e* to secure and maintain uniform the desired supply of steam to the auxiliary pump. The usual drain-pipes 17 for the steam end of the main pump and the induction-pipe D is shown.

The valve 11 is controlled directly by the auxiliary pump and opened to admit steam to the main pump through the valve-chamber F when the withdrawal of water from the system is in excess of the amount for the supply of which the auxiliary pump is designed, so that the desired supply of water and pressure in the system is not maintained by the auxiliary pump.

In the construction shown in Fig. 1 the auxiliary pump acts upon the valve 11 through a device so actuated by the auxiliary pump that when the speed of the auxiliary pump rises sufficiently through the reduction of pressure in the system by the withdrawal of water therefrom the valve 11 is opened to start the main pump. For this purpose the auxiliary pump has connected therewith a speed-governor, which may be of any suitable form, the governor *f* shown being well known under the name of the "Mason" pump-governor, (fully shown and described in United States Letters Patent No. 312,138, dated February 10, 1885,) the operating-arm of this governor being connected to a moving part of the auxiliary pump by a link 13, so as to be actuated therefrom, and having its weighted bell-crank lever 14 connected to the valve 11 through a slotted link 15, and slide 16 mounted in the head of the valve-chamber F and bracket 3 on the end of the valve-chamber. In this construction with the suction of the auxiliary pump connected to the cylinder of the main pump the speed of the auxiliary pump will normally be maintained while the main pump is in operation, but a slotted connection 4 between the end of the bell-crank lever 14 and the link 15 is preferably used and arranged as shown in Fig. 1, so that the auxiliary pump acting through the speed-governor *f* will open the valve 11, but on the return of the bell-crank lever 14 by the weight in case the auxiliary pump should slow down the valve 11 will not be closed thereby, but will remain open and the main pump remain in action until the valve 11 is closed by hand by the attendant or by any suitable automatic means independently of the auxiliary pump. If the suction of the auxiliary pump be not assisted by the pumping action of the main pump, then such lost-motion connection is necessary unless it be desired to close the valve 11 by the slowing down of the auxiliary pump as the pressure in the system is raised by the main pump. In order to assure the valve 11 not being closed accidentally, I preferably provide some means for positively holding the valve 11 against closing after it has been opened by the auxiliary pump. Simple means for this purpose is shown, consisting in a spring-pressed pawl 5, mounted on the bracket 3 and engaging a notched portion of the slide 16.

The operation of the construction shown in Fig. 1 will be understood from a brief description. The supply of water and pressure in the system, of which the force-main C forms a part, is maintained by the auxiliary pump supplying the loss by leakage or other causes, involving small withdrawal of water from the system, the auxiliary pump under such conditions of pressure operating at a speed below that at which the governor *f* is operated to open the valve 11. When a larger withdrawal of water from the system occurs—as, for instance, in case of a sprinkler opening on a fire-service of an automatic sprinkler system—the pressure against which the auxiliary pump is working is immediately lowered and the speed of the auxiliary pump increases, thus operating the speed-governor *f* to throw the bell-crank lever 14 to the right in Fig. 1 against the resistance of the weight on its horizontal arm, which through the link 15 and slide 16 moves the valve 11 to the right in this figure, so as to admit steam to the main pump through the by-pass pipe E and valve-chamber F. The valve 11 is then held in opened position by the engagement of the pawl 5 with a notch on slide 16, and the main pump thus continues in operation until again closed by hand or otherwise, when the normal operation of the apparatus, with the auxiliary pump in operation and the main pump out of operation, is to be resumed. When the withdrawal of water ceases and the main pump is stopped, the auxiliary pump slows down to normal speed, and the speed-governor returns to the position shown in Fig. 1.

