No. 865,504. PATENTED SEPT. 10, 1907.

C. LAGER.

CENTRIFUGAL HIGH PRESSURE PUMP.

APPLICATION FILED MAY 26, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

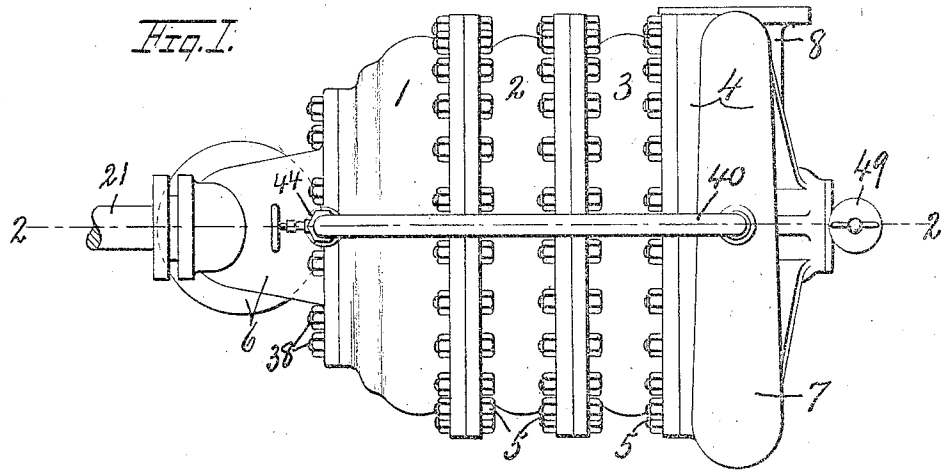


Fig. 2.

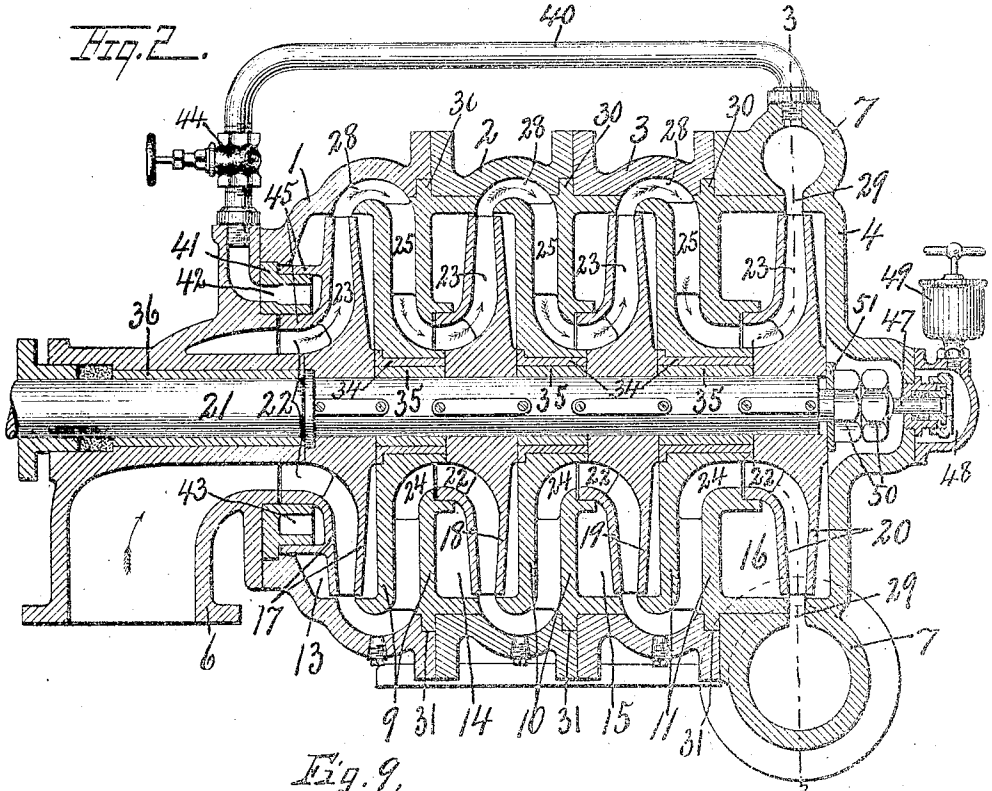
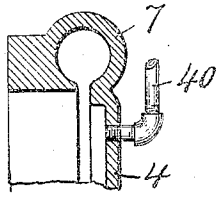


Fig. 9.



