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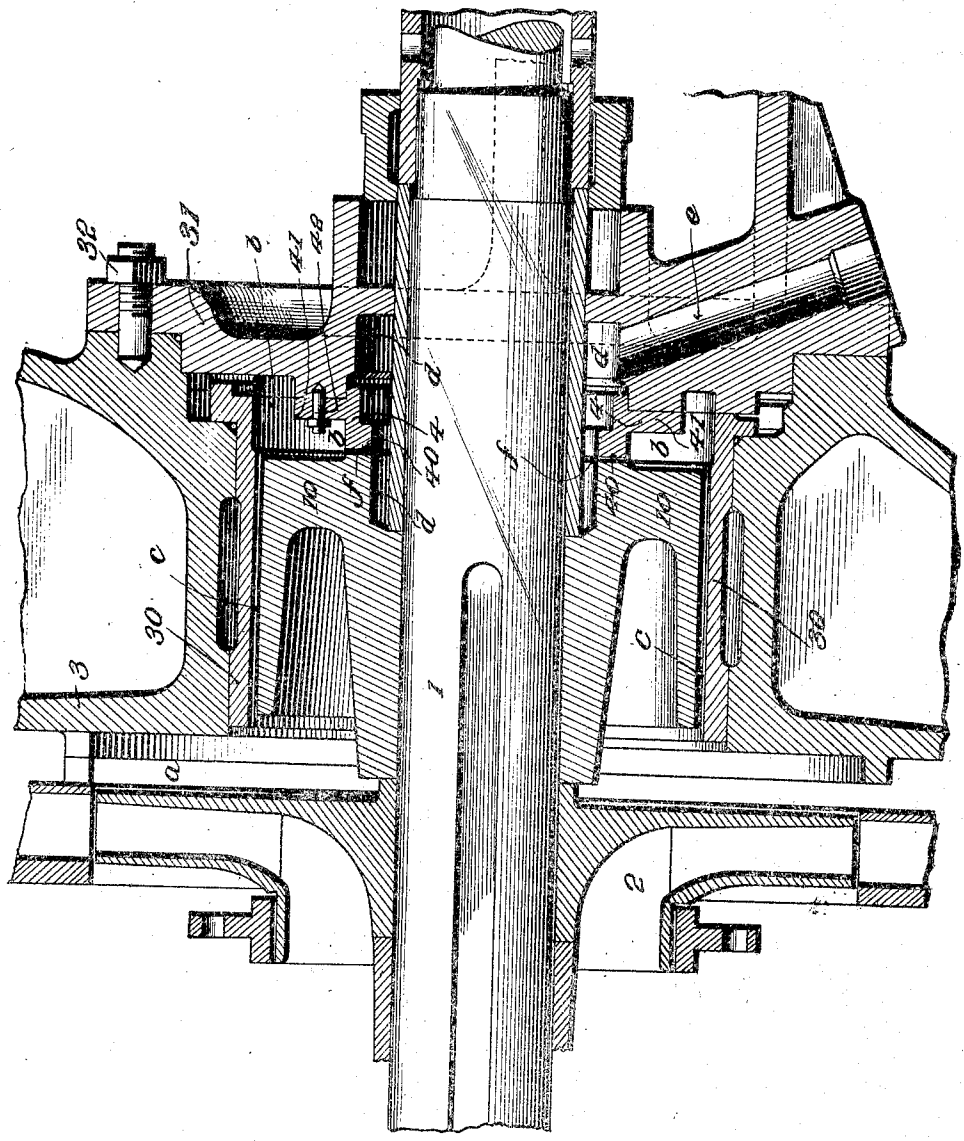
AUTOMATIC BALANCING DEVICE FOR CENTRIFUGAL PUMPS, TURBINES, AND THE LIKE.

APPLICATION FILED SEPT. 28, 1911.

1,025,621.

Patented May 7, 1912.



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AUTOMATIC BALANCING DEVICE FOR CENTRIFUGAL PUMPS, TURBINES, AND THE LIKE.

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Application filed September 28, 1911. Serial No. 651,783.

