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CENTRIFUGAL MACHINE CASING

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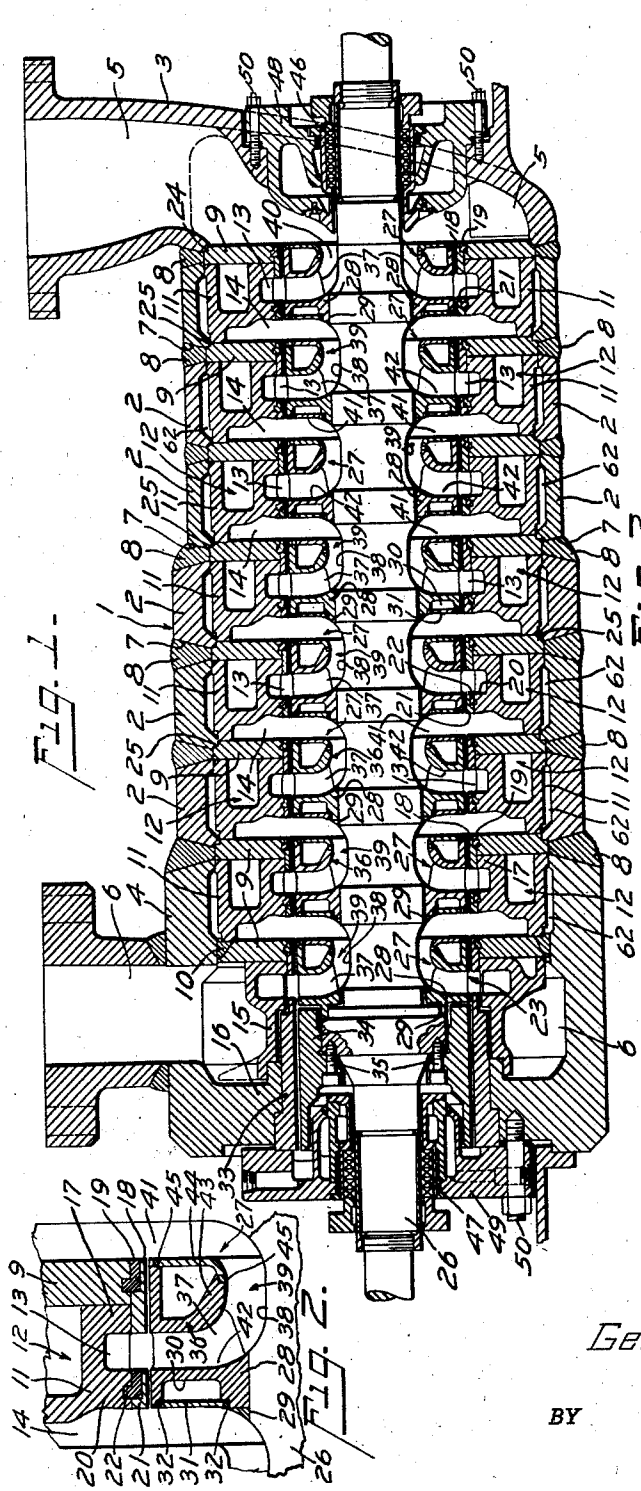


FIG. 1.

FIG. 2.

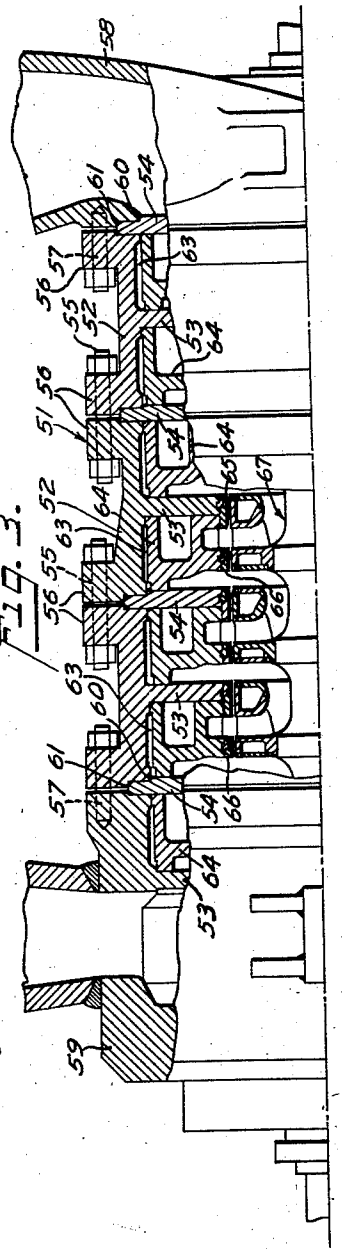


FIG. 3.

