F. W. & C. A. KROGH.

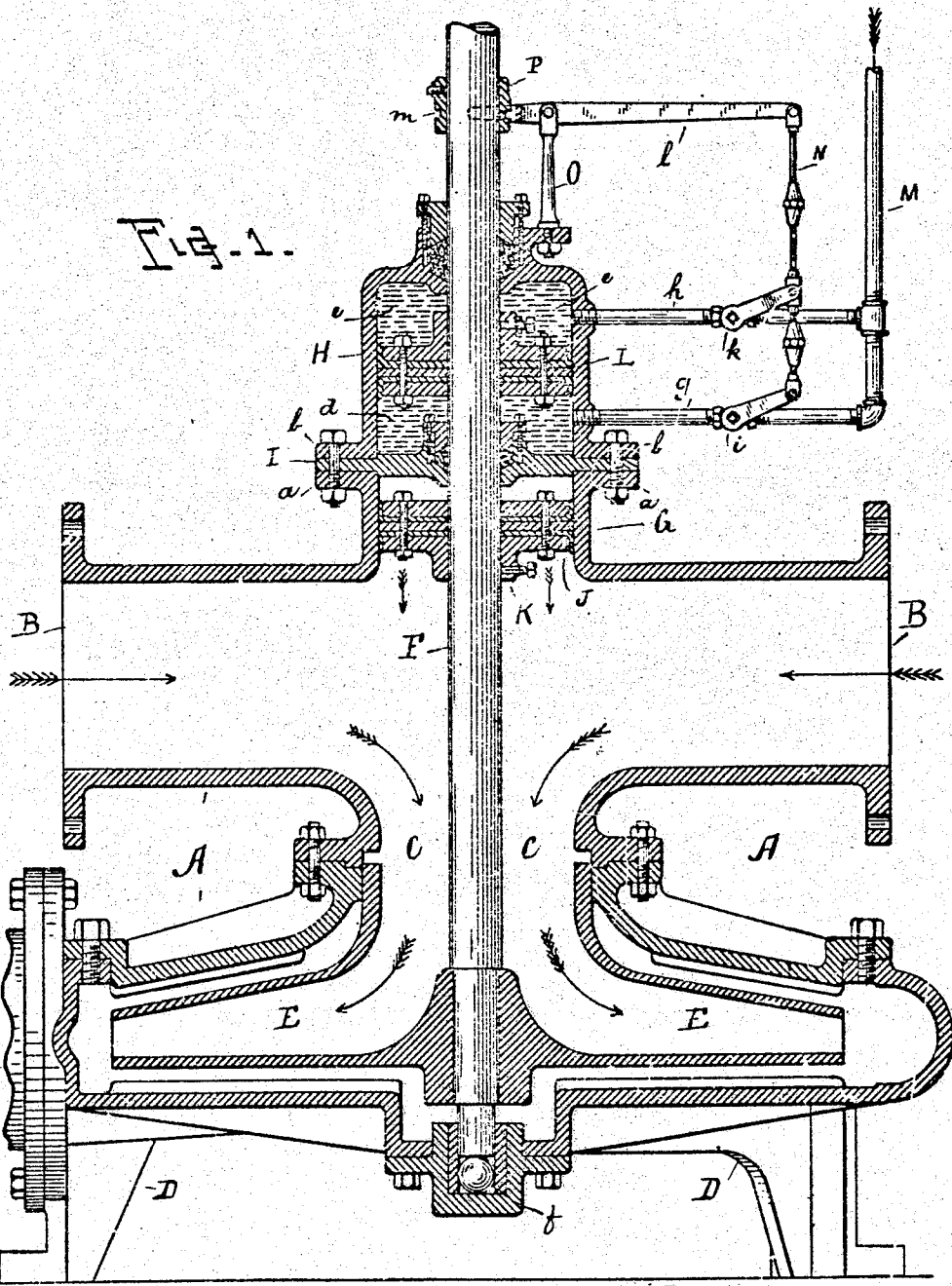
CENTRIFUGAL PUMP.

APPLICATION FILED NOV. 27, 1903.

