

Dec. 22, 1931.

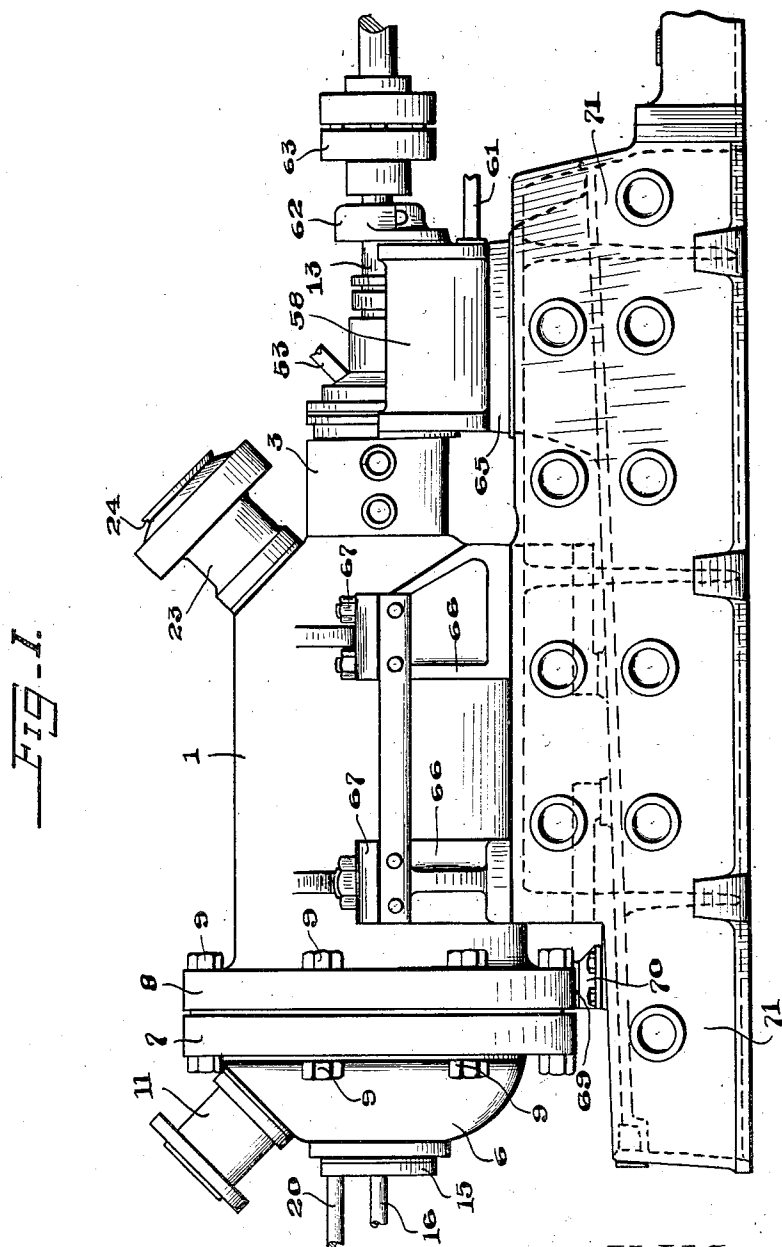
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1,837,873