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2 SHEETS--SHEET 2

Fig. 3.

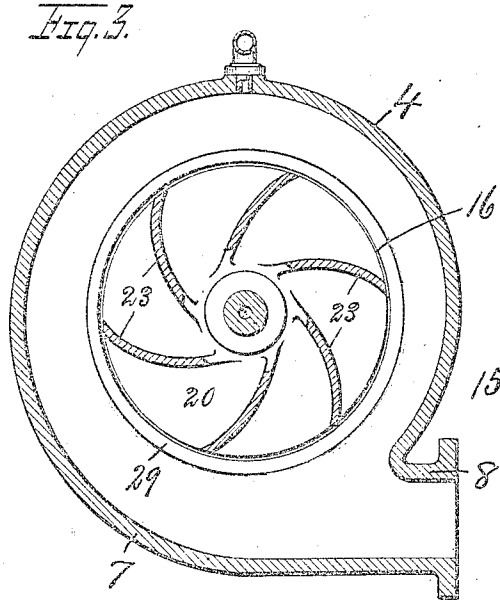


Fig. 4.

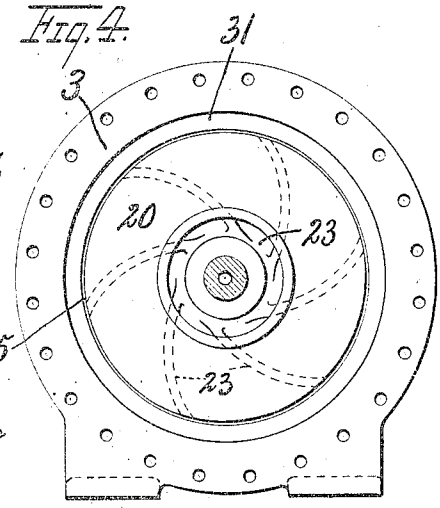


Fig. 5.

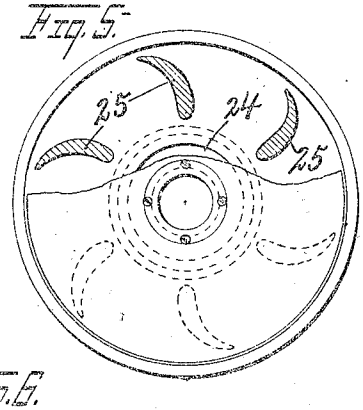


Fig. 7.

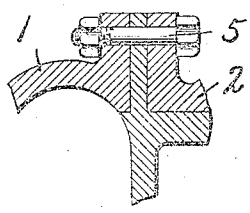


Fig. 8.

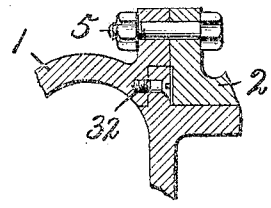
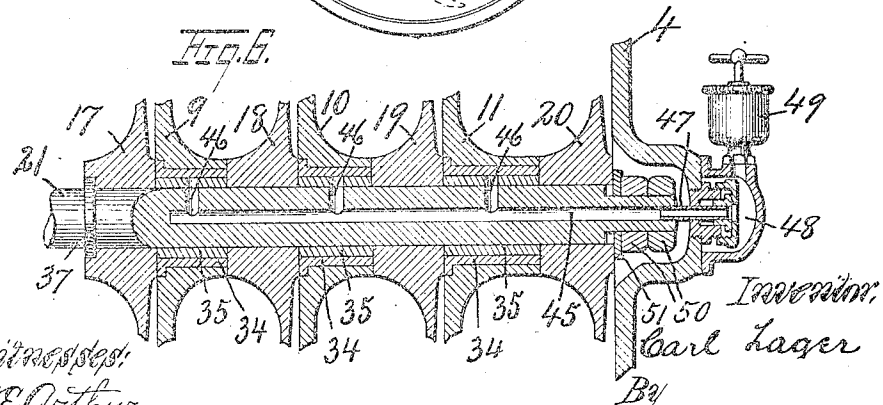


Fig. 6.