971,849. Patented Oct. 4, 1910.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses
J. Corinson
John Echtler

Inventors
Ferdinand W. Krogh and
Carl A. Krogh
per A.S. Paré
Attorney

F. W. & C. A. KROGH.

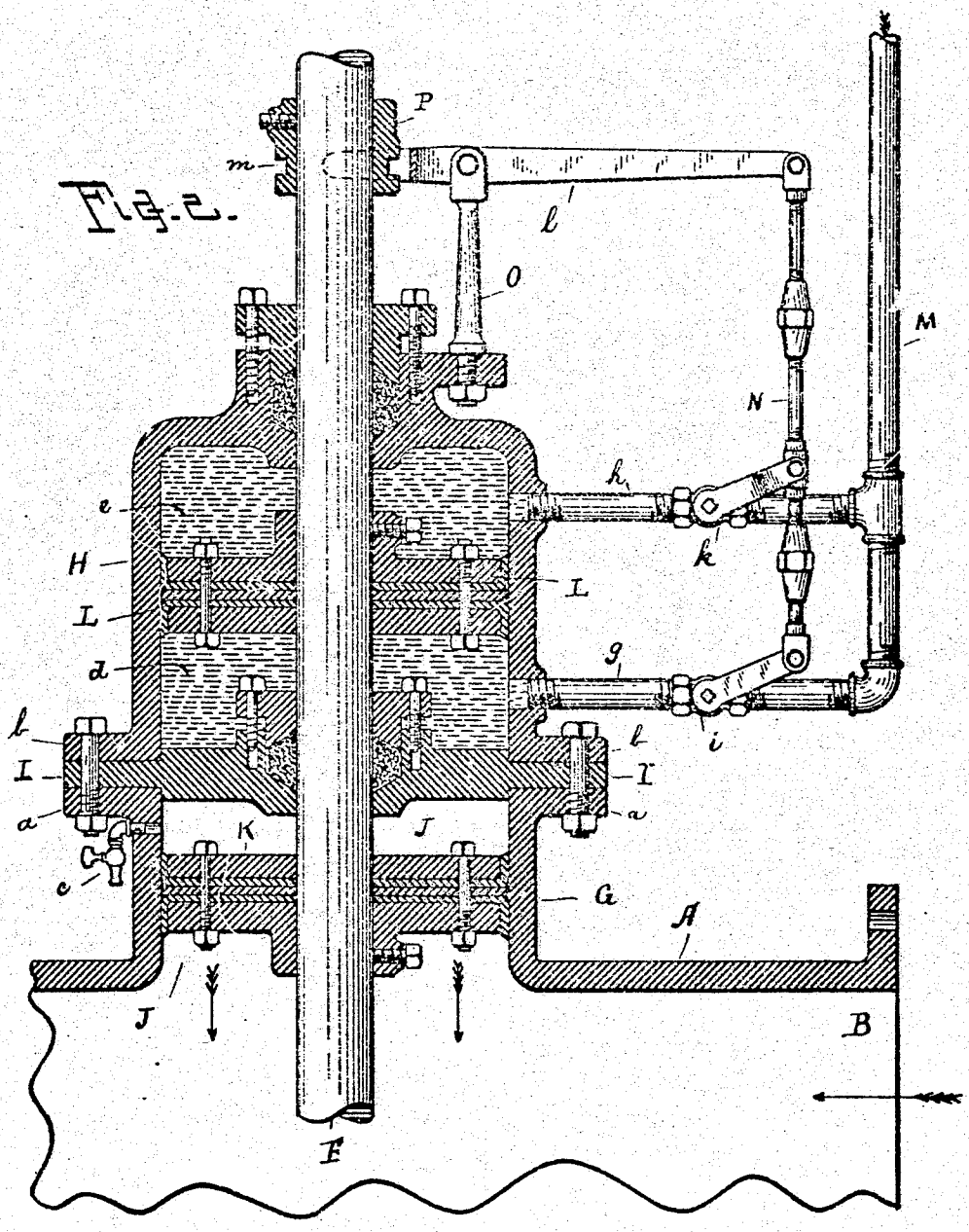
CENTRIFUGAL PUMP.

APPLICATION FILED NOV. 27, 1903.

971,849. Patented Oct. 4, 1910.

4 SHEETS—SHEET 2.

Fig. 2.