CENTRIFUGAL PUMP

Filed Jan. 25, 1928

5 Sheets-Sheet 1



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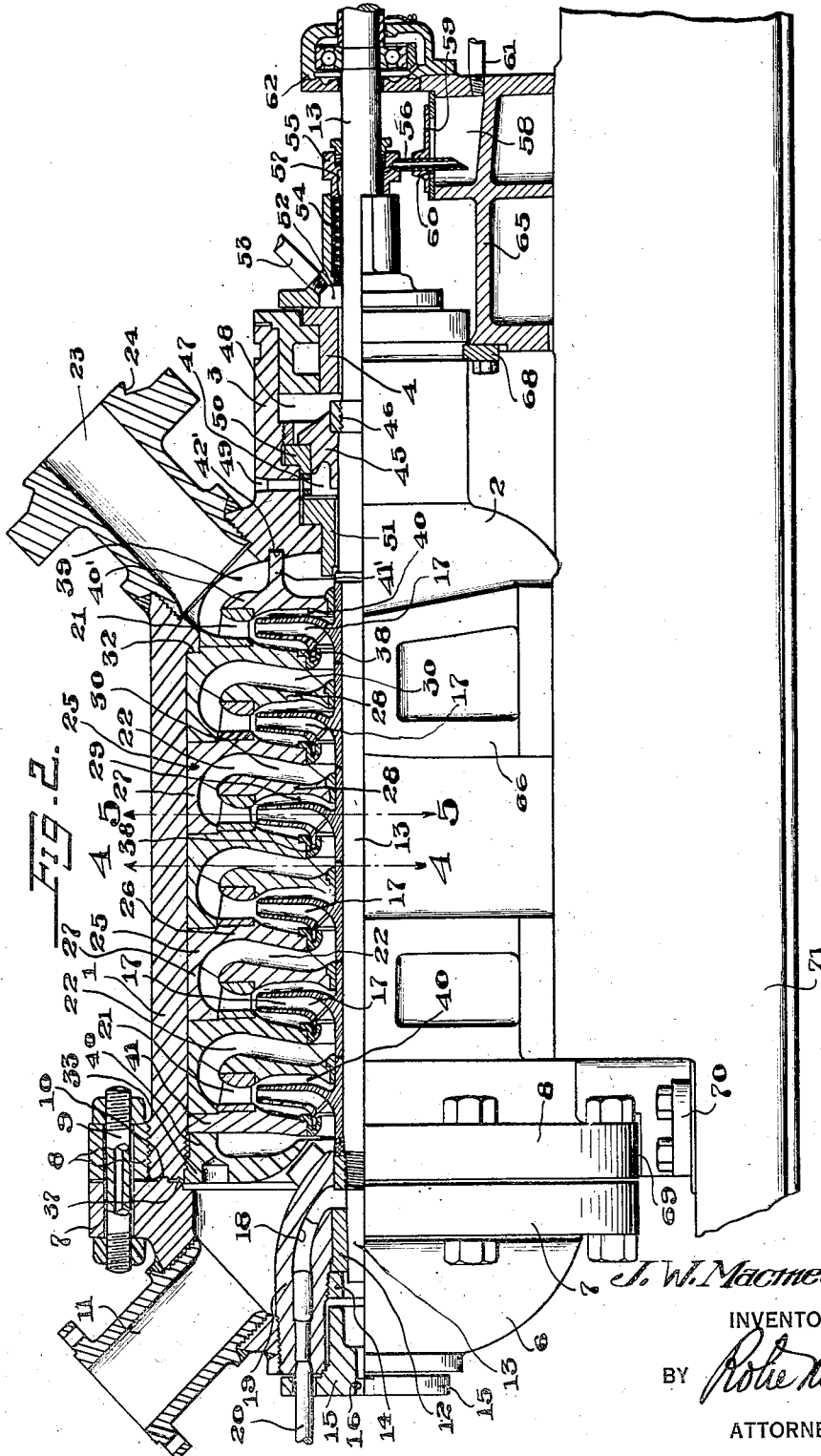
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5 Sheets-Sheet 2



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Fig. 4.

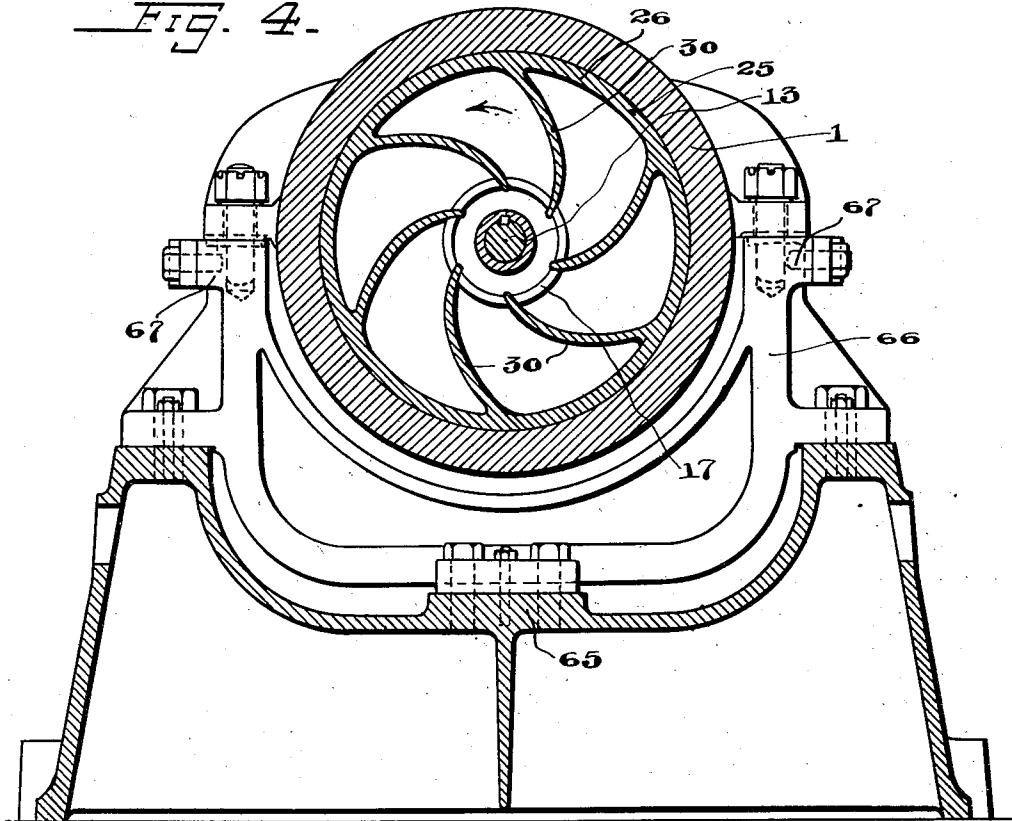
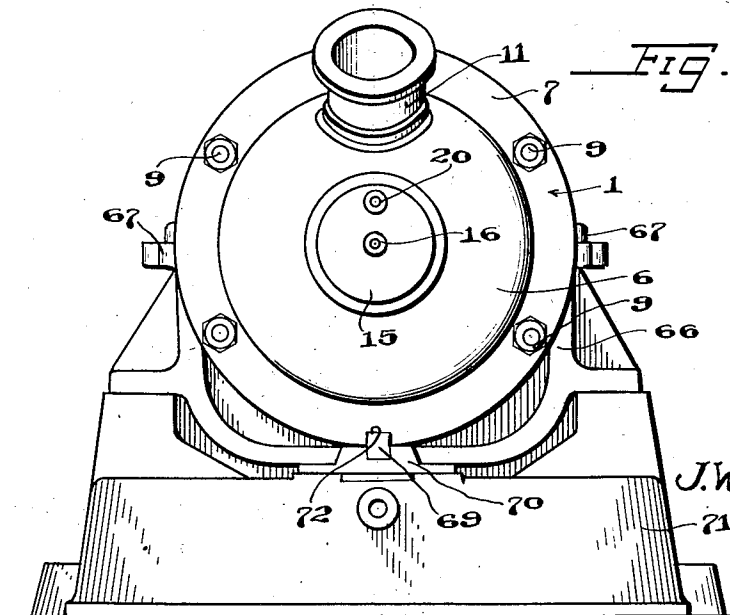


