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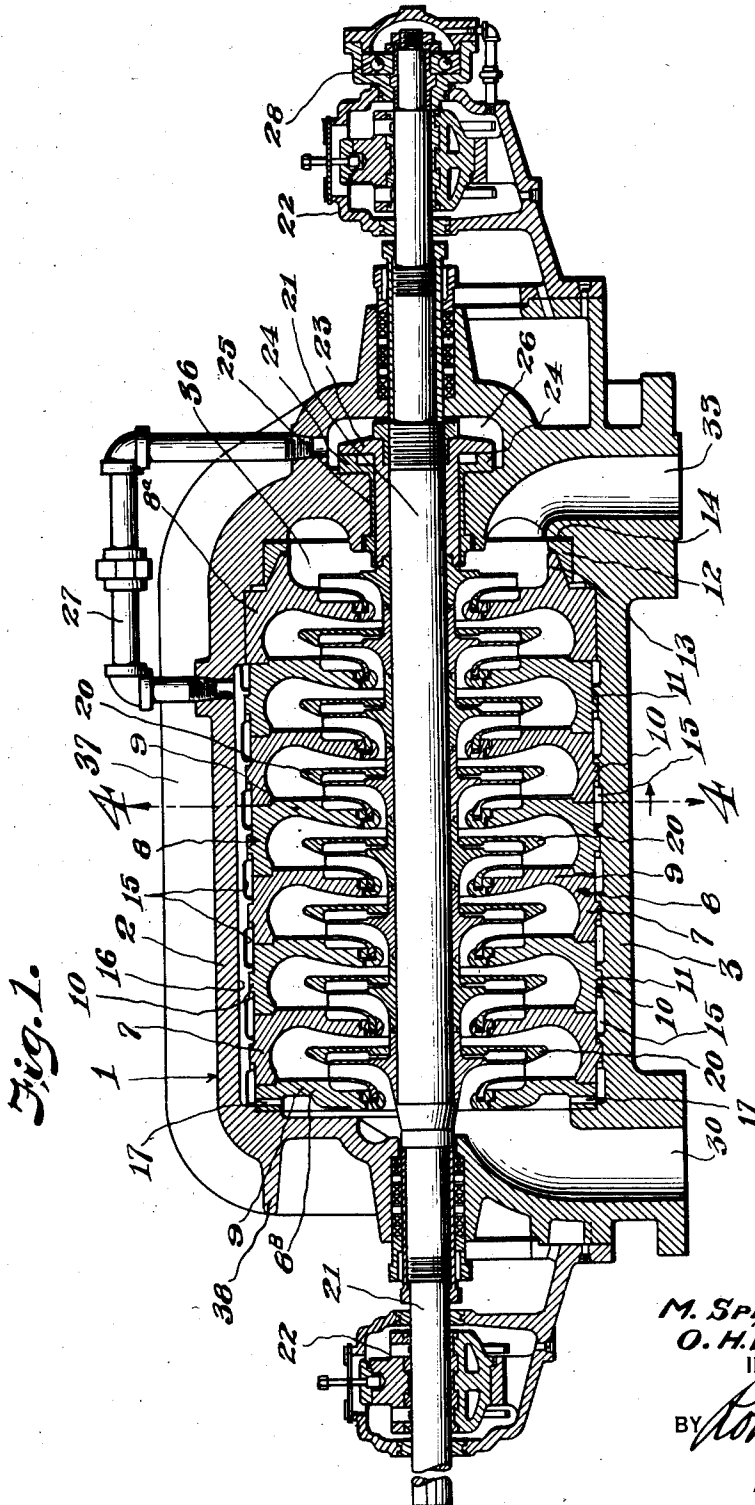
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M. SPILLMANN ET AL