Witnesses
J. Courtenay
John Echtler

Inventors
Ferdinand W. Krogh
Carl A. Krogh
and
Jr. A.S. Paré
Attorney

F. W. & C. A. KROGH.

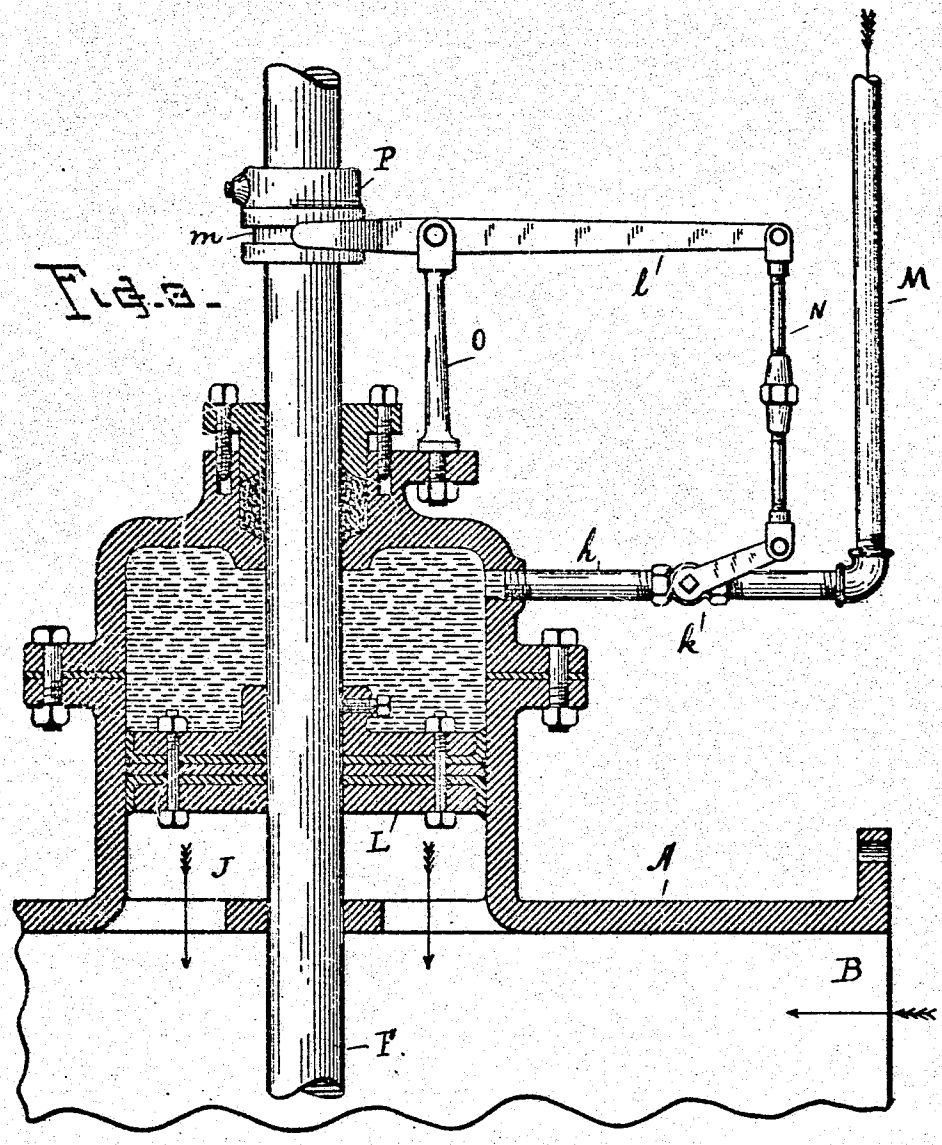
CENTRIFUGAL PUMP.

APPLICATION FILED NOV. 27, 1903.

971,849. Patented Oct. 4, 1910

4 SHEETS—SHEET 3.

Fig. 3.