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CENTRIFUGAL MACHINE CASING

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11 Claims. (Cl. 103—108)

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This invention relates to centrifugal machines such as pumps, compressors, or the like, and more particularly to a casing structure for such machines.

An object of the present invention is to provide a casing of such design as to permit the use of forged parts so assembled and connected together as to perform efficiently under high temperature and pressure working conditions.

A further object is to provide a multistage casing which comprises an assembly of forged stage pieces or casing rings, in which the stage pieces are so designed as to facilitate assembly thereof, and in which the stage pieces are effectively connected together to withstand high temperatures and pressures.

With these and other objects in view, as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first described in connection with the accompanying drawings, showing a centrifugal machine casing of a 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 sectional view of a centrifugal machine in accordance with the present invention, the rotor of which is partly shown in elevation.

Figure 2 is an enlarged sectional view of a portion of the casing and the rotor.

Figure 3 is a longitudinal sectional view of a portion of a modified form of casing structure, wherein the stage pieces are bolted together in contradistinction to the welded construction of Figure 1.

Referring more particularly to the drawings, the improved casing 1 of the multistage centrifugal pump shown in Figure 1 comprises a plurality of forged steel stage pieces or casing rings 2, an inlet end piece or section 3, and an outlet end piece or section 4. The pieces 2 are of annular contour and arranged in co-axial relationship one with the other. A fluid inlet passage 5 is provided in the end piece 3, and a fluid discharge passage 6 is provided in the end piece 4. All the pieces 2, 3, and 4 are spaced apart in an axial direction to provide troughs 7 for the reception of circumferentially extending welds 8, which connect the pieces into a unitary casing structure devoid of either vertically or horizontally separable sections or halves. The bottoms of the troughs 7 comprise peripheral faces of fluid passage defining walls 9.

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The walls 9 comprise steel forgings of washer-like contour, all of which have a common outside diameter and a common inside diameter. One of the walls 9 is secured inside the end piece 4 by a weld 10, and the remaining walls lie substantially in the planes of the respective welds 8 and comprise fixed parts of the casing 1 by reason of the welds 8. Between the walls 9 are arranged diffusion rings 11, the diffusion rings having end engagement with the walls 9, peripheral engagement with the stage pieces 2, and being shaped for co-action with the walls 9 to provide stage fluid passages 12, each of the latter having a fluid inlet 13 and a fluid outlet 14. The last stage diffusion ring 15 is interposed between the last stage wall 9 and the end structure 16 of the outlet end piece 4, and within the discharge passage 6.

Each of the diffusion rings 11 and the diffusion ring 15 has an annular wall 17 lying face to face with one of the walls 9, and the inside diameter of the walls 17 is the same as the inside diameter of the walls 9. Wearing rings 18 are pressed into the openings defined by the engaging walls 9 and 17 and are anchored by locking rings 19 associated with the walls 9. All the wearing rings 18 are of the same inside diameter. The diffusion rings 11 also include annular walls 20 which separate the inlets 13 from the outlets 14 and which carry wearing rings 21 of the same inside diameter as the wearing rings 18. Locking rings 22 anchor the wearing rings 21 to the walls 20. It will thus be seen that the wearing rings 18 and 21 define the smallest inside diameter of the casing 1, this inside diameter being uniform throughout the axial length of the casing, and providing a chamber for the rotor 23.

The first stage wall 9 has annular shouldered engagement at 24 with the inlet end piece 3, and the remaining walls 9, with the exception of the wall 9 inside the outlet end piece 4, have annular shouldered engagement at 25 with the pieces 2. Such annular shouldering provides means for accurately positioning the parts in true co-axial relationship with convenience. Exact stage distances are assured by pre-machining the individual stage pieces 2 before welding, and the piece by piece construction of the casing facilitates cleaning of the fluid passages. The individual stage pieces 2 may be produced in large quantities and kept in stock cleaned, pre-machined, and ready for assembly. The stage pieces 2 may be made in different radial thicknesses to meet different pressure conditions in the pump, the greatest thickness being at the discharge end of the casing 1, as shown in the drawing. Final ma-

chining of the casing is done after it has been welded together.

The rotor 23 includes a shaft 26 to which impellers 27 are fixedly and permanently attached. Each impeller 27 comprises an annular side wall or disc 28 which is co-axial with and welded at 29 to the shaft 26. With the exception of the last stage wall 28, each of the remaining walls is provided with a circumferentially extending groove 30 in one side face, which groove is covered by a ring-like plate 31 made secure by welding 32. This provides a hollow wall structure which is light in weight, in addition to requiring less material. All the walls 28 are of the same outside diameter, and each, with the exception of the last stage wall, lies in the plane of one of the wearing rings 21.