Fig. 3.



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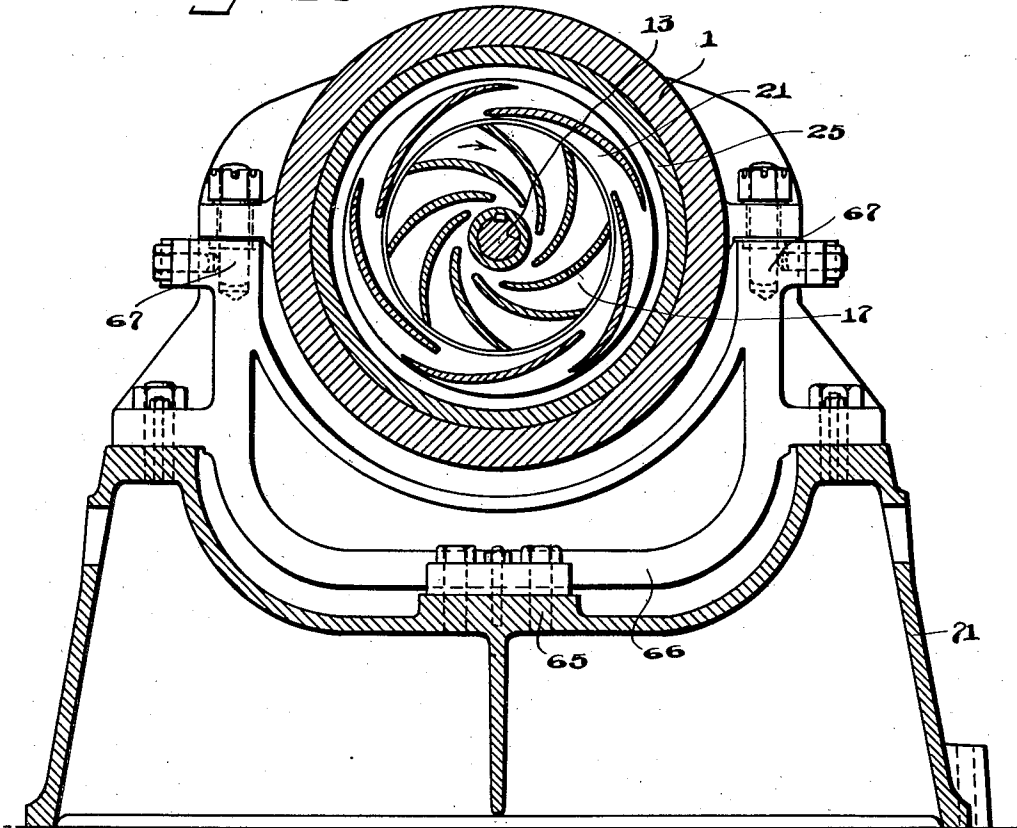
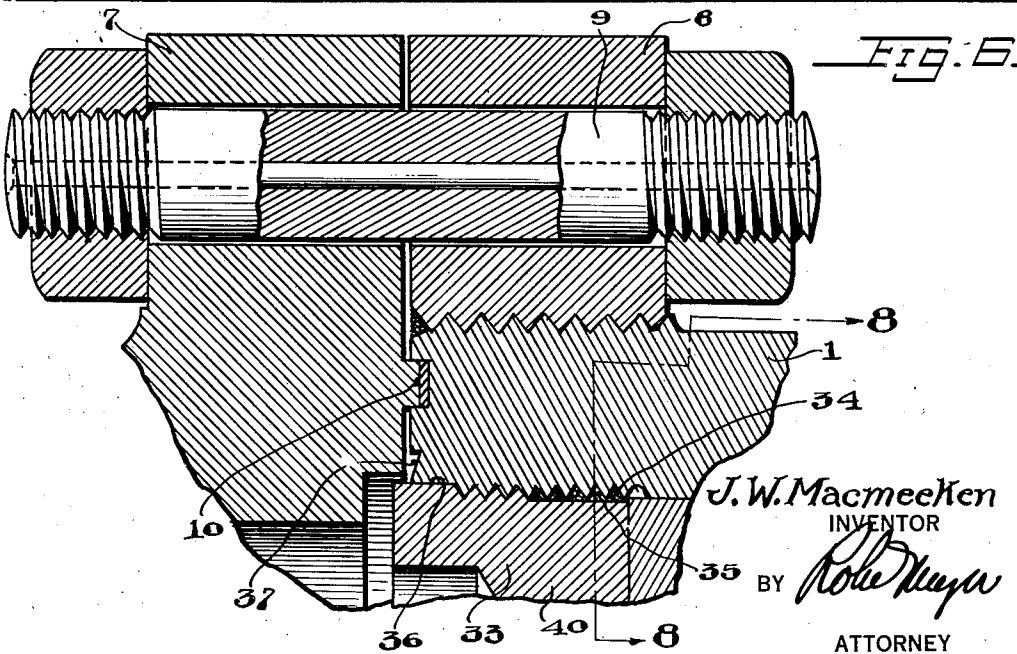
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FIG. 5.