Witnesses
J. Corinson
John Kehtler

Inventors
Ferdinand W. Krogh and
Carl A. Krogh
per A.S. Pare
Attorney

F. W. & C. A. KROGH.

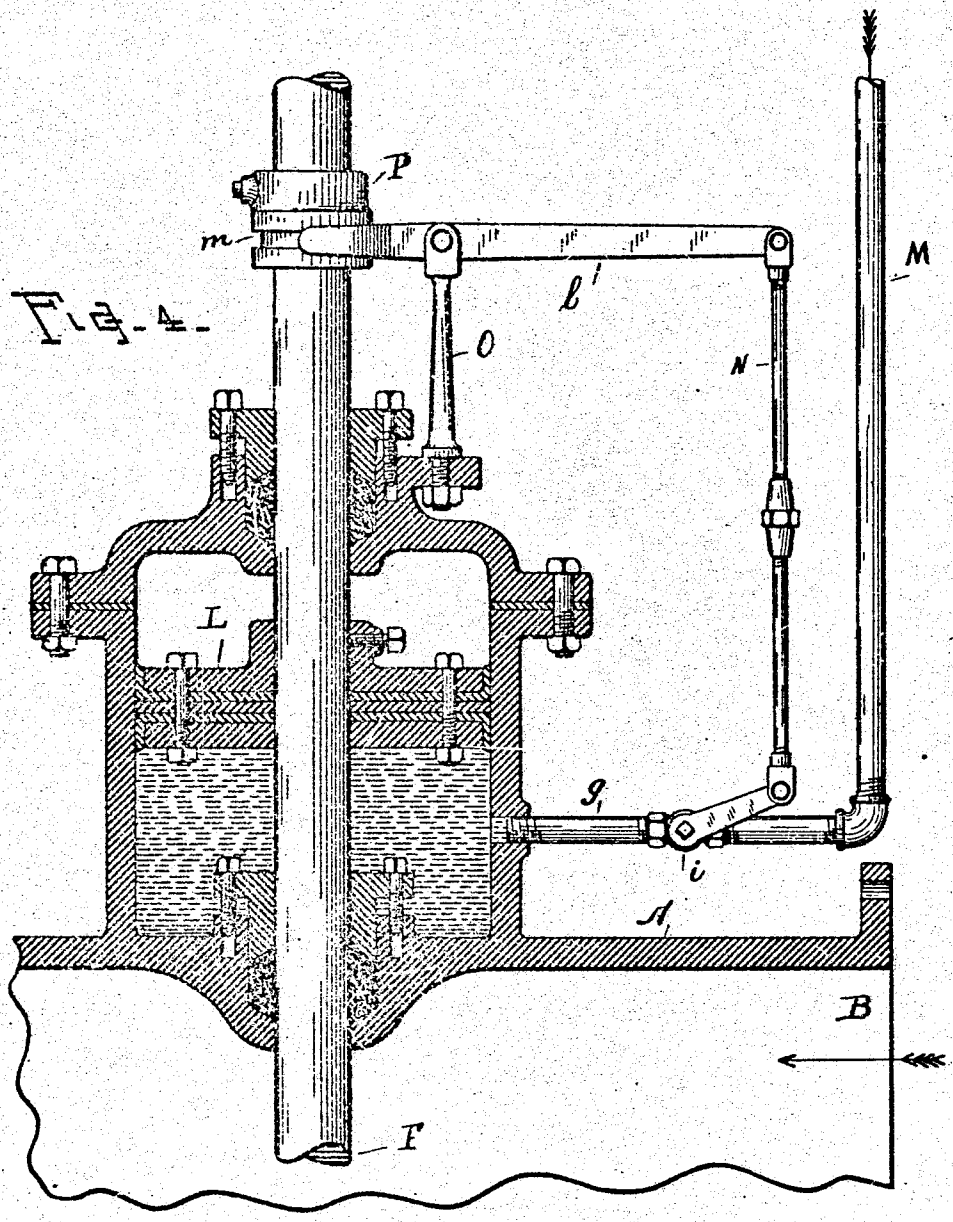
CENTRIFUGAL PUMP.

APPLICATION FILED NOV. 27, 1903.

971,849. Patented Oct. 4, 1910.

4 SHEETS—SHEET 4.

Fig. 4.



Witnesses
J. Courson
John Echtler

Inventors
Ferdinand W. Krogh and
Carl A. Krogh
per A.S. Pare
Attorney

UNITED STATES PATENT OFFICE.

FERDINAND W. KROGH AND CARL A. KROGH, OF SAN FRANCISCO, CALIFORNIA.

CENTRIFUGAL PUMP.

971,849. Specification of Letters Patent. Patented Oct. 4, 1910.

Application filed November 27, 1903. Serial No. 182,870.

To all whom it may concern:

Be it known that we, FERDINAND W. KROGH and CARL A. KROGH, both citizens of the United States, and residents of San Francisco, in the county of San Francisco, State of California, have invented new and useful Improvements in Centrifugal Pumps; and we do hereby declare that the following is a full, clear, and exact description of said invention, such as will enable others skilled in the art to which it most nearly appertains to make, use, and practice the same.

Our invention relates particularly to pumps constructed with incased wheels or impellers having either a horizontal or vertical position as the case may be, but for the purpose of this application we have illustrated our improvements as applied to vertical pumps.

The main object of our invention is to provide automatic means to equalize the uneven pressure which arises from various sources against the running parts, and avoid the friction and at the same time lubricate their bearing faces while in operation.

To these ends our invention consists in the construction and arrangement of the various parts coöperating to obtain the desired result as will be fully described hereinafter and pointed out in the claims.