HIGH PRESSURE CENTRIFUGAL PUMP

Filed April 7, 1926

4 Sheets-Sheet 1



**M. SPILLMANN.
AND
O. H. DORER.
INVENTORS**

BY Rohit K. Gupta
ATTORNEY

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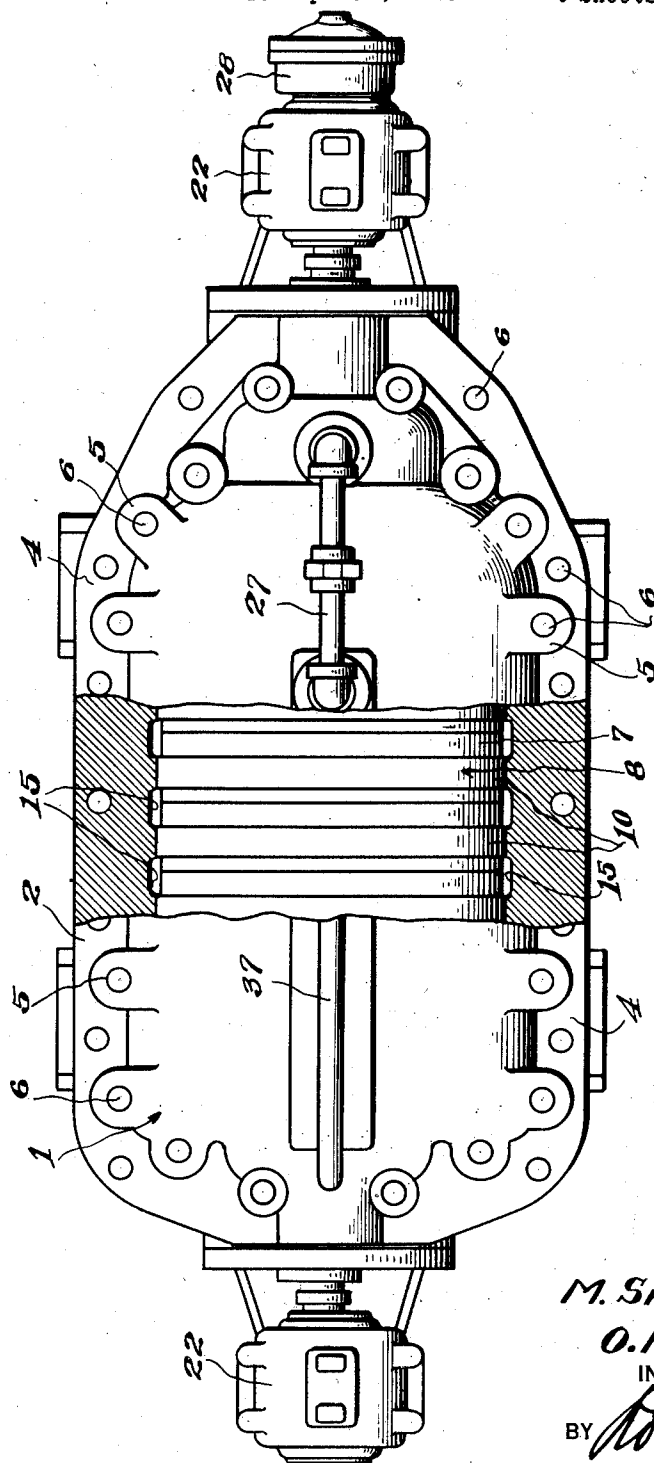
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Fig. 2.