Running clearances are provided between the wearing rings 21 and the peripheral or wearing faces of the walls 28, with the exception that the peripheral or wearing face of the last stage wall 28 has running clearance with a balancing drum 33 attached to the outlet end piece 4. The balancing drum 33 has the same inside diameter as the wearing rings 18 and 21 and is of considerable length, since it is located at the discharge end of the casing 1. A balancing drum head 34 is bolted at 35 to the shaft 26 and operates inside the balancing drum 33. The balancing drum head 34 is of the same outside diameter as the walls 28, and is also of substantially the same length as the balancing drum 33.

Between the walls 28 are arranged annular rings 36 which are coaxial with the shaft 26. Outward flow fluid impinging vanes 37 fixedly relate the annular rings 36 to their respective walls 28, so that each impeller 27 is made up of one wall 28, one annular ring 36, and the outward flow fluid impinging vanes 37 which connect the two parts into a unitary structure. The shaft 26 is undercut by circumferential grooves 38 located between the walls 28, and the annular rings 36 are so contoured and co-act with the side faces of the walls 28 and the faces of the grooves 38 as to provide fluid passages 39 generally U-shaped in cross-section. The inlet eye 40 of the pump has communication with the inlet passage 5.

Each fluid passage 39 extends circumferentially of the axis of the rotor 23, and the legs 41 and 42 of the fluid passages comprise fluid inlets and fluid outlets which communicate with the outlets 14 and inlets 13, respectively, of the casing fluid passages 12. Both the fluid inlets 41 and the fluid outlets 42 extend 360° about the rotor 23 and open outwardly through the annular perimeter thereof. All the annular rings 36 are of the same outside diameter as the walls 28, and are arranged in the planes of the wearing rings 18. The peripheral or wearing faces of the annular rings 36 are, therefor, arranged in operative relationship with the wearing rings 18.

The annular rings 36 include body portions 43 which are generally channel-shaped in cross-section, and annular plates 44 which are welded at 45 to the portions 43, thus the annular rings 36 also are hollow along the lines of the walls 28. The shaft 26 extends through stuffing boxes 46 and 47 which are carried by end covers 48 and 49, the latter being respectively bolted at 50 to the sections 3 and 4. The shaft 26 extends beyond the stuffing boxes 46 and 47 and may be supported in the usual line and thrust bearings (not shown).

Figure 3 illustrates a multistage pump casing 51 wherein the forged steel casing rings or stage pieces 52 differ from the pieces 2 of Figure 1. In Figure 3, the annular pieces 52 are made in two-stage lengths, and each provided with an integral wall 53. Thus the walls 53 are axially spaced two stages apart, and second forged steel walls 54 are arranged alternately between the walls 53, so that the successive walls 53 and 54 are spaced one stage apart axially of the casing. Peripheral margins of the walls 54 are clamped between the ends of the stage pieces 52 and the end pieces 58 and 59, the stage pieces being secured into a unitary structure by bolts 55 passing through flanges 56 on the stage pieces. The endmost stage pieces 52 are bolted at 57 to respective inlet and outlet end pieces or sections 58 and 59 corresponding to the end pieces 3 and 4 of Figure 1. Annular shoulders 60 are formed on the side faces of walls 54 to engage the inside faces of the pieces 52 and 58, and the peripheral faces of the pieces 52 lie in engagement with annular shoulders 61 on all the pieces 52, 58, and 59, so that all the pieces are thereby positioned in true co-axial alignment. Such shouldered engagement, in both forms of Figures 1 and 3, also provides a strong casing, one in which the annular stage pieces and the end pieces are effectively restrained against relative radial displacement.

Since the walls 53 and 54 are spaced one stage apart, the interior contour of the pump casing 51 is identical with that of Figure 1. Accordingly, the stage pieces 2 and the end piece 4 in Figure 1, and the stage pieces 52, the end piece 59, and the walls 53 and 54 of Figure 3 co-operate to provide circumferentially extending stage chambers 62 and 63, respectively, which are generally U-shaped in cross-section and opening inwardly for communication with the rotor chamber. The diffusion rings 11 of Figure 1 are contained in the chambers 62, while diffusion rings 64 are contained in the chambers 63 of Figure 3.

In Figure 3, the diffusion rings 63 and the walls 54 carry wearing rings 65 identical with the wearing rings 18, and the diffusion rings 63 carry wearing rings 66 identical with the wearing rings 21. A rotor 67 is contained in the casing 51, which rotor is identical with the rotor 23 of Figure 1. In both forms of Figures 1 and 3, the rotors 23 and 67 are axially removable intact from their respective casings 1 and 51 by merely detaching one or both end covers of the casing. Since no horizontal split is necessary to remove the rotor from the casing, both forms avoid the weakness of either the horizontally split or vertically split casing designs, particularly with respect to the objectionable leakage characteristics of the split type of casing of present day pump designs.