Referring to the herewith annexed drawings, consisting of four sheets, which form a part of this specification and in which—

Figure 1 is a vertical section through an ordinary pump provided with our automatic equalizing and lubricating device. Fig. 2 is an enlarged vertical section of our automatic equalizing and lubricating device with a broken portion of the pump casing. Figs. 3 and 4 are vertical sections showing various modifications in the arrangement of our automatic equalizing and lubricating device.

Like letters of reference made use of in the several figures indicating like parts whenever employed.

The pump or main casing A provided with the double suction inlets B and central passage C, the base D upon which the casing is mounted, the impeller E inclosed within the casing and the driving shaft F with which the impeller rotates constitute the principal parts of a centrifugal pump to which our improvements are applicable.

Projecting outwardly above the casing in a line with the central passage C is a piston casing or cylinder through which the driving shaft passes and as shown in Figs. 1 and 2 this piston casing or cylinder is formed in two sections viz.—the lower section G and the upper section H which are divided by the partition I bolted between the outward projecting annular flanges *a* and *b* of the sections and adapted to hermetically seal each section against communication with the other. This method of constructing and fastening the cylinder permits the various parts placed therein to be most conveniently assembled and disassembled. The lower section G is provided with a vacuum chamber J the diameter of which is equal in area to the central passage C. The end of this chamber J toward the suction inlet is wholly open and in communication with said inlets, and mounted in said chamber is a piston K which is thus exposed to suction from said inlets. This piston is fixed on the driving shaft F and is placed near the closed end of such chamber, in such position, however, as to leave a small space between its top surface and the wall of the closed end of the vacuum chamber. It will be observed that the construction described causes the pressure imposed on the impeller through the suction inlets to be counteracted by the suctional force acting on the piston in a direction opposite that of said pressure, thus balancing said impeller as far as the suction is concerned. The space in the vacuum chamber J located behind said piston K is provided with a valve or cock *c* (see Fig. 2) leading to the outer air, and which may be operated to create in said space, if desired, an air cushion when the piston moves upward or a vacuum when the same moves downward. The upper section H of the cylinder is also provided with a chamber in which the piston or other head adapted to receive the effect of pressure, such as hereinafter disclosed L, is placed. The piston is fixed to the driving shaft F and revolves therewith. This piston divides the chamber into two compartments viz. the lower compartment *d* and the upper compartment *e* which are of about equal area. The top part of cylinder H and the partition I provide bearings for the driving shaft F and said bearings are provided with the usual stuffing boxes as shown in the drawings for adjusting properly the driving shaft and make tight joints. The central lower part of the casing is provided with the usual journal

box in which a steel ball *f* is placed for the purpose of reducing the friction at the end of the driving shaft upon which it rests while starting and adjusting the running parts. A plurality of balls may be used if desired, yet we believe one is sufficient to carry on the object we have in view (this feature is shown in Fig. 1).

As particularly shown in Figs. 1 and 2 the preferred form of our automatic controlling device, herein exemplified consists of pipes *g* and *h* connected respectively to the compartments *d* and *e* below and above the piston L in such a manner that the movements of the piston do not interfere with the inlet of the pipes *g* and *h*. These pipes are also connected to a suitable source of supply, as the main supply pipe M mounted vertically nearby and the pipes *g* and *h* are provided with valves *i* and *k* respectively and are controlled by the connecting rod N which is pivoted to the bifurcated lever *l* mounted upon the standard O secured to the top of cylinder H. One end of the lever *l* is engaged with an annular groove *m* in a collar P which collar is secured to the driving shaft F and revolves therewith. The object of the supply pipe M is to carry liquid into the compartments *d* and *e* through the pipes *g* and *h* and its height and quantity of liquid therein regulate the pressure desired. The liquid within the pipe M may be of various substances, yet we intend to use ordinary oil of lubricating nature so that the surrounding bearing faces can be lubricated automatically while operating with our invention. The relation of the shaft F, valves *i* and *k* and connections between said shaft and valves is such that movement of said shaft in an upward direction opens the valve *k* without opening the valve *i*, and movement of said shaft in the opposite direction opens the valve *i* without opening the valve *k*, so that, if the pressures at the opposite sides of the piston be unequal and said shaft and the impeller E and piston L connected thereto move in the direction of greater pressure, the valve connected with the compartment at the side of lesser pressure will be opened and liquid will thereby be admitted to the latter compartment until said greater pressure has been counterbalanced and said piston, shaft and impeller have resumed their former respective positions, in balance. In the operation of the parts just referred to, it will be understood that the elements are so adjusted that the upward pressure due to the pressure of water in the discharge pipe on the area opposite the inlet of the impeller is balanced by the downward pressure on and the weight of the parts. As long as these relative pressures remain thus counterbalanced both the valves *i* and *k* will remain in the positions to which they were adjusted in the production of such equal pressures. There is however, or is liable to be, more or less leakage through the packing boxes which would destroy the balance of pressure and cause the piston and its shaft to move in the direction of the preponderance of pressure: the extent of such movement being at the utmost approximately one-fourth of an inch. When from said cause, for example, such movement of said piston and shaft occurs, communication of the pipe M is immediately established with the proper compartment until the pressures have become equalized and the parts have been restored to their former positions at which they operate with minimum friction between the stationary and moving parts. Thus, assuming that the compartments *d* and *e* are full and the valves *i* and *k* are closed, so that the downward and upward pressures are counterbalanced, the shaft and its impeller will be locked, so to speak, in their proper positions of operation. If, now, leakage occurs in compartments *d* and *e*, or in compartment *e*, and the upward pressure due to the pressure of the water in the discharge pipe on the area opposite the inlet of the impeller (pressure on the remaining portion of the impeller being balanced) causes the shaft to move upward, its upward movement will open the valve *k* (without opening the valve *i*) thus admitting the liquid under pressure from the pipe M, into the compartment *e* and placing said piston L under pressure sufficient to check further upward movement of the parts and restore them to their former positions, in balance. Similarly, if the leakage be such as to permit a downward movement of said shaft F, and the impeller and piston connected thereto, such movement will cause the valve *i* only to be opened, and cause the same to be kept open until said downward movement has been checked and said shaft and its said connected parts have returned to their proper positions.