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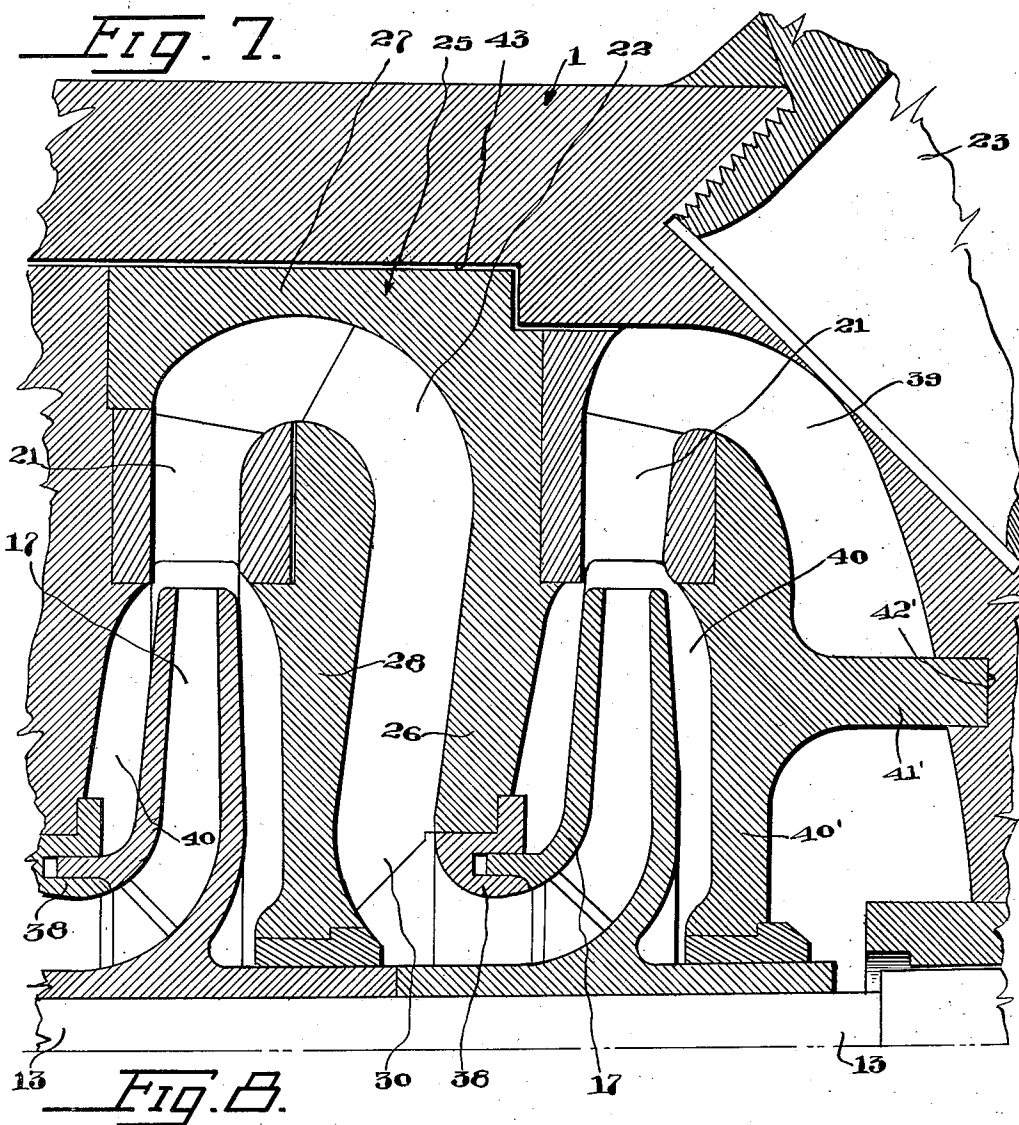
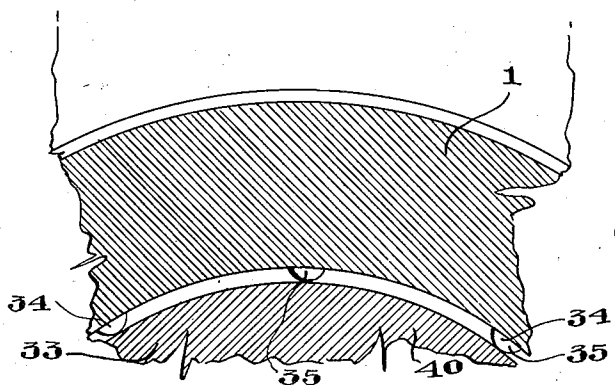
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CENTRIFUGAL PUMP

Application filed January 25, 1928. Serial No. 249,233.