To all whom it may concern:

Be it known that I, FRANZ ARNO GRIESSMANN, a subject of the Emperor of Germany, residing at Berlin, Germany, have invented certain new and useful Improvements in Automatic Balancing Devices for Centrifugal Pumps, Turbines, and the Like; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to certain improvements in automatic balancing devices for pumps, turbines, blowers and the like; and the objects and nature of my invention will be readily understood by those skilled in the art in the light of the following explanation of the accompanying drawings illustrating what I now consider to be my preferred embodiment from among other formations and arrangements within the spirit and scope of my invention.

The invention consists in certain novel features in construction and in combinations and arrangements as more fully and particularly pointed out hereinafter.

The accompanying drawings show in section a portion of a pump embodying my invention.

In the drawings, 1, is the rotary pump shaft carrying suitable rotary members, such as impellers 2, inclosed by and rotatable within any suitable casing 3.

It is the object of the invention to provide simple, durable, readily accessible means for automatically balancing or equalizing the end thrust of the pump shaft and impellers. To this end, I fix a balancing member, such as piston 10, preferably on the outer (pump discharge or pressure) end portion of the pump shaft to both rotate and move axially therewith, and provide a liquid passage from the interior or pressure chamber of the pump, extending exteriorly of said piston to the outer face thereof and therefrom to any suitable discharge. This passage comprises a throttling fissure or outlet around and arranged transversely (radially or diagonally) of the axis of rotation, and a pressure chamber at the outer end face of the piston from which said outlet opens inwardly toward the shaft, said outlet being annular and of reduced diameter with respect to the piston and being automatically increased and diminished in capacity by the longitudinal movement of the piston and shaft to reduce or increase the pressure in said chamber.

The equalizing or balancing piston 10, is housed and movable in a fixed cylinder or cylindrical wall 30, rigid with the pump casing and at its inner end open to the pump (or inner pressure) chamber *a*, containing liquid under pressure due to the action of the pump impeller thereon. The inner end face of the piston 10, is hence constantly exposed to the pressure of said liquid. At the outer end of said cylinder 30, I provide annular outer pressure chamber *b*, the inner end wall of which is formed by the outer end face of the piston 10. The piston 10, is interposed in the cylinder 30 between the chambers *a* and *b*, but the exterior diameter of the piston is slightly reduced with respect to the interior diameter of the cylinder 30, to provide the narrow contracted or restricted annular water passage or sealing fissure *c*, for constant flow or leakage of liquid under pressure between the adjacent concentric surfaces of piston 10, and cylinder 30, and from chamber *a*, to the outer or circumferential portion of chamber *b*. The fissure *c*, is of constant or fixed capacity, although restricted.

The outer end wall of the chamber *b* is formed by the outer end head 31, of the pump casing. This head 31, is preferably removably secured to the pump casing by suitable means such as bolts 32, and at its central portion is so formed as to provide a liquid passage *d*, around the pump shaft open to any suitable liquid discharge *e*. The discharge *e*, can open to atmosphere, or to any suitable point or means for taking care of the leakage through the throttling fissure. The liquid chamber or passage *d*, is arranged concentrically and of reduced diameter with respect to the annular pressure chamber *b*, and a transversely arranged annular throttle outlet *f*, or fissure is provided between the chamber *b*, and the liquid chamber *d*, opening inwardly from chamber *b*, toward the pump shaft. This outlet is formed by and between an annular flat edge or portion of the outer end piston face near the center of the piston, and a corresponding annular stationary edge or face

fixed to or rigid with the casing head 31 so that said opposing parallel faces forming the walls of the outlet recede from and approach each other as the pump shaft moves longitudinally and hence increase or diminish the capacity of said throttle outlet. If the pump shaft moves to the left, the capacity of the outlet is increased and hence the pressure in chamber *b*, is reduced below the pressure in chamber *a*, by the increased flow of liquid therefrom to chamber or passage *d*. The excess of pressure in chamber *a*, then tends to force the piston (and pump shaft) to the right to counteract the thrust and restore the shaft to normal position. This movement to the right contracts the outlet *f*, to increase the pressure in chamber *b*, to approximately that in chamber *a*. If the shaft moves beyond normal position toward the right, the throttle outlet will be abnormally contracted or closed and the pressure in chamber *b*, will be increased to resist undue movement of the shaft toward the right and to tend to cause movement thereof to normal position. The parts are so arranged and proportioned as to tend to automatically maintain the piston and shaft in normal, balanced or intermediate position with the pressures in chambers *a* and *b*, about equal.