In Fig. 2 I have shown a construction similar to that of Fig. 1, except that instead of the supply of steam to the auxiliary pump being constant a steam-pressure accumulator is connected to the auxiliary pump, which regulates the supply of steam to the auxiliary pump, so that the operation of the latter is varied in accordance with the amount of water withdrawn from the system on account of leakage or other causes resulting in a small withdrawal of water. The steam-pressure accumulator shown is the same as described and claimed in my prior patent, No. 524,013, dated August 7, 1894, and requires but a brief description. In this construction, as shown in detail in Figs. 4 and 5, *g* is the pressure-chamber, *h* the steam-chamber, and *i* the piston of the accumulator, the pressure-chamber being connected to the delivery-pipe *c* of the auxiliary pump by a pipe *c'*, opening to the end of the chamber. The steam-supply pipe *e* connects directly with the steam-chamber *h*, and the steam from the chamber *h* passes through openings 6 into the hollow stem 18, carried by and moving with the piston, and from the stem through the openings 7 into chamber 8, with which pipe *e'* connects and through which the steam passes to the valve-chamber of the auxiliary pump, the supply of steam to the auxiliary pump thus being increased as the piston *i* moves toward the delivery end of the pressure-chamber *g* by the passage of the steam through more of the openings 6 into the stem 18, as these openings are uncovered by being moved through the head of the chamber *h*, so as to open into the chamber, and the supply of steam to the auxiliary pump is decreased as the piston *i* moves in the opposite direction and closes some of the openings 6 by moving them into or past the head of the chamber *h*. The operation of this construction is as follows: The main pump being out of operation, the water supply and pressure of the system is main-

tained against leakage and other slight withdrawal of water by the auxiliary pump, this pump delivering more or less water, according to the amount of withdrawal from the system, the accumulator-piston *i* controlling the supply of steam to the auxiliary pump, so as to increase such supply as the accumulator-piston *i* moves toward the delivery end of the pressure-chamber *g* on the withdrawal of water in excess of that delivered by the auxiliary pump and to decrease the supply of steam as the piston *i* is moved in the opposite direction by the pumping pressure of the auxiliary pump. The accumulator may be arranged so as to cut off the steam entirely from the auxiliary pump or always to admit sufficient steam to keep the pump running at a low speed, this depending upon the leakage or other withdrawal of water from the system. The action of the accumulator in connection with the pump is fully explained in my prior patent, No. 524,013, above referred to. On the withdrawal of water from the system in excess of the pumping capacity of the auxiliary pump the pressure in the system is reduced and the speed of the auxiliary pump increased, and the valve 11 is then opened by the increased speed of the auxiliary pump acting through the Mason governor *f* exactly as fully described above in connection with the construction shown in Fig. 1, and the main pump then remains in operation until the valve is closed again, when the speed of the auxiliary pump is reduced and the parts of the governor returned to position, as previously described.

In the construction shown in Fig. 2 the speed-governor *f* may be omitted and the valve 11 connected so as to be operated by the piston *i* of the accumulator. Such a construction is shown in Fig. 3 and in the detail Figs. 4 and 5, with the stem 18, carried by the accumulator-piston *i*, extending through the head of the chamber *h* and connected to the slide 16 of the valve 11. As shown, the accumulator-piston is connected to the valve 11, so as to move it in both directions, a lost-motion connection *x* preferably being used to secure the proper action; but such a connection may be used that the valve will be opened by the accumulator-piston, but not closed thereby. The suction *b* of the auxiliary pump in this construction is connected to the suction side of the main pump, so that the auxiliary pump charges the suction or supply side of the main pump, but not the pump-chambers, and the auxiliary pump works against the pressure of the system when the main pump is in operation, so that it slows down as the pressure in the system is raised by the main pump. The suction of the auxiliary pump may be connected to both the suction and delivery sides of the main pump, if desired, as indicated in Fig. 2, the connection to the suction side being shown in dotted lines. The operation of this accumulator construction is the same as that shown in Fig. 2 and previously described, except that the accumulator and auxiliary pump are arranged so that the accumulator-piston *i* will be normally some distance from the delivery end of the pressure-chamber *g*, as shown in Fig. 5, and will not move toward the delivery end of the pressure-chamber from this position sufficiently to open the valve 11, except in case of such withdrawal of water from the system as renders the operation of the main pump desirable. When, therefore, by the withdrawal of water from the system in excess of the pumping capacity of the auxiliary pump the accumulator-piston *i* moves toward the delivery end of the pressure-chamber *g* sufficiently beyond the point at which it is shown in Fig. 5, the valve 11 will be opened and the main pump brought into action, and the accumulator-piston *i* is again moved to the left from the delivery end of the pressure-chamber *g*, as the pressure in the system is raised by the main pump when the withdrawal of water from the system ceases and at the proper time closes the valve 11 and throws the main pump out of action, the normal operation of the apparatus being then resumed. If a flexible or similar connection be used between the accumulator-piston and the valve 11, the valve 11 will remain open until closed by hand or otherwise, as in the constructions previously described. If the suction-pipe *b* of the auxiliary pump be connected to the suction of the main pump, as in Fig. 3, the speed-governors of the constructions shown in Figs. 1 and 2 may be connected to the valve 11, so as to both open and close the valve, the means for holding the valve open being omitted.