The modifications shown in Figs. 3 and 4 relate to simplified arrangements of the automatic controlling devices which are applicable particularly to pumps already constructed and where the pressure is constantly in one direction, thus upward in Fig. 3 and downward in Fig. 4. In the form shown in Fig. 3, the connecting pipe *g* with its valve *i* and compartment *d* are dispensed with and the operation of the valve *k'* is substantially as hereinbefore described with reference to the valve *k*, that is to say, the upward movement of the shaft (F') is checked by means of the liquid pressure within the remaining compartment (*e'*): so that if, in the operation of the device, a reduction of the downward pressure occurs sufficient to cause the remaining pressure to be overcome by the upward tendency of the shaft and its con-

nected parts, the rising movement of said shaft will open the valve k' and admit additional pressure on the piston L' until the shaft and its said connected parts have returned to their normal positions. In the form shown in Fig. 4, the connecting pipe h and valve k of the form shown in Figs. 1 and 2 are dispensed with, and the valve (i^2) is operated in the manner and for the purpose set forth in the foregoing description with reference to the corresponding valve i.

This arrangement is particularly intended to counterbalance the weight of the driving shaft and machinery which may be connected thereon and have in some cases a tendency to force down the impeller.

It will be readily seen that by the above described construction and arrangement the uneven pressure from the suction inlets or beneath the impeller is fully counteracted and the running parts kept in steady position without the usual collars secured to the driving shaft for that purpose as heretofore and,

Having thus described same what we claim as new and desire to secure by U. S. Letters Patent is—

1. A centrifugal pump having, in combination, an impeller and means for maintaining the impeller in a predetermined position, said means comprising a chamber, a head which is mounted in the chamber and partakes of the movement of the impeller and is subject to the pressure of liquid in the chamber, a valved pipe for supplying the chamber with liquid under pressure to act upon the head, and means whereby the valve of said pipe is automatically opened and closed by variations in the position of the impeller from its predetermined position to thereby restore it to such position, comprising a valve-operating lever connected with the shaft and operated thereby to admit or cut-off the supply of liquid to the chamber.

2. A centrifugal pump comprising an impeller, a driving shaft connected with said impeller, a piston connected with said shaft, a casing for said piston, valved fluid-supply means connected with said casing and connecting devices between the valve of said fluid supply means and said shaft whereby pressure on said piston is automatically regulated, said connecting devices comprising an oscillatory lever actuated by said shaft, and a connecting rod between said lever and valve.

3. A centrifugal pump, having in combination with its casing, impeller and impeller-shaft; means for automatically maintaining the impeller in predetermined position, comprising a chamber, a fluid-conducting pipe arranged outside the casing and connected with the chamber, a valve in said pipe for controlling the flow of fluid therethrough, means in said chamber, partaking of movement of the impeller and upon which the fluid acts to maintain the impeller in its predetermined position, and a lever having connection at one end with the shaft of the impeller and at the other end with the valve and adapted to be operated by movements of the shaft from and toward its proper position to open and close the valve.