In the specific example illustrated, I show the inner peripheral or horizontal wall of the chamber *b*, and the fixed wall of the throttle outlet formed by a removable flanged ring or sleeve 4, secured to the casing head 31. The internal diameter of this ring is slightly greater than the diameter of the pump shaft, arranged concentrically therein, to provide the internal fluid passage *d*, around the shaft, while the inner end edge 40 of the ring forms the fixed wall of the throttle outlet and is arranged closely adjacent to the opposing vertical face of the balancing piston, and the chamber *b*, surrounds the ring. The ring fits concentrically within the center opening of the casing head 31, and is formed with an exterior radial flange 41, in the chamber *b*, and fitting the inner side face of said head. The ring is suitably secured to said head, as by screws or bolts 42, extending through said flange 41, into the head.

The surfaces of the piston and ring forming the walls of the throttle outlet are subject to wear and friction and hence advantages are attained by arranging said surfaces as close as possible to the pump shaft, that is, by forming said surfaces of a small diameter with respect to the diameter of the piston whereby the area and peripheral speed of said surfaces can be greatly reduced, and the friction thereof or load imposed thereby on the pump shaft is reduced to the minimum.

Advantages are also attained by providing the removable or renewable ring 4, to sustain the wear and tear of the throttle outlet forming walls and whereby said wear can be taken up, and hence material advantages in manufacture and operation are gained by arranging this ring at the outer end face of the piston so as to be readily accessible on the removal of the casing or bearing head 31, without necessitating removal of the piston or disturbance of the adjustment thereof with respect to the shaft. By this arrangement, the casing or bearing head can be removed and a new ring can be readily substituted for a worn out ring, or the worn ring can be easily and quickly adjusted to take up wear by manipulation of the ring fastening screws and the location of liners behind the ring, or otherwise. Access can be easily had to the ring for properly adjusting the same both in process of assembling in manufacture and when the pump is in operation.

It is usually desirable that the ring be accurately adjusted with respect to the piston to attain the desired balancing efficiency, and hence it is highly desirable that means be provided whereby access to the ring can be had by a minimum expenditure of time and labor. The ring is subjected to cooling liquid both externally and internally and presents but a comparatively narrow edge and slight surface area to the wear of the adjacent face of the rotating piston and interposed grit. The wear on the ring tends to reduce the length thereof and hence the ring is comparatively long lived as in the example illustrated, the ring is elongated or in the form of a sleeve, and therefore is capable of considerable longitudinal adjustment to take up wear.

In centrifugal pumps the thrust is primarily always toward the suction end, but the balancing piston is introduced to overcome and possibly overbalance the normal thrust toward the suction end of the pump. The area of the inner face of this piston constantly exposed to the discharge pressure in chamber *a*, is preferably in excess of the area of any impeller balancing ring, that is, the area exposed to the suction pressure, so that the suction pressure is thereby overbalanced, while the throttling fissure and pressure chamber at the outer face of the pump are depended on to automatically maintain proper balance notwithstanding the overbalancing of the rotor toward the pressure end of the pump when the inner face only of the piston is considered. The length of the piston must also be considered in connection with the number of stages employed and the packing width thereof.

It is evident that various changes and modifications might be resorted to in the forms, constructions, and arrangements of parts described without departing from the

spirit and scope of my invention, and hence I do not wish to limit myself to the exact disclosure hereof.

Desiring to protect my invention in the broadest manner legally possible, what I claim is:

1. In combination, in a centrifugal pump, turbine, or the like, a rotor, a casing therefor comprising a cylinder at its inner end constantly open to the pump pressure and at its outer end having a removable head, a balancing piston rotating and longitudinally movable with said rotor and in said cylinder, said piston and cylinder forming a pressure chamber between the outer end face of the piston and said removable head and a sealing fissure of constane capacity for the flow of liquid under pump pressure from the inner end of said cylinder to said pressure chamber, the inner end face of said piston being constantly and freely exposed to the pump pressure and longitudinally overbalancing the rotor in a direction to carry the piston toward said head, said pressure chamber provided with an annular throttling outlet concentric with and discharging inwardly toward the rotor axis and of reduced diameter with respect to the piston and controlled by the longitudinal movement thereof to vary the pressure in said chamber, said throttling outlet being arranged between said head and the outer end face of the piston and comprising a removable ring forming one wall of the outlet and accessible on the removal of said head.