M. SPILLMANN.
AND
O. H. DORER.
INVENTORS

BY *R. H. Meyer*

ATTORNEY

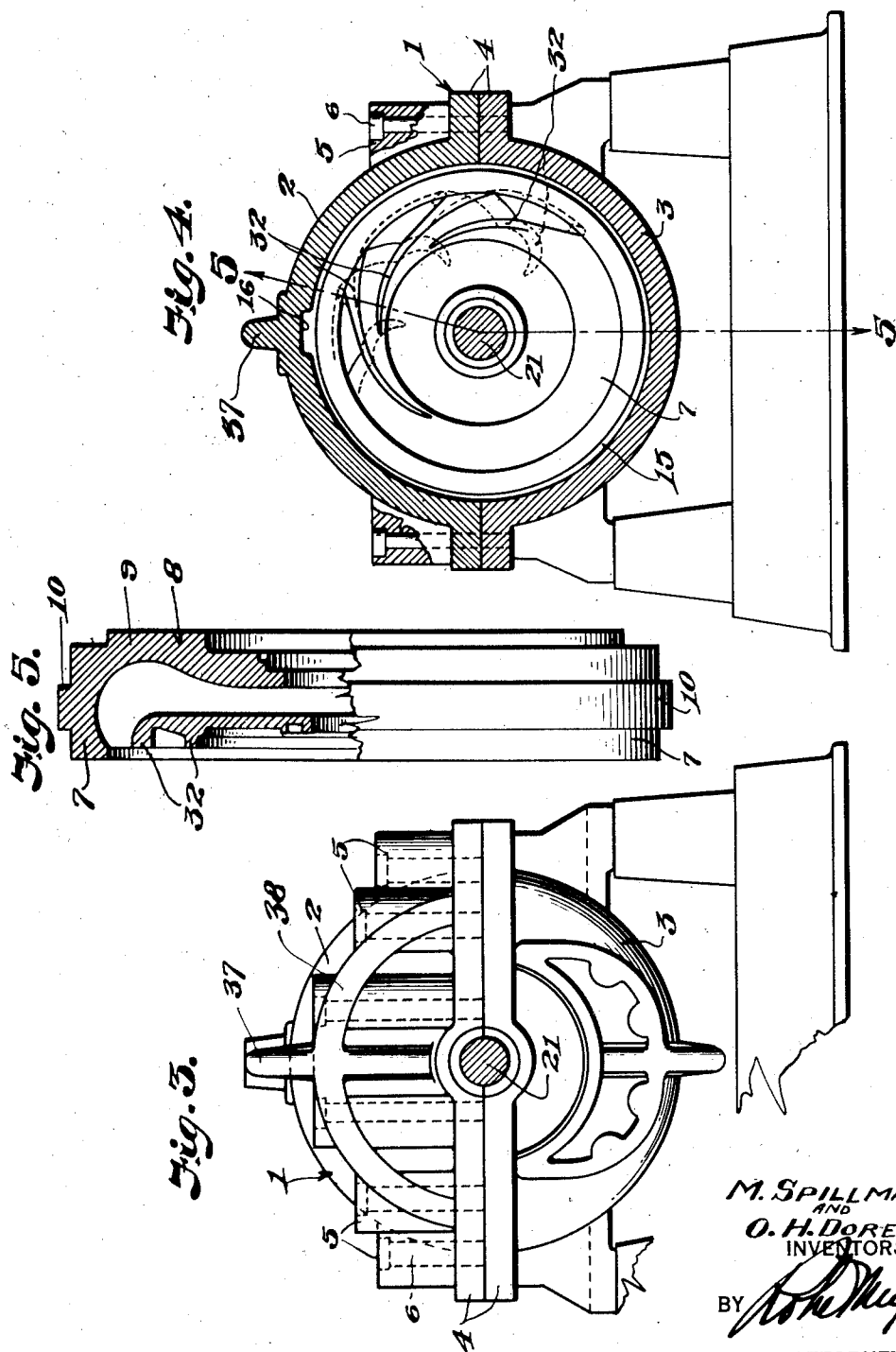
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M. SPILLMANN.
AND
O. H. DORER.
INVENTORS.