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UNITED STATES PATENT OFFICE.

CARL LAGER, OF BALDWINSVILLE, NEW YORK.

CENTRIFUGAL HIGH-PRESSURE PUMP.

No. 865,504. Specification of Letters Patent. Patented Sept. 10, 1907.

Application filed May 26, 1904. Serial No. 209,898

To all whom it may concern:

Be it known that I, CARL LAGER, of Baldwinsville, in the county of Onondaga, in the State of New York, have invented new and useful Improvements in Centrifugal High-Pressure Pumps, of which the following, taken in connection with the accompanying drawings, is a full, clear, and exact description.

This invention relates to improvements in centrifugal high pressure pumps in which the liquid is drawn and forced through a succession of pumping runners with cumulative force so that it may be elevated to high altitudes or against considerable hydrostatic pressure without excessive speed of the runners. In this class of pumps it is imperative that the walls of the water passages, and particularly those of the inclosing shell or casing where the impact of the liquid is greatest should be as smooth as possible so as to reduce to a minimum the incidental friction and consequent loss of power and force. This is accomplished by carefully boring or milling the walls of the passages and it is found that it can be more easily and perfectly done by making the inclosing shell in separate substantially annular sections, one for each runner, which are secured together end to end and are comparatively narrow so that the interiors are easily accessible for boring or milling tools.

One of my objects, therefore, is to build the shell in sections secured together end to end and to make the intermediate sections substantially identical and interchangeable so that the capacity or size of the pump may be readily increased or diminished by the addition or removal of one or more intermediate sections and a corresponding number of runners. In carrying out this object it becomes necessary to make the diaphragms between the runners separate from the case sections, and also separate from each other so that they also may be more perfectly and smoothly finished to complete the passage ways from one runner chamber to another. The primary object, however, of these separate diaphragms, which are also identical and interchangeable, is to facilitate the work of assembling the parts of the pump and to enable it to be readily and easily enlarged or reduced to meet different work requirements to correspond to the changes in the number of case sections and runners.

In any centrifugal pump where the water is received into the runner from one side, there is always an end pressure on the runner towards the opening, which pressure is equivalent to the area of the inlet opening, multiplied by the pressure, which will produce an end thrust in the direction towards the opening in the runner. In a four-series centrifugal pump, as shown by the drawing, there will be an end thrust on each runner, dependent upon the pressure it produces. The total end pressure due to all the runners, whether two or more, will, however, be equal to the sum of the pressures upon all the runners multiplied by the area of the inlet opening.

My object is to provide means to counteract, as far as practicable, this excessive end thrust by a counteracting water pressure against the front or inlet side of the first runner so that the pressure at both ends of the series is effectively balanced.

A further object is to provide means whereby the several runner bearings are simultaneously lubricated from a single source of supply.

Other objects and uses will appear in the following description.

In the drawings—Figure 1 is a top plan of a centrifugal high pressure pump embodying the various features of my invention. Figs. 2 and 3 are sectional views taken respectively on lines 2—2, Fig. 1, and 3—3, Fig. 2. Figs. 4 and 5 are end elevations respectively of one of the detached intermediate shell sections and one of the diaphragms, the runner being shown in place in Fig. 4. Fig. 6 is an enlarged sectional view through the driving shaft and adjacent portions of the diaphragms and runners showing the lubricator conduits. Figs. 7 and 8 are detail views of modified forms of uniting the diaphragms to the case sections. Fig. 9 is a sectional view of a modified connection of the pressure balancing conduit.

The inclosing shell or casing consists essentially of a series of cast metal rings or sections, in this instance four, which may be designated as an inlet section —1—; intermediate sections —2— and —3— and an outlet section —4—, all of which parts are secured together end to end by suitable clamping means, as bolts —5—; the section —1— being provided with an inlet nozzle —6— which is detachably secured thereto and discharges centrally into its front end, while the discharge section —4— is provided with a peripheral volute conduit —7— having a discharge nozzle —8—.