Both forms of casing are so designed as to facilitate construction of the casing from steel forgings, and the casing structure is a durable one, capable of withstanding heavy duty service under high temperature and pressure working conditions. Obviously, the casing pieces and the washer-like walls may comprise material other than steel forgings and both forms of the invention may be easily adapted to other types of centrifugal machines, such as compressors, turbines, or the like, without departing from the spirit of the present invention.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be

widely modified within the invention defined by the claims.

What is claimed is:

1. In a centrifugal multistage machine such as a pump, compressor, or turbine, the combination of a casing having a rotor chamber and circumferentially extending stage chambers opening into the rotor chamber, diffusers in said stage chambers and co-acting therewith to provide stage fluid passages having inlets and outlets communicating with the rotor chamber, a rotor in said rotor chamber and having stage impellers arranged in operative relationship with said inlets and said outlets; said impellers comprising channeled discs, channeled rings and fluid deflecting vanes connecting the rings with the respective discs, plates welded to said discs to close the channels therein to provide hollows in the discs, and plates welded to said rings to close the channels therein to provide hollows in said rings.

2. In a multi-stage centrifugal machine such as a pump, compressor, or turbine, a casing composed of an inlet end piece and an outlet end piece, and a plurality of intermediate annular ring pieces arranged in axial relation one to the other and having their facing edges spaced apart to form annular troughs, stage defining walls composed of flat rings having their perimeter located to close the inner sides of said annular troughs, and welds in said troughs to join said annular ring pieces, end pieces and stage defining rings into a unitary structure.

3. The invention as claimed in claim 2 wherein said annular ring pieces and said stage defining rings have shouldered engagement one with the other to insure proper axial aligned engagement thereof.

4. The invention as claimed in claim 2 wherein the diffuser rings are placed between each contiguous pair of stage defining rings, wearing rings covering the inner walls of said diffuser rings and said stage defining rings and spanning the joints between the diffuser rings and the stage defining rings, and locking rings locking said wearing rings to said diffuser rings and to said stage forming rings.

5. In a multi-stage centrifugal machine such as a pump, compressor, or turbine, a casing composed of an inlet end piece and an outlet end piece, and a plurality of intermediate annular ring pieces arranged in axial relation one to the other and having their facing edges spaced apart to form annular troughs, stage defining walls composed of flat rings having their perimeter located to close the inner sides of said annular troughs, and welds in said troughs to join said annular ring pieces, end pieces and stage defining rings into a unitary structure, said casing having a rotor chamber therein, a rotor in said rotor chamber and including a plurality of stage impellers, each of said impellers comprising channeled discs, channeled rings, and fluid deflecting vanes connecting the rings with the respective discs, plates welded to said discs to close the channels therein to provide hollows in the discs, and plates welded to said rings to close the channels therein to provide hollows in said rings.

6. The invention as claimed in claim 5 wherein diffuser rings are placed between each contiguous pair of stage defining rings, wearing rings, covering the inner walls of said diffusion rings, said stage definings and spanning the joints between the diffusion rings and the stage defining rings, and locking rings locking said wearing rings to said diffusion rings, and to said stage forming rings.

7. The invention as claimed in claim 2 wherein the facing sides of said annular rings and said end pieces are taped to provide weld receiving troughs of gradually decreasing cross-sectional area from their outer edges to their inner edges.

8. In a multi-stage centrifugal machine such as a pump, compressor or turbine, a casing composed of an inlet end piece, and an outlet end piece, and a plurality of intermediate annular ring pieces arranged in end to end axial aligning engagement, stage defining walls formed of flat rings joined to said annular ring pieces, said casing having a rotor chamber therein, a rotor in said rotor chambers including a plurality of stage impellers, each of said impellers comprising channeled discs, channel rings, and fluid deflecting vanes connecting the rings with their respected discs, plates welded to said discs to close the channels therein to provide hollows within the discs and plates welded to said rings to close the channels therein to provide hollows in said rings.

9. The invention as claimed in claim 8 wherein certain of said stage defining rings have shouldered engagement with said certain annular ring pieces to insure proper axial aligning engagement when assembled.

10. In a multi-stage centrifugal machine such as a pump, compressor, or turbine, a casing composed of an inlet end piece, an outlet end piece, and a plurality of intermediate annular ring pieces arranged in end to end axial aligning arrangement, stage defining walls formed of flat rings joined to said annular ring pieces, diffusion rings placed between each contiguous pair of stage defining rings, wearing rings covering the inner walls of said diffusion rings and said stage defining rings and spanning the joints between the diffusion rings and the stage defining rings, and locking rings locking said wearing rings to said diffusion rings and to said stage forming rings.

11. The invention as claimed in claim 8 wherein certain of said stage defining rings have reduced annular portions at their perimeters, said annular ring pieces provided with recesses in their facing sides into which said reduced annular portions of said stage forming rings extend.

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