The invention has been described as applied to the common sprinkler system in which the whole system is liquid; but such an apparatus may readily be applied also in connection with what is known in fire-protection systems as the "dry-pipe" system, where air-pressure is maintained on the piping and sprinkler distribution until such time as the sprinkler opens, when the air-pressure escapes and water for the extinguishing of the fire follows. On such a system the auxiliary pump described might be an air-compressor used for the maintenance of the air-pressure, its subsequent operations with reference to the main pump being the same as those already described, or this auxiliary pump may be both a water-pump for keeping up the leakage in such portion of the system as is constantly under water-pressure and an air-pump for keeping up the air-supply on the dry-pipe portion of the system.

It will be understood that other arrangements of the main and auxiliary pumps and devices for controlling the operation of the main pump by the auxiliary pump may be used and that I am not to be limited to the specific arrangements or devices shown for this purpose. The pumps shown are of a common form of duplex steam-pump; but it will be un-

derstood that the invention may be applied in connection with pumps of any other suitable form or driven by other than steam-power. Should the pumps be electrically driven, it will be readily understood that the devices described may be made to operate switches of well-known form or other devices for turning on or off the electric current to the motor or motors driving the main pump.

In case electricity be used the steam-accumulator described will not be applicable except where the auxiliary pump is steam driven and the main pump electrically driven, in which case there will be substituted for the balanced valve 11 an electrical switch connected to the main pump, as indicated in Fig. 6, in which x is the electrical switch to which the operating-rod 16 from the governor is connected and which controls the electrically-driven main pump. If both the auxiliary and main pump be electrically driven, the speed-governor or similar device operated by the auxiliary pump will operate the switch controlling the main pump when the speed of the auxiliary pump exceeds a certain limit.

What I claim is—

1. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, a device controlling the operation of the main pump, and mechanism through which the pumping action of the auxiliary pump controls said device for operating the main pump on a larger withdrawal of fluid from the system, substantially as described.

2. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, a device controlling the operation of the main pump, and means controlled by the speed of the auxiliary pump for operating said device to start the main pump by the increase in the speed of the auxiliary pump on a larger withdrawal of fluid from the system, substantially as described.

3. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, a speed-governor actuated by the auxiliary pump, and means for controlling the operation of the main pump by the speed-governor to operate the main pump on a larger withdrawal of fluid from the system, substantially as described.

4. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of water from the system, means for controlling the operation of the auxiliary pump in accordance with the withdrawal of fluid from the system, a speed-governor actuated by the auxiliary pump, and means for controlling the operation of the main pump by the speed-governor to operate the main pump on a larger withdrawal of fluid from the system, substantially as described.

5. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, a valve controlling the supply of steam to the main pump, and means controlled by the auxiliary pump for opening said valve on a larger withdrawal of fluid from the system and arranged to permit the valve to remain open independently of the action of the auxiliary pump, substantially as described.

6. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, a valve controlling the supply of steam to the main pump, means controlled by the speed of the auxiliary pump for opening said valve when the speed of the auxiliary pump is increased on a larger withdrawal of fluid from the system, and means for holding said valve in position when opened by the auxiliary pump, substantially as described.

7. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, a speed-governor actuated by the auxiliary pump, and means for controlling the operation of the main pump by the speed-governor to operate the main pump on a larger withdrawal of fluid from the system and arranged to permit the main pump to remain in operation independently of the auxiliary pump, substantially as described.

8. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, a valve controlling the supply of steam to the main pump, a speed-governor actuated by the auxiliary pump, and connections between said speed-governor and valve for opening said valve when the speed of the auxiliary pump is increased on a larger withdrawal of fluid from the system and permitting the valve to remain open independently of the action of the auxiliary pump, substantially as described.

9. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, a valve controlling the supply of steam to the main pump, a speed-governor actuated by the auxiliary pump, connections between said speed-governor and valve for opening said valve when the speed of the auxiliary pump is increased on a larger withdrawal of fluid from the system, and means for holding said valve in position when

opened by the auxiliary pump, substantially as described.

10. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, means for controlling the supply of steam to the auxiliary pump in accordance with the amount of fluid withdrawn from the system, and means controlled by the auxiliary pump for controlling the main pump to secure the operation of the main pump on a larger withdrawal of fluid from the system, substantially as described.

11. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, means for controlling the supply of steam to the auxiliary pump in accordance with the amount of fluid withdrawn from the system, a valve controlling the supply of steam to the main pump, and means controlled by the auxiliary pump for opening said valve on a larger withdrawal of fluid from the system, substantially as described.

12. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, means for controlling the supply of steam to the auxiliary pump in accordance with the amount of fluid withdrawn from the system, a valve controlling the supply of steam to the main pump, and a speed-governor actuated by the auxiliary pump for opening said valve when the speed of the auxiliary pump is increased on a larger withdrawal of fluid from the system, substantially as described.

13. The combination with a main pump and its connected system, of an auxiliary pump connected to the system for maintaining the pressure against a small withdrawal of fluid from the system, a steam-pressure accumulator connected to the auxiliary pump and means for varying the supply of steam to the auxiliary pump in accordance with the movement of the accumulator-piston, and means controlled by the auxiliary pump for securing the operation of the main pump on a larger withdrawal of fluid from the system, substantially as described.

14. The combination with a main pump and its connected system, of an auxiliary water-pump connected to the system for maintaining the supply of water against a small withdrawal of liquid from the system, a steam-pressure accumulator connected to the auxiliary pump and means for varying the supply of steam to the auxiliary pump in accordance with the movement of the accumulator-piston, a valve controlling the supply of steam to the main pump, and a speed-governor actuated by the auxiliary pump for opening said valve when the speed of the auxiliary pump is increased on a larger withdrawal of water from the system, substantially as described.

15. The combination with an intermittently-operating pump, of a second pump with its suction or supply side connected with the water-cylinder of the first-mentioned pump, whereby the operation of the second pump charges with water the cylinder of the intermittently-operated pump, substantially as described.

16. The combination with a pump normally out of operation, of a second pump with its supply side connected with the water cylinder or cylinders of the first-mentioned pump, whereby the operation of the second pump charges with water the cylinder of the normally inoperative pump, and means controlled by the operation of the second pump for starting the normally inoperative pump, substantially as described.

17. The combination with a pump normally out of operation, of a second pump with its supply drawn from the supply of the first-mentioned pump, whereby the operation of the second pump charges with water the supply of the normally inoperative pump, and means controlled by the operation of the second pump for starting the normally inoperative pump, substantially as described.

18. The combination with an intermittently-operating pump, of a second pump drawing its supply from the supply of the intermittently-operating pump, whereby the operation of the second pump charges with water the supply of the intermittently-operating pump, substantially as described.

19. The combination with a pump normally out of operation, of a second pump drawing its supply from the water cylinder or cylinders of the first-mentioned pump, whereby the operation of the second pump keeps the water cylinder or cylinders of the normally-inoperative pump charged with water, and valves 2 so arranged as to prevent the circulation of water between the pulsation-chambers of the normally inoperative pump when in action, substantially as described.

20. The combination with a pump-cylinder having chamber 10 and passages 1 from the opposite ends of the cylinder, of a second pump having its suction side connected with said passages, and valves 2 permitting the passage of fluid through said passages to the second pump but preventing the circulation of fluid between the pulsation-chambers of the first-mentioned pump, substantially as described.

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

CHARLES C. WORTHINGTON.

Witnesses:
LOUIS ROSS ALBERGER,
B. W. PIERSON.