The interior of the shell is divided transversely by a series of transverse diaphragms or partitions —9, 10, and 11, for forming a series of compartments or runner chambers 13, 14, 15 and 16, in which are movable a corresponding number of rotary pumping runners —17—, 18—, 19— and —20— alternating with the diaphragms —9—, 10— and 11 and keyed or otherwise removably secured to a rotary driving shaft —21—. These runners, with the exception of the one nearest the inlet, are identical in construction, and are therefore interchangeable, and each consists of a circular disk having a central annular inlet opening —22— facing the inlet nozzle and extending radially through the periphery of the runner for forming an annular water-way which

divided at intervals by transverse partitions or involute vanes —23— whereby the liquid entering the inlet is deflected by centrifugal force from the periphery of the runner.

The diaphragms —9—, 10— and 11— are separate from the shell, but are preferably secured between by the meeting faces of the shell sections irrespective of the means by which the case sections are secured together, and are each provided with a central annular water-way —24— at one side of the meeting ends of the case sections opening at the side of the diaphragm toward the discharge end of the shell and extending radially through the periphery of the diaphragm, the radial water-way being divided by transverse partitions or involute vanes —25— for the purpose of preventing the vortical motion of the liquid as it is discharged from the runners.

The interior chambers of the shell sections —1—, 2—, and —3— are provided with annular waterways —28— which are arched outwardly or semi-circular in cross section and the periphery of the inlet portion of the diaphragm is also semi-circular in cross section and concentric with the cross sectional contour of the annular enlargement —28— for forming a transverse passage connecting the peripheral discharge of one runner with the peripheral inlet of the next adjacent diaphragm so that the liquid entering the inlet nozzle —6— is drawn into the inlet —22— of the first runner and is discharged by centrifugal force through the water-way —28— of the shell section —1— from which it is diverted through the water-way in the diaphragm —9— into the inlet of the next runner, and so on through the succession of runners and diaphragms until it is finally discharged from the last runner —20— through a passage —29— in the shell section —4— into the volute conduit —7— and out through the discharge nozzle —8—.

It has been previously stated that the diaphragms —9—, 10— and 11— are held rigidly in place between the meeting faces of the shell sections —1—, 2— and —3—, and in order that this may be accomplished in as simple a manner as possible I provide each of the diaphragms with an annular rib or flange —30— which is fitted in an annular recess —31— in the meeting face of one of the disks, as seen in Figs. 2 and 4 so that when the meeting faces are clamped together the rib —30 is inpinged between the meeting faces of the shell sections, and thereby firmly held in place. It is evident, however, that this rib may be extended to the periphery of the shell sections, as seen in Fig. 7 to receive the same clamping bolts which clamp the shell sections together, or the annular rib may be secured to one of the shell sections by suitable means as screws —32—, as seen in Fig. 8. The manner of securing these diaphragms in place is, however, immaterial, the essential object being to construct the diaphragm separate from the shell sections so that the water passages in both the shell sections and diaphragms may be more perfectly finished and more easily and readily assembled than if the diaphragms were formed integral with the shell sections, or if the shell sections were formed integral with each other.

The rotary pumping runners are held a definite distance apart by suitable spacing sleeves —35— which encircle the shaft —21— within bearings —34— of the diaphragms.

In assembling the various parts of the pump the shaft —21— is inserted in a suitable bearing —36— in the inlet nozzle —6— after which the shell section 1 is then placed over the other end of the shaft and moved endwise into engagement with the nozzle section —6— to which it is clamped by suitable means, as bolts —38—. The pumping runner —17— is then slipped over and upon the shaft until it abuts against a shoulder —37— with its inlet —22— registered with the outlet of the nozzle. One of the sleeves —35— is then placed upon and moved along the shaft —21— until it engages the first runner —17—, after which the diaphragm —9— is similarly moved lengthwise of the shaft upon its spacing sleeve —35— adjacent to the runner —17— with its annular rib —30— seated in the groove or recess —31— in the adjacent face of the shell section —1—. The shell section 2; runner 18— and diaphragm —10— are then successively placed in position, as seen in Fig. 2, to form the second pumping element, and in like manner the shell section —3—, pump runner —19— and diaphragm —11— are successively placed in position, and finally the runner —20— and end shell section —4— are placed in operative position, the meeting faces of said shell sections being clamped together by the bolts —5— as each pumping element is completed.