This invention relates to centrifugal pumps, and more particularly to a high pressure centrifugal pump for pumping hot liquids.

5 An object of the invention is to provide a multi-stage centrifugal pump, capable of generating high pressures, which pump will have relatively high efficiency and long life and one which is capable of handling hot
10 fluids, such as oil in a refinery, under the temperature variances contingent with such work, in an efficient, reliable manner, reducing to a minimum stoppages for repairs, replacement, etc., and liability of leakage of
15 hot fluid to atmosphere, and a pump which embodies novel features for balancing the thrust of the pump, preventing stage to stage leakage, cooling the bearings, together with other novel and advantageous features, as
20 will be hereinafter pointed out.

In high pressure centrifugal pumps, especially those handling hot liquids, it is particularly advantageous to reduce to a minimum, joints in the pump structure which are
25 subjected to the discharge pressure of the pump, and the present invention, comprises a pump in which there are no high pressure joints, or joints which are subjected to the discharge pressure, provision being made
30 that the only pressure joint in the pump structure is subjected only to suction pressure, and a thrust head is provided at the suction end of the pump to absorb the pressure load of the diffusion rings and fluid passage forming diaphragms of the pump.

35 Pumps employed for pumping hot liquids are subjected to expansion and contraction due to temperature variances, and to prevent such contraction and expansion from affecting the alignment of the pump, with the resultant disadvantages, excessive wear, etc., provision is made to permit the pump to move
40 under expansion and contraction action in a direction parallel to the axis of the pump and prevent movement in a direction transversely of the axis; also the fluid passage forming diaphragms have a clearance from the inside surface of the casing, so that rising
45 temperatures will not expand the diaphragm tight against the casing. This clearance al-

lows full discharge pressure to exist inside the casing all the way from the discharge end of the thrust head at the suction end of the pump, which results in the pressure differential between the inside and the outside of
55 the fluid passage forming diaphragms being always at least one stage less than the discharge pressure of the pump, while the full discharge pressure of the pump is available for pressing the diaphragm together in an
60 axial direction, to prevent inter-stage leakage.

The invention further comprehends the provision of novel means for balancing the thrust of the pump, such means embodying a
65 high and a low pressure chamber associated with a balancing disc in such manner that the pressure difference between the chambers acting on the disc area will balance the thrust of the pump, while the fluid leaking from the
70 low pressure chamber will serve to lubricate one of the bearings of the pump.

Another object of the invention is to provide a high pressure centrifugal pump designed so that it may be readily dismantled
75 for inspection or repair without disturbing the prime mover of the pump, the high pressure flanged or welded joint between the discharge of the pump and the outlet pipe, or the alignment of the pump relative to the
80 prime mover.

With these objects in view, the invention consists in various features of construction and combination of parts, which will be first
85 described in connection with the accompanying drawings, showing a 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,

Fig. 1 is a side elevation of the improved pump.

Fig. 2 is a view partly in longitudinal section and partly in elevation of the pump.

Fig. 3 is an end view of the pump.

Fig. 4 is a cross section through the pump taken on the line 4—4 of Fig. 2.

Fig. 5 is a cross section through the pump taken on line 5—5 of Fig. 2.

Fig. 6 is an enlarged detailed section of a part of the pump.

Fig. 7 is an enlarged fragmentary, longitudinal section of the pump illustrating the clearance space between the fluid passage forming diaphragms and the casing, and

Fig. 8 is a detailed section on the line 8—8 of Fig. 6.

Referring more particularly to the drawings, the improved centrifugal pump is preferably designed for pumping hot fluids, such as hot oil in distilleries or refineries, and it is a multi-stage centrifugal pump, conceived to meet the requirements of installations in which the pressure to be generated is higher than can be obtained at available speeds of prime movers with a single stage pump and where the pressure is so high that peripheral speed of the impellers would result in too high stresses in the material if the head had to be generated in a single impeller, and it is well known that within certain limits the efficiency of a centrifugal pump increases as the number of stages employed to generate the pressure increases.

The pump includes a solid cylindrical casing 1 which is formed of any suitable material, of one piece, and has a substantially semi-spherical end 2 at the discharge part of the pump. The substantially semi-spherical end 2 is continued in an axial cylindrical barrel 3 of smaller diameter than the main part of the casing. The cylinder 3 forms the housing for the bearing 4 and for the balancing elements which will be hereinafter more fully described. The forward or suction end of the casing 1 is open to the full diameter of the bore of the pump so as to permit the insertion into the casing of the various elements which make up the hurling and fluid guiding members of the pump.

The open suction end of the casing is closed by a suction head 6 which is attached to the cylindrical casing 1 by means of flanges 7 and 8 and the bolts 9. In Fig. 1 of the drawings, the flange 8 is shown as formed of a separate part and attached to the casing 1, however this flange may be formed on the casing if desired, without departing from the spirit of the invention. The suction head 6 and the casing 1 are held in alignment by a tongue and groove joint 10 and their connection may be made hydraulically tight by suitable gaskets.