2. Means for automatically balancing the end thrust of the shafts of rotors comprising a casing provided with a removable end head, a balancing piston rotating and longitudinally movable with said shaft and forming an annular pressure chamber between its outer end face and said head, and a sealing fissure of constant capacity for constant uniform flow of liquid to said chamber, said piston longitudinally overbalancing said rotor in a direction to constantly tend to move said piston toward said head and against the pressure in said chamber, the central portion of the outer end face of said piston and said head being provided with opposing annular walls concentric with and surrounding said shaft and of reduced diameter with respect to said piston and surrounded by said chamber and forming a throttling outlet discharging inwardly from said chamber toward said shaft, one of said walls formed by a separate ring removably secured to and carried by and removable with said head independently of and without disturbing said shaft and said piston.

3. In combination, a rotary shaft subjected to end thrust, a piston fixed thereon, a casing therefor forming a pressure chamber at the outer face of the piston and provided with a removable head forming the outer side wall of said chamber, a stationary ring having its inner face adjacent to the outer face of said piston to coöperate therewith in forming an automatically throttling outlet opening inwardly from said chamber, said ring surrounding said shaft and at its inner surface spaced therefrom to form a discharge passage from said outlet, said ring forming the center wall of said chamber and separating the same from said passage and provided with an exterior flange, and means removably securing the ring to the head through the medium of said flange.

4. In combination, a rotary shaft subjected to end thrust, a piston fixed thereon, a casing therefor forming a pressure chamber at the outer face of the piston and provided with a removable end head having an enlarged center opening around said shaft, and a stationary ring having its inner edge adjacent to the outer face of said piston to coöperate therewith in forming an automatically throttling outlet opening inwardly from said chamber to a liquid offtake passage around said shaft and within said opening of said head, said ring being fitted within said center opening of said head and being carried by and removably secured to said head and at its inner surface forming the outer wall of said passage.

5. In combination, a rotary shaft subjected to end thrust, a balancing piston fixed thereon, a casing forming pressure chambers at the faces of said piston, and a stationary ring carried by and removably fixed to said casing concentric with said shaft and of reduced diameter with respect to said piston and presenting an end edge adjacent to the central portion of a face of said piston to coöperate therewith in forming an automatically throttling pressure agent passage, means being provided whereby said ring is adjustable independently of said casing and piston and longitudinally of said shaft whereby wear can be taken up without disturbing the piston adjustment.

6. Means for automatically balancing the end thrust of shafts of pumps and the like, comprising a balancing piston on the pump shaft and having an inner face of fixed area constantly and freely exposed to the pump discharge pressure to overbalance thrust toward the suction end of the pump, said piston having an outer face of fixed area, and means providing a liquid passage for the constant and uniform flow of liquid from the pump discharge pressure to a chamber at said outer face having a throttling outlet controlled by the axial movement of said piston for varying the pressure at said outer face to counteract thrust toward the pressure end of the pump.

7. Means for automatically balancing the end thrust of rotors of centrifugal pumps and the like, comprising a balancing piston

on the pump shaft and having its inner face constantly and freely exposed throughout its area to the pump discharge pressure and of an area to overbalance thrust toward the suction end of the pump and set up normal thrust toward the pressure end of the pump, and means providing a liquid passage from the pump discharge to the outer piston face comprising a sealing fissure at the periphery of the piston constantly open to the pump discharge pressure for the flow of liquid under said discharge pressure, a pressure chamber at the outer face of the piston, and a throttling fissure controlling the discharge from and the thrust resisting pressure in said chamber at said outer face.

In testimony whereof I affix my signature, in presence of two witnesses.

FRANZ ARNO GRIESSMANN.

Witnesses:
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