BY

Robert Meyer

ATTORNEY

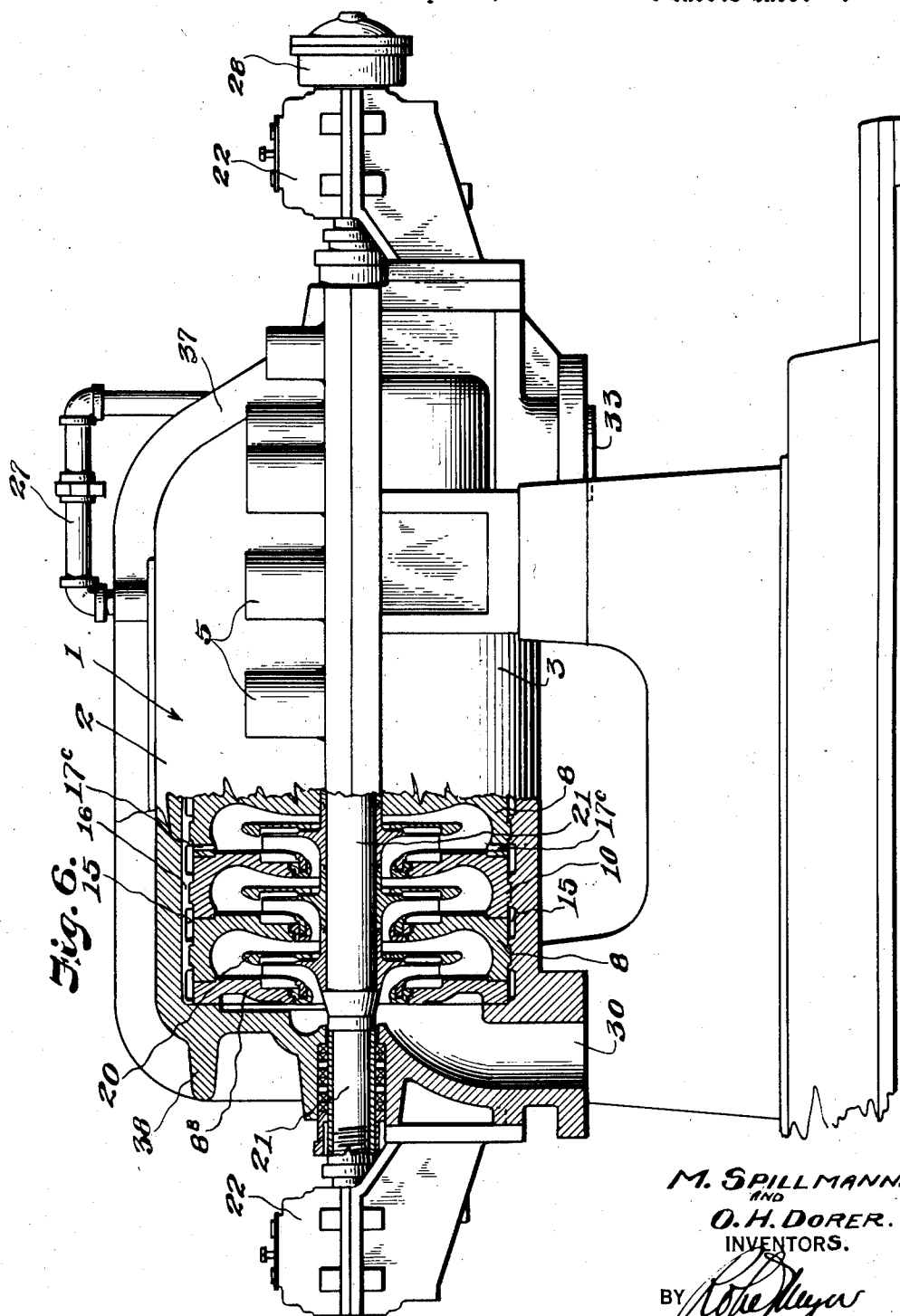
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M. SPILLMANN
AND
O. H. DORER.
INVENTORS.

BY *Robert Meyer*
ATTORNEY

UNITED STATES PATENT OFFICE.

MAX SPILLMANN, OF RICHFIELD, AND OSCAR H. DORER, OF EAST ORANGE, NEW JERSEY, ASSIGNORS TO WORTHINGTON PUMP AND MACHINERY CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF VIRGINIA.

HIGH-PRESSURE CENTRIFUGAL PUMP.

Application filed April 7, 1926. Serial No. 100,205.

This invention relates to centrifugal pumps and more particularly to high pressure boiler feed pumps.

The present and growing practice in the design and construction of power plants is to feed the water to the boilers under high pressure and at relatively high temperatures, such pumps operating at very high discharge pressures. In the construction of high pressure feed pumps of this type it is difficult to provide casings of sufficient strength to handle or withstand the stresses due to the pressure within the pump and particularly in pumps which have the casing constructed or split so as to permit access to the interior parts of the pump; such as diffusion rings, impellers, etc., for purpose of replacement or repair.

It is an object of the present invention to provide a pump capable of handling high pressures which embodies in substance an inner and outer casing with pressure fluid between them, giving in effect a two-stage distribution of the stresses. These casings are arranged to provide in substance a space or chamber between their facing surfaces which preferably has communication with the suction end or an intermediate stage of the pump to permit the fluid pumped to enter the chamber under suitable pressure, the said fluid cooperating with the casings in absorbing the stresses due to the high pressures under which the fluid is pumped.

A further object of the invention is to provide in a pump as specified, diffusion rings which are connected one to the other with suitable fittings and wherein the individual stage pressures acting on the diffusers hold the rings tight against leakage without the use of bolts or analogous fastening devices.

With these objects in view, the invention consists in various features of construction and combination of parts, which will be first described in connection with the accompanying drawings, showing a high pressure centrifugal pump of the preferred form embodying the invention, and the features forming the invention will be specifically pointed out in the claims.