It will be noted that the joint between the suction head 6 and the casing 1 is the only joint in the pump casing and that this joint is so located that it will be under the suction pressure of the pump only, thereby providing a pump free from joints which are subjected to the high discharge pressure of the pump.

A suction pipe 11 is attached to the suction head 6 in any suitable fluid tight manner and the forward or suction end bearing

12 for the shaft 13 of the pump is mounted in the suction head. The usual type of bearing collar 14 is mounted at the outer end of the bearing 12 while an end play permitting member 15, is mounted in the suction head outwardly of the end of the shaft 13. The member 15 is provided with an inlet opening 16 through which cool oil for lubricating the bearing is introduced. The cool oil passing through the entrance 16 flows through the bearing 12 towards the impellers 17 of the pump and into an annular passage 18 formed in the bearing supporting casting 19 and out through the pipe 20, and thus the bearing is lubricated by cool lubricating oil and is separated and protected from the hot fluid being pumped. Any vapour generated by the vapourizing of volatile elements of the cool lubricating oil may pass out through the outlet pipe 20 without passing to the entrance of the first impeller 17 of the series of impellers in the pump, thereby eliminating liability of the pump becoming vapour bound.

The hurling and fluid guiding members of the pump include the impellers 17 which may be of any approved construction necessary for the proper pumping of the fluid and they have associated therewith the usual type of sealing rings 38. The impellers 17 are mounted on the shaft 13 for rotation thereby, and each of these propellers discharge through a diffusion ring 21 with or without vanes, and through the fluid guiding passage-way 22 to the suction of the next succeeding impeller or stage of the pump, with the exception of the final or last stage of the pump which discharges from the diffusion ring 21 through the discharge chamber 39 and discharge outlet pipe 23. The discharge outlet pipe 23 is attached in fluid tight connection with the casing 1 and has a high pressure flanged joint 24 on its outer end for connection with the pipe through which the fluid is pumped.

The fluid guiding passages 22 are formed in the fluid passage forming diaphragms 25 and these diaphragms comprise the radial portions 26 and the peripheral portions 27, the perimeters of which face the inner surfaces of the casing, while the outer edges of the peripheral portions abut the adjacent surface of the radial portion of the diaphragm next thereto, thereby providing in effect, an inner casing for the pump which is made up of the various fluid passage forming diaphragms 25. In Fig. 2 of the drawings, the diaphragms are shown as formed of one piece, including besides the radial portions 26 and the peripheral portions 27, the inner or tongue like portions 28 which define one wall of the fluid passages and one wall of the impeller chambers 29. However, if it is so desired, the inner or tongue like portions 28 may be made as a separate piece from the radial and

peripheral portions 27, without departing from the spirit of the invention. The inner portions 28 and the radial portions 26 are maintained in proper spaced relation by spiral ribs 30 which spiral inwardly towards the axis of the pump and towards the suction end of the pump. These ribs 30 are spiral shaped to eliminate danger of cracking of the ribs during temperature variances, as, if the ribs were purely radial, they would be subjected to greater strains upon expansion and contraction under temperature variances and the danger of their cracking or breaking would be greatly increased.

The diaphragms 25 are held tightly against each other and forced against the shoulder 32 formed near the discharge end of the casing 1 by a thrust head 33 in the suction end of the casing. The thrust head 33 is threaded or screwed into the casing 1 by screw threads 34 of appropriate dimensions, and while these screw joints need not necessarily be tight and without leakage, leakage under pressure may be prevented or reduced to a minimum by packing the thread with graphite or similar material under pressure, introduced into the grooves 35 of the thread. The grooves 35 are cut transversely of the thread, as clearly shown in Fig. 6 of the drawings, and they also serve for clearance spaces to facilitate cleaning of the packing from the threads in case of dismantling of the pump.

The thrust head 33 has in addition to its screw threaded surface, a smooth portion 36 which has smooth tight fit with the corresponding portion of the casing 1. If desired to make a tight fit between the casing and the thrust head 33, a portion of the casing at its end may be upset by the use of a caulking tool applied as indicated at 37.

The inner side of the peripheral flange 40 of the thrust head 33, presses tightly against the first diaphragm 41 of the series. This diaphragm 41 differs from the other diaphragms 25 in that it does not have the overhanging peripheral portion 27, this part being unnecessary as the diaphragm forms only the suction side of the impeller chamber 40 of the first or suction stage of the pump and sufficient surface for carrying the first diffusion ring 21 and for abutment thereagainst of the adjacent edge of the peripheral portion 27 of the first of the diaphragms 25.

The final or discharge end diaphragm 40 has an annular rib 41' thereon which fits into a groove 42' in the casing 1.

A slight clearance as shown at 43 in Fig. 7 of the drawings is provided between the outer perimeters of the peripheral sections 27 of the diaphragms 25, from the inside or inner surface of the casing 1, so that rising temperatures in the pump will not expand the diaphragms tightly against the casing. This clearance also allows full discharge pressure to exist inside the casing all the way from the

discharge end of the pump to the threaded joint or connection between the pressure head 33 and the casing 1. This results in the differential pressure between the inside and outside of the diaphragms 25, being always at least one stage less than the discharge pressure, while full discharge pressure or the pressure under which the fluid is finally discharged from the pump, is available and serves to press the diaphragms 25 together in an axial direction in order to prevent inter-stage leakage.