The method here proposed to balance the end thrust of the shaft and runner- series is to admit a counteracting pressure of water from the high pressure chamber or discharge conduit of the last runner against the inlet end or face of the first runner through a suitable conduit as —40— and pressure distributing ring —41— having an inlet —42— and an annular chamber —43—. The conduit —40— is shown as having one end connected to the volute conduit —7— and its other end connected to a passage in the suction nozzle —6— which passage connects with the passage —42— in the ring or annulus —41— the conduit —40— having a valve —44— to control the pressure in the annular chamber —43— in the ring —41— and thereby produce the balancing effect to a nicety. The ring —41— is secured between the meeting ends of the section —1— and nozzle —6— and is inclosed by flanges —45— on the adjacent face of the first runner —17— which flanges have a close running fit with the ring to reduce leakage at the joint, and the area of the annular groove —43— is proportioned to keep the water pressure up to counteract the opposing pressure at the opposite end of the runner series.

In Fig. —6— I have shown the means for simultaneously lubricating all of the runner bearings which means consist of a main passage —45— formed in the longitudinal center of the shaft —21— and provided with branch passages —46— which communicate with the bearings —34—, one end of the passage —45— being connected by a conduit —47— to an oil chamber —48— on the end section —4— the lubricator being supplied to said chamber from a reservoir —49—. This end of the shaft is preferably threaded and protrudes a short distance beyond the runner —20— and upon this threaded end are mounted clamping nuts —50— and a washer 51 bearing against the adjacent end face of the runner —20— and whereby all of the runners and their separating sleeves —35— are clamped upon the shaft against endwise movement.

The construction and operation of my invention is now believed to be sufficiently clear to enable any one skilled in the art to make, construct and use the same.

Having thus described my invention what I claim and desire to secure by Letters Patent is—

1. In a series-runner centrifugal pump, a series of separate annular case-sections one for each runner and means securing them end to end, each case-section having an annular waterway arched transversely, separate circular diaphragms interposed between and held by the meeting faces of the case-sections dividing the interior of the case into runner chambers and each provided with a water-passage leading from its periphery inwardly through one of its end faces, and a runner in each chamber having its inlet communicating with the waterway in one of the diaphragms and its outlet opening into the waterway of its case-section, said runners having their inlet openings all facing in the same direction, and an external conduit connecting the waterway of one of the case sections with the inlet side of one of the runner chambers and discharging against the inlet side of the first runner of the series.

2. In a series-runner centrifugal pump, a series of separate annular case-sections one for each runner and means securing them end to end, each case-section having an annular waterway arched transversely, separate circular diaphragms interposed between and held by the meeting faces of the case-sections dividing the interior of the case into runner chambers and each provided with a water-passage leading from its periphery inwardly through one of its end faces, and a runner in each chamber having its inlet communicating with the waterway in one of the diaphragms and its outlet opening into the waterway of its case-section, said runners having their inlet openings all facing in the same direction and a separate conduit connecting the waterway of the case section for the last runner of the series with the inlet side of the chamber for the first runner of said series and discharging against the inlet side of said first runner for balancing the end thrust.

3. In a centrifugal high-pressure pump, a casing comprising an inlet section and an outlet section and intermediate sections, said sections being secured end to end, the intermediate sections being identical and interchangeable, each section inclosing an impeller chamber, and having an annular water-passage, a series of impellers in said chambers each delivering into the passage of the case section which incloses it, and a series of partitions forming the sides of adjacent impeller chambers, each partition being clamped between the meeting ends of the adjacent case sections and having a water-way communicating with the water-way in one of the case-sections, and delivering into the next adjacent impeller, and a conduit leading from the annular passage of one of the case sections and discharging against the inlet side of one of the impellers.

In witness whereof I have hereunto set my hand this 16th day of May 1904.

CARL LAGER.

Witnesses:
H. E. CHASE,
HOWARD P. DENISON.