In the drawings—

Figure 1 is a longitudinal section through the improved pump.

Figure 2 is a top plan of the pump having parts broken away.

Figure 3 is an end view of the pump with parts of the bed plate broken away.

Figure 4 is a vertical section through the pump taken on the line 4—4 of Figure 1.

Figure 5 is a view partly in section and partly in elevation of one of the diffusion rings.

Figure 6 is a view partly in side elevation and partly in section of a modified form of the invention.

Referring more particularly to the drawings, the improved high pressure centrifugal pump comprises the outer casing 1 which is formed of the upper section 2 and the lower section 3. The sections 2 and 3 are provided with engaging flanges 4 and the upper section 2 has a plurality of bosses 5 thereon, through which bolts 6 extend for detachably connecting the sections 2 and 3 to permit removal of the section 2 for access to the interior of the pump and still provide sufficient strength of connection to maintain the sections tightly connected under stresses due to the relatively high pressures to which the pump is subjected.

In pumps designed for use in connection with extremely high pressures of fluid pumped, it is practically impossible to provide a split casing of sufficient strength to withstand the pressures and hold the sections of the casings together with bolts and in the present invention a second or inner casing is formed by the diffusion rings 8. The diffusion rings 8 are constructed in such manner as to form the inner casing as well as to form the diffuser and return channel. The rims 7 of the diffusion rings are shown, in Figure 1 of the drawings as having edge engagement with the webs 9 of the diffusion ring next thereto and aside from such engagement the diffusion rings are free from connection with each other. The unbalanced or thrust pressure of the diffusion rings 8 is that due to stage pressure and exposed surface and each diffusion ring carries the thrust from the next succeeding ring. These high pressures serve to hold the joints be-

tween the successive rings tight, and the use or need of bolts or other analogous attaching devices for connecting the rings is eliminated. Each of the rings 8 has an annular rib 10 on its perimeter which engage in grooves 11 in the casing sections 2 and 3. By particular reference to Figure 1 on the drawings, it will be noted, however, that the grooves 11 are wider than the ribs 10 so as to permit the effective sealing between the successive rings by the action of the pressure thereon. Any leakage that may occur simply passes to the chamber 15 and does no harm.

For sealing the last diffusion ring indicated at 8^a in Figure 1 of the drawings a lead bull ring 12 is provided which fits over the cone 13 on the diffusion ring 8^a. The bull ring 12 fits against the shoulder 14 on the casing 1 and the pressure in the pump forces the ring 12 tightly on the cone joint 13 and gives the effect of two casings in one. The last pressure stage is shown at 36 without diffusion ring so as to give the discharge chamber a small radial dimension and aid in reducing casing stresses.

The diffusion rings 8 and the casing sections 2 and 3 are constructed to provide a series of clearance spaces 15 between the perimeters of the diffusion rings and the inner surfaces of the casing sections 2 and 3. These clearance spaces 15 are connected by a channel 16 providing in effect a single clearance space between the inner and outer casings of the pump. The clearance space or chamber 15 and the channel 16 have communication through openings 17 in the first impeller ring indicated by 8^b in Figure 1 of the drawings to permit the fluid to be pumped to enter the chamber 15 under suction pressure. The fluid under suction pressure acts in conjunction with the inner casing formed by the diffusion rings 8 and the outer casing 1 to withstand the stresses and pressure of the fluid pumped and to distribute the pressure in such manner as to subject the outer casing 1 to a pressure so much lower than the pump pressure as to permit the casing to be made in sections 2 and 3, joined by the bolts 6 even with the highest discharge pressure. With the stresses on the outer casing distributed by proper pressure in the chamber 15 the outer casing 1 may be comparatively light and if desired, may be strengthened to support the discharge pressure and the thrust against the suction head by longitudinal and peripheral ribs as shown at 37 and 38.

In pump structures where the suction pressure is not sufficient to secure the desired pressure in chamber 15 or a desired amount of pressure from other source is not available, any one of the other diffusion rings 8 such as the third-stage diffusion ring 8^c may be provided with openings 17^c as shown

in the modified form illustrated in Figure 6 of the drawings, to provide the desired pressure within the chamber 15 and in such instances the first or initial diffusion ring is free from openings having communication with the chamber 15 or the channel 16. In all other respects the modified form of pump illustrated in Figure 6 is identical with the preferred type of pump illustrated in the other figures of the drawings.