The cylindrical extension 3 which is formed on the casing 1 has a balancing disc 45 positioned therein which is mounted on the shaft 13 and is held in place by a threaded collar 46. The balancing disc 45 divides the interior of the extension 3 into a high pressure chamber 47 and a low pressure chamber 48. Cool oil or other liquid is introduced, under a pressure equal to or greater than the discharge pressure of the pump, into the high pressure chamber 47 through a suitable inlet 49. This cool oil escapes between the balancing disc 45 and its seat 50 into the low pressure chamber 48. The difference in pressure between the chambers 47 and 48 acting on the area of the balancing disc 45 will balance the thrust of the pump. A separating bushing 51 is mounted on the shaft 13 between the discharge chamber 39 of the pump and the high pressure chamber 47.

The cool oil in the low pressure chamber 48 passes through the bearing 4 into a second or still lower pressure chamber 52 from which it flows outwardly through a suitable outlet pipe 53. A stuffing box 54 of approved construction, is provided about the shaft 13 outwardly of the second low pressure chamber 52 and part of the cool oil will pass through the stuffing box 54, and into the gland 55 thereof.

A drain pipe 56 is connected to the oil receiving chamber 57 in the gland 55 and it extends into a suitable chamber 58 provided for receiving the oil leaking into the gland 55. The chamber 58 has a moveable cover 59 forming a closure for its mouth or receiving opening 60. The pipe 56 is connected to the cover 59 so that proper connection between the pipe 56 and the chamber 58 will be maintained under adjustment of the gland 55. A suitable outlet pipe 61 is provided for the chamber 58.

An external bearing 62 is shown in the drawings, and this bearing is optional and may be used to carry the load of the coupling 63 which is provided for connecting the pump to its prime mover. The bearing 62 may also be used to prevent the balancing disc 45 and the shaft 13 from travelling too far when the pump is adjusting itself to conditions of operation.

The variances in the temperature due to the pumping of hot oil or analogous fluid

will cause expansion and contraction of the pump which, if proper provision were not made to prevent it, would cause misalignment of the pump parts, which would result in serious impairment of the operation of the pump and materially reduce its life. To prevent such misalignment, the pump is held in alignment under temperature variances by supports 65 and 66 which latter are attached to the casing 1 at the horizontal centre line of the shaft 13 in any approved manner as shown at 67, and by a fixed ring 68. A key 69 is provided which is carried by a support 70 from the bed plate 71 of the pump. The key 69 engages in a groove 72 formed in the flange 8 and it acts to prevent turning or lateral movement of the pump casing and stationary parts with respect to the shaft 13, this construction being similar to the construction disclosed and claimed in my companion application filed September 29th, 1927, Serial Number 222,757. If it is so desired, any other approved means may be provided to prevent lateral or twisting movement of the pump casing and stationary parts, with respect to the shaft 13, under temperature variances, without departing from the spirit of this invention.

By removal of the coupling 63 and bearing 62, the pump may be dismantled for inspection or repairs without disturbing the prime mover (not shown), or the high pressure flanged joint 24, or the alignment of the pump relative to the prime mover. The bearing 4, balancing disc 45 and seat 50 may be readily removed from the discharge end of the pump for inspection or repair of these parts and the suction head 6 may be removed to expose the thrust head 33 which may be unscrewed and removed at which time the entire interior of the pump, both the rotary and stationary elements may be withdrawn from the suction end of the pump for the purpose of inspection, replacing or repair.

From the foregoing description, taken in connection with the accompanying drawings, it will be apparent that a multi-stage pump has been provided which is particularly applicable for the pumping of hot fluids under high pressures and it is also to 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. A multi-stage centrifugal pump comprising a casing formed of two parts and having its only joint located so as to be free from discharge pressure of any stage of the pump, a plurality of fluid passage forming diaphragms in said casing and a thrust head adjacent to said casing joint for absorbing thrust from said diaphragms.

2. A multi-stage centrifugal pump, including a casing, fluid passage forming dia-

phragms in said casing and arranged whereby the thrust thereon will be towards the suction end of the pump, and a thrust head removably carried by said casing at its suction end for absorbing thrust from said diaphragms.

3. A multi-stage centrifugal pump including a casing having only one joint therein, said joint located so as to be subjected only to the lowest pressure within the pump, a plurality of fluid passage forming diaphragms in said casing, and a thrust head in the suction end of the casing for absorbing thrust from said diaphragms, said diaphragms and casing having a clearance space between their facing surfaces to permit expansion of the diaphragms.

4. A multi-stage centrifugal pump including a casing having only one joint therein, said joint located so as to be subjected only to the lowest pressure within the pump, a plurality of fluid passage forming diaphragms in said casing, a thrust head in the suction end of the casing for absorbing thrust from said diaphragms, one of said diaphragms and casing having a clearance space between their facing surfaces for receiving fluid under discharge pressure of the pump, whereby said diaphragms will be pressed together in an axial direction to prevent inter-stage leakage in the pump.