4. A centrifugal pump, having in combination with its casing, impeller and impeller-shaft; means for automatically maintaining the impeller in predetermined position, comprising a chamber, a fluid-conducting pipe arranged outside the casing and connected with the chamber, a valve in said pipe for controlling the flow of fluid therethrough, means in said chamber, partaking of movement of the impeller and upon which the fluid acts to maintain the impeller in its predetermined position, and means for opening and closing the valve by movements of shaft from and toward its proper position, comprising jointed levers connecting the valve with the shaft.

5. A centrifugal pump, having in combination with its casing, impeller and impeller-shaft; means for automatically maintaining the impeller in predetermined position, comprising a chamber, a fluid-conducting pipe arranged outside the casing and connected with the chamber, a valve in said pipe for controlling the flow of fluid therethrough, means in said chamber, partaking of movement of the impeller and upon which the fluid acts to maintain the impeller in its predetermined position, and means for opening and closing the valve by movements of the shaft from and toward its proper position, comprising an oscillatory lever connected with the shaft, and a link connected with said lever and with the valve.

6. A centrifugal pump, having in combination with its casing, impeller and impeller shaft; means for automatically maintaining the impeller in predetermined position, comprising a chamber encircling the shaft, means mounted in the chamber and partaking of movements of the impeller and adapted to receive the effect of fluid pressures within the chamber, a plurality of fluid conducting pipes having connection with the chamber and with source of supply of fluid under pressure, valves in said pipes, and an operating means for the valves comprising an oscillatory lever having connection with the shaft and the valves.

7. A centrifugal pump having, in combination with its casing, impeller and impeller-shaft; means for automatically maintaining the impeller in predetermined position, comprising a chamber encircling the shaft, a head mounted on the shaft and in the chamber, pipes having communication with a source of fluid supply and entering

said chamber at opposite sides of the head, valves in said pipes, and means for actuating said valves by movements of the shaft from or toward its proper position, having an oscillatory lever connected with the shaft and connections between said lever and valves.

8. A centrifugal pump comprising a casing, an impeller mounted therein, a driving shaft connected with said impeller, and means for automatically balancing the pressures on said impeller, said balancing means comprising a casing encircling said shaft, a piston mounted in said casing and upon said shaft, pipes having communication with a source of liquid supply and entering the last mentioned casing above and below said piston and through which liquid is admitted to said casing to act upon said piston and produce the balance which maintains said impeller and shaft in their predetermined positions, valves in said pipes for cutting off the supply through the same during the normal operation of the impeller, and operating devices by which said valves are opened and closed independently of each other, for the purpose described, under the control of movement of said impeller from and to its predetermined position, said operating devices comprising an oscillatory lever actuated by said shaft and connecting means between said lever and valves.

9. A centrifugal pump, comprising a main casing having suction inlets, an impeller, a driving shaft carrying said impeller, and means for balancing the suctional forces and pressures to which said impeller is subjected in operation, comprising a piston on said shaft, means through which said piston is exposed to suction opposed to that on the impeller, a second piston and means for imposing pressure on said second piston to counterbalance the pressure on the impeller, the last mentioned means having devices for regulating the pressure to which said second piston is exposed.

10. A centrifugal pump, comprising a main casing having suction inlets, an impeller, a driving shaft carrying said impeller, and means for balancing the suctional forces and pressures to which said impeller is subjected in operation, comprising a plurality of pistons mounted on said shaft, means through which one of said pistons is exposed to suction opposing that acting on said impeller, a liquid-containing casing in which the other of said pistons is arranged, and means for controlling the supply of liquid to said casing to act on the piston therein, said means comprising devices by which the supply of liquid is cut off when the pressures are counterbalanced.

11. A centrifugal pump comprising a main casing, an impeller and its driving shaft rotatably mounted therein, a cylinder encircling said shaft and having non-communicating chambers one of which is open to the suction inlets of said main casing for the creation of a vacuum therein, a piston mounted on said shaft within the vacuum chamber, a second piston secured to said shaft and mounted in the other of said chambers, and means for supplying fluid to the latter chamber.

12. In a centrifugal pump, provided with a casing, an impeller within said casing, a driving shaft journaled upon said casing and connected to the impeller, a cylinder mounted upon said casing around the driving shaft and having a chamber formed therein, a piston secured to said shaft within said chamber, in combination with means to balance said piston consisting of a liquid device provided with carrying pipes communicating with said chamber, valves secured to said pipes provided with automatic means to open and close said valves consisting of connecting rod N, secured to said valves, lever *l* mounted upon standard O and connected to the driving shaft, substantially as set forth and for the purpose specified.