The impellers 20 are mounted upon the shaft 21 which shaft is rotatable in suitable bearings 22 and in the present form of the invention hydraulic balancing of the impeller thrust is provided. The hydraulic balancing of the impeller thrust is accomplished through the balancing disc 23 and in case the shaft 21 and impellers 20 move longitudinally the disc 23 will be forced away from engagement with the casing-carried disc 24 and the fluid will leak through the sleeve 25 and through the space formed between the discs 23 and 24 into the chamber 26 from which it will be returned through the piping 27 into the chamber 15. The back pressure through the piping 27 may be controlled by suitable choke (not shown) of any approved construction in the piping 27. The hydraulic balancing of centrifugal pump is well known and in the present application differs from previous structures in that the back pressure fluid flows into the chamber 15. A ball thrust bearing 28 of approved construction is provided at the end of the shaft 21 and is designed so as to run free under ordinary circumstances; however, when the engaging surfaces of the discs 23 and 24 wear to such an extent as to decrease their efficiency the thrust bearing 28 will be brought into effective operation.

In the operation of the improved centrifugal pump the fluid to be pumped enters through the intake or suction 30 and passes through the successive stages of the pump identified by the various diffusion rings 8 and the impellers 20, the path and directional flow of the fluid being regulated and the pressure increased from stage to stage through the specific construction of the diffusion rings, the vanes on the diffusion rings as shown at 32 and the impellers. The discharge is through the opening 33.

From the foregoing description taken in connection with the accompanying drawings it will be apparent that a pump has been provided in which the outer casing, with the exception of the portion surrounding the last stage, is subjected only to suction pressure or such pressure depending upon the stage which is tapped to provide the balancing fluid in the chamber 15, and which construction, therefore, gives variable stresses on the inner casing depending on the particular stage and is maximum at next to the last stage only, which stage, being of small ex-

posed area, notwithstanding the high pressure, does not produce a stress greater than can be taken care of by proper construction of the outer casing and this stress is supported by the adjacent casing head.

In high pressure power plants the practice is to feed water to the boilers at relatively high temperature so that the heat element also enters into the construction of a pump for pumping feed water in such instances; in that in a pump embodying a casing having irregular surfaces, the expansion and contraction due to the variances in temperature and particularly to the heat caused by the hot water flowing through the pump, cause cracking and distortion which, in turn, affects the efficiency of the pump and in the present invention, the use of the diffusion rings 8 as the inner casing, enables the outer casing to be of symmetrical construction and eliminates irregular surfaces and consequently reduces liability of cracking or distortion of the outer casing under heat action.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown but that these may be modified widely within the invention defined by the claims.

What is claimed is:

1. In a centrifugal pump, an outer casing and series of diffusion rings within the outer casing disposed in engagement one with the one next thereto and constructed and providing exposed surfaces whereby the stage pressure in the pump causing thrust pressure on the diffusion rings will maintain the rings in tight engagement with each other, and means engaging the last diffusion ring in the series and engaging said outer casing for joining, in effect, said rings and outer casing in a unit, said outer casing and diffusion rings having a chamber between their facing surfaces, said chamber having communication with the interior of the diffusion rings at a pre-determined stage to receive fluid under pressure from within the rings and hydraulic end thrust balancing means having communication with said chamber.

2. In a centrifugal pump an outer casing, a plurality of diffusion rings within the outer casing and constructed to form an inner casing, said outer casing and diffusion rings having a chamber between their facing surfaces for receiving fluid under pressure, and hydraulic end thrust balancing means having communication with said chamber.

3. In a centrifugal pump, an outer casing, a plurality of diffusion rings within the outer casing and constructed to form an inner casing, said diffusion rings and outer casing arranged to form a chamber between their facing surfaces, said chamber provided for receiving fluid under pressure, the last stage diffusion ring of the pump having a

cone bearing thereon, and a bull ring engaging said cone bearing and the interior of the outer casing to form a seal and bind the inner and outer casings substantially, in effect, into a single casing.