5. A multi-stage centrifugal pump including a casing, fluid passage forming diaphragms in said casing, said casing having a clearance space between the facing surfaces of one of said diaphragms and casing for receiving fluid under discharge pressure of the pump whereby said diaphragms will be pressed together in an axial direction to prevent inter-stage leakage in the pump, and a thrust head carried by the casing for absorbing thrust from said diaphragms.

6. A multi-stage centrifugal pump including a casing having only one joint therein, said joint located so as to be subjected only to the lowest pressure within the pump, an extension formed on said casing and having a high pressure chamber and a low pressure chamber therein, a balancing disc between said chambers, said high pressure chamber adapted to receive liquid under pressure equal to or greater than the discharge pressure of the pump, parts of which liquid leak past the disc into the low pressure chamber, whereby the differences of pressure between said chambers acting on said disc will balance the thrust of the pump, a shaft, a bearing for said shaft outwardly of said low pressure chamber, the fluid from said low pressure chamber adapted to leak to said bearing to lubricate it, a stuffing box about said shaft outwardly of said bearing and receiving leakage fluid from the bearing, a drain pipe for said stuffing box, a receptacle for receiving fluid from said drain pipe, and

a movable cover for said receptacle carried by said pipe and movable with movement of the stuffing box gland.

7. In a stuffing box, a gland, a drain pipe carried by the gland for draining fluid therefrom, a receptacle for receiving the fluid from the pipe, a movable cover for said receptacle, said pipe being connected to said cover whereby the cover will be moved in unison with movement of the gland.

8. In a multi-stage centrifugal pump, a casing, a plurality of fluid passage forming diaphragms in said casing, a thrust head in the suction end of the casing for absorbing thrust from said diaphragms, said diaphragms and casing having a clearance space between their facing surfaces to permit expansion of the diaphragms.

9. In a multi-stage centrifugal pump, a casing, fluid passage forming diaphragms in said casing and having their peripheries spaced from the casing to permit expansion of the diaphragms, the diaphragm at the discharge end of the pump spaced from the casing to provide a clearance chamber for receiving fluid under discharge pressure of the pump whereby the diaphragms will be pressed together in an axial direction to prevent inter-stage leakage in the pump.

10. In a multi-stage centrifugal pump, a casing, fluid passage forming diaphragms in said casing and having their peripheries spaced from the casing to permit expansion of the diaphragms, the diaphragm at the discharge end of the pump spaced from the casing to provide a clearance chamber for receiving fluid under discharge pressure of the pump whereby the diaphragms will be pressed together in an axial direction to prevent inter-stage leakage in the pump, and a thrust head carried by the casing at the suction end of the pump for absorbing thrust from said diaphragms.

11. In a centrifugal pump, a jointless casing open only at its suction end, a suction head attached to said casing whereby the casing will have its only joint subject to pressure of fluid in the pump located so as to be free from discharge pressure of any stage of the pump, a plurality of fluid passage forming diaphragms in the casing, means whereby the diaphragms will be pressed together in an axial direction towards the pump suction to prevent inter-stage leakage, and a thrust head between the first stage diaphragm and the casing joint.

12. In a centrifugal pump a jointless casing open only at its suction end, a suction head attached to said casing whereby the casing will have its only joint subject to pressure of fluid in the pump located so as to be free from discharge pressure of any stage of the pump, a plurality of fluid passage forming diaphragms in the casing, the diaphragm at the discharge end of the pump

spaced from the casing to provide a clearance chamber for receiving fluid under discharge pressure of the pump whereby the diaphragms will be pressed together in an axial direction to prevent inter-stage leakage in the pump.

13. In a centrifugal pump a jointless casing open only at its suction end, a suction head attached to said casing whereby the casing will have its only joint subject to pressure of fluid in the pump located so as to be free from discharge pressure of any stage of the pump, a plurality of fluid passage forming diaphragms in the casing, the diaphragm at the discharge end of the pump spaced from the casing to provide a clearance chamber for receiving fluid under discharge pressure of the pump whereby the diaphragms will be pressed together in an axial direction to prevent inter-stage leakage in the pump, and a thrust head between the first stage diaphragm and the casing joint.

14. In a centrifugal pump, a jointless casing open only at its suction end, a suction head attached to the casing whereby the casing will have its only joint subject to pressure of fluid in the pump located so as to be free from discharge pressure of any stage of the pump, and means carried by the casing and sealing the joint from the interior of the casing inwardly of the pump suction.

15. In a centrifugal pump, a jointless casing open only at its suction end, a suction head attached to the casing whereby the casing will have its only joint subject to pressure of fluid in the pump located so as to be free from discharge pressure of any stage of the pump, a plurality of fluid passage forming diaphragms in the casing, and means carried by the casing between the first stage diaphragm and the casing joint for sealing the joint from the interior of the casing.

16. In a multiple stage centrifugal pump, a casing having only one joint therein, said joint located so as to be subjected to the lowest pressure within the pump, fluid passage forming diaphragms in said casing arranged whereby the thrust thereon will be toward said joint, and a thrust head removably carried by said casing adjacent to said joint for absorbing thrust from said diaphragms.

In testimony whereof I affix my signature.
JOHN W. MACMEEKEN.