13. In a centrifugal pump, provided with a casing, an impeller within said casing, a driving shaft journaled upon said casing and connected to the impeller, a cylinder mounted upon said casing around the driving shaft and having chamber formed therein, a piston secured to said shaft within the chamber, in combination with means to balance said piston consisting of liquid circulating in said chamber and a combined automatic carrying and regulating device communicating with said chamber for said liquid, consisting of supply pipe M, connecting pipe *h*, valve *k*, connecting rod N, lever *l* mounted upon standard O and pivoted to the connecting rod and the driving shaft substantially as set forth and for the purpose specified.

14. In a centrifugal pump, provided with a casing, an impeller rotating within said casing, a driving shaft journaled upon said casing and connected to the impeller, a cylinder mounted upon said casing around the driving shaft and having chamber formed therein, a piston secured to said shaft within the chamber, in combination with means to balance said piston consisting of liquid circulating in said chamber and an automatic carrying and regulating device communicating with said chamber for said liquid consisting of supply pipe M connecting pipes *g* and *h* valves *i* and *k* secured to said connecting pipes, lever *l* mounted upon standard O and pivoted to the driving shaft, connecting rod N secured to the lever and the valves *i* and *k* substantially as set forth and for the purpose specified.

15. A centrifugal pump comprising a main casing, an impeller and its driving shaft rotatably mounted therein, a piston casing encircling said shaft, a piston mounted in said piston casing and secured to said shaft, a valved liquid supply pipe having communication with said piston casing and extending a distance above the same, and means connecting the valve of said pipe with said shaft for operating the same automatically.

16. A centrifugal pump having, in combination, an impeller and means for maintaining the impeller in a predetermined position, said means comprising a chamber, a head which is mounted in the chamber and partakes of movement of the impeller and is subject to the pressure of liquid in the chamber, means for supplying the chamber with liquid under pressure to act upon the head, said means having a valve and comprising a pipe which extends from a place at a distance above the chamber, and valve-operating connections between said valve and the shaft of the impeller.

17. A centrifugal pump having, in combination, an impeller and means for maintaining the impeller in a predetermined position, said means comprising a chamber, a head which is mounted in the chamber and partakes of movement of the impeller, and means for supplying the chamber with liquid under pressure to act upon the head, including a stand pipe extending from a distance above the chamber, connections leading from the stand pipe to portions of the chamber at opposite sides of the head, and valvular means for controlling the flow through said connections having operating elements the action of which is controlled by changes in the position of the impeller.

18. A centrifugal pump having, in combination, a main casing, an impeller mounted in the casing and having a shaft, a chamber into which said shaft extends, a head mounted in the chamber and upon said shaft, a standpipe extending from a distance above the chamber, pipes leading from the stand pipe into the chamber at opposite sides of said head, valves in said pipes, and valve-operating means connected with and operated by the impeller shaft and adapted to operate the valves independently of each other.

19. A centrifugal pump, comprising an impeller and its driving shaft, a casing having suction inlets and a passage leading from said inlets to the impeller, said casing also having a vacuum chamber one end of which is closed and the other end of which is wholly open and of approximately the same diameter as that of said passage and having communication with said passage, and a piston secured to said driving shaft and located in said vacuum chamber, substantially as set forth and for the purposes specified.

20. In a centrifugal pump, provided with a casing, an impeller having a driving shaft and rotating within the casing, suction inlets secured to said casing, a vacuum chamber formed around the driving shaft and having closed and opened ends, a piston placed within said chamber, in combination with a relief valve secured between the piston and the closed end of the chamber, substantially as set forth and for the purposes specified.

21. A centrifugal pump comprising a main main casing having suction inlets and a vacuum chamber, said vacuum chamber having a closed and an open end, a piston casing, an impeller and its driving shaft, said shaft extending through said vacuum chamber and piston casing, a piston secured to said shaft and arranged in said vacuum chamber, a relief valve between said piston and the closed end of said vacuum chamber, a second piston mounted in said piston casing and secured to said shaft, and means for conducting liquid under pressure to said piston casing.

In testimony whereof, we have affixed our signatures in the presence of two witnesses this 10th day of October, A. D. 1903.

FERDINAND W. KROGH.
CARL A. KROGH.

In presence of—
J. CORINSON,
JOHN ECHTLER.