4. In a centrifugal pump, an outer casing, a series of diffusion rings within the outer casing and constructed to form an inner casing, said diffusion rings disposed in engagement one with the one next thereto and constructed and providing exposed surfaces whereby the stage pressure in the pump causing thrust pressure on the diffusion rings will maintain the rings in tight engagement with each other, the last stage diffusion ring having a cone bearing thereon, and a bull ring engaging said cone bearing and the interior of the outer casing to form a seal and bind the inner and outer casings substantially, in effect, into a single casing.

5. In a centrifugal pump, an outer casing, an inner casing, said inner casing having a cone bearing thereon at the discharge end of the pump and a bull ring engaging said cone bearing and the interior of the outer casing to form a seal and bind the inner and outer casings substantially, in effect, into a single casing.

6. A centrifugal pump including an outer casing and an inner casing and having a series of annular clearance spaces between said casings for receiving fluid under pressure, said outer casing provided with a channel establishing communication between said clearance spaces, and hydraulic end thrust balancing means having communication with said channel.

7. A centrifugal pump having an outer casing, a plurality of diffusion rings within the outer casing, said diffusion rings and casing arranged to form a series of annular clearance spaces between the outer surfaces of the rings and the inner surfaces of the casing, and hydraulic end thrust balancing means having communication with said spaces.

8. A centrifugal pump including an outer casing, a plurality of diffusion rings within the casing and each forming one of the stages of the pump, said diffusion rings and casing having a chamber between their facing surfaces for receiving fluid under pressure, the diffusion ring subject to pressure of fluid entering the pump being provided with openings to permit a part of the fluid entering the pump to pass into said chamber, and hydraulic end thrust balancing means having communication with said chamber.

9. In a centrifugal pump, a series of diffusion rings disposed in engagement one with the one next thereto and constructed and providing exposed surfaces whereby the stage pressures in the pump causing thrust pressure on the diffusion rings will maintain

the rings in tight engagement with each other, and means establishing a pressure tightened fluid tight engagement between the discharge stage diffusion ring and the casing, said means forming the perimetric portion of the discharge stage of the pump.

10. In a centrifugal pump, a series of diffusion rings disposed in engagement one with the one next thereto and constructed and providing exposed surfaces whereby the stage pressures in the pump causing thrust pressure on the diffusion rings will maintain the rings in tight engagement with each other, and each ring will carry the thrust from the next succeeding ring, and members having inclined engaging surfaces carried by the last stage diffusion ring and casing for providing a pressure tightened connection between the last stage diffusion ring and casing, said members forming the perimetric portion of the discharge stage of the pump.

11. In a multi-stage centrifugal pump, an outer casing, a plurality of diffusion rings within the outer casing and each forming substantially one stage of the pump, a chamber between all the said rings and outer casing except the final ring at the discharge end of the pump, said chamber adapted to receive fluid under pressure from a point where it is less than it is at the pump discharge.

12. In a multi-stage centrifugal pump, an outer casing, a plurality of diffusion rings within the outer casing and each forming substantially one stage of the pump, a chamber between all the said rings and outer casing except the final ring at the discharge end of the pump, said chamber adapted to receive fluid under pressure from a point where it is less than it is at the pump discharge, and a tapered pressure tightened thrust con-

nection between the discharge stage forming ring and the casing.

13. In a multi-stage centrifugal pump, an outer casing, a plurality of diffusion rings within the outer casing and each forming substantially one stage of the pump, a chamber between all the said rings and outer casing except the final ring at the discharge end of the pump, said chamber adapted to receive fluid under pressure from a point where it is less than it is at the pump discharge, and hydraulic end thrust balancing means having communication with said chamber.

14. In a multi-stage centrifugal pump, an outer casing, a plurality of diffusion rings within the casing and forming the stages of the pump, said casing provided with a plurality of spaced annular ribs, and annular ribs on said rings extending into the spaces between the casing carried ribs.

15. In a centrifugal pump, a series of diffusion rings disposed in engagement one with the one next thereto and constructed and providing exposed surfaces whereby the stage pressures in the pump causing thrust pressure on the diffusion rings will maintain the rings in tight engagement with each other, and each ring will carry the thrust from the next succeeding ring, inclined engaging surfaces carried by the last stage diffusion ring and casing for providing a pressure tightened connection between the last stage diffusion ring and casing, said casing provided with a plurality of annular ribs, and spaced annular ribs on said rings extending into the spaces between the casing carried ribs.

In testimony whereof we affix our signatures.

MAX SPILLMANN.
OSCAR H. DORER.