Aug. 28, 1962 P. C. ZUMBUSCH 3,051,090

SEGMENTED CASING FOR MULTISTAGE CENTRIFUGAL FLUID MACHINES

Filed Aug. 4, 1960 2 Sheets-Sheet 1

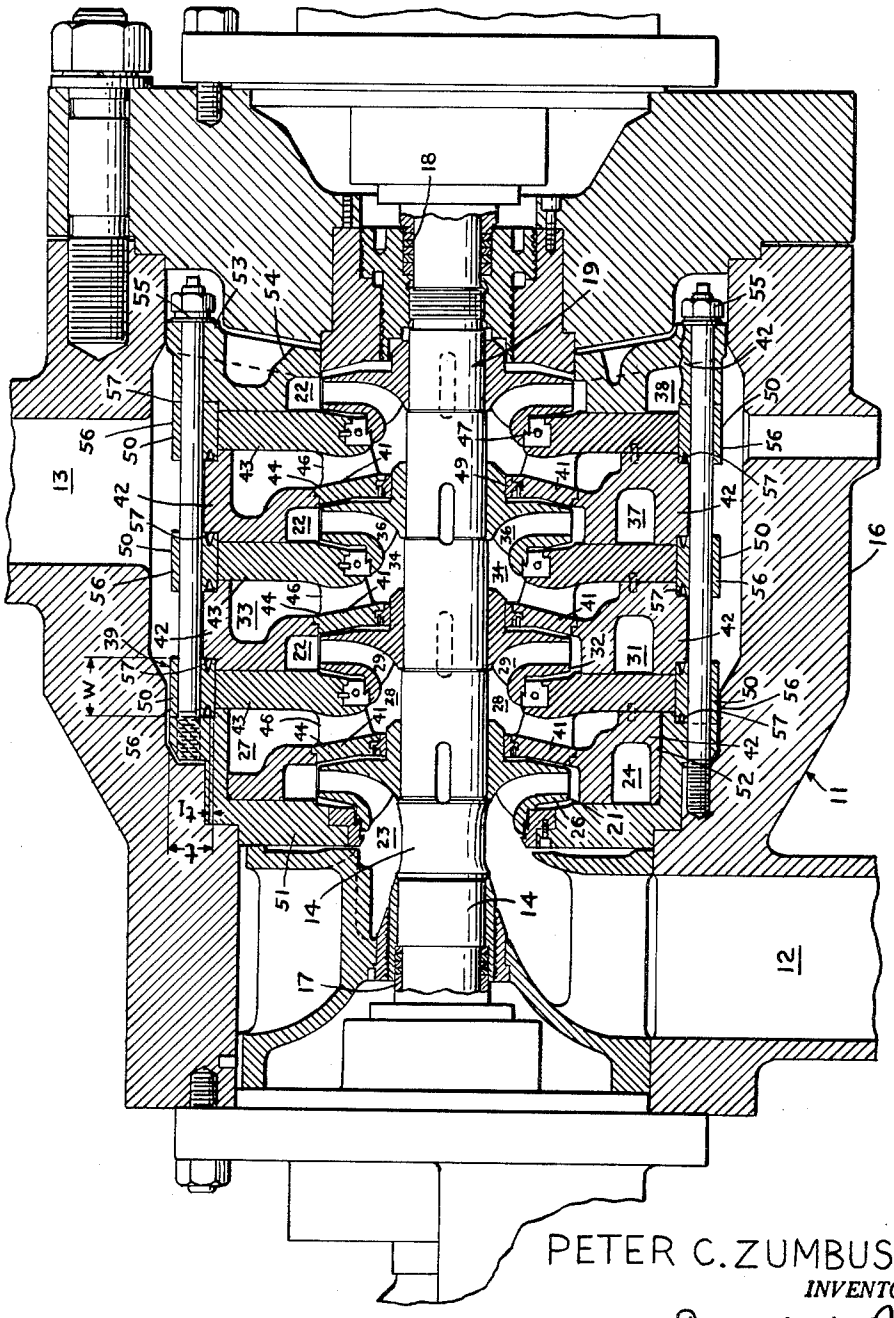


FIG. 1

PETER C. ZUMBUSCH
INVENTOR.
BY Daniel H. Bobis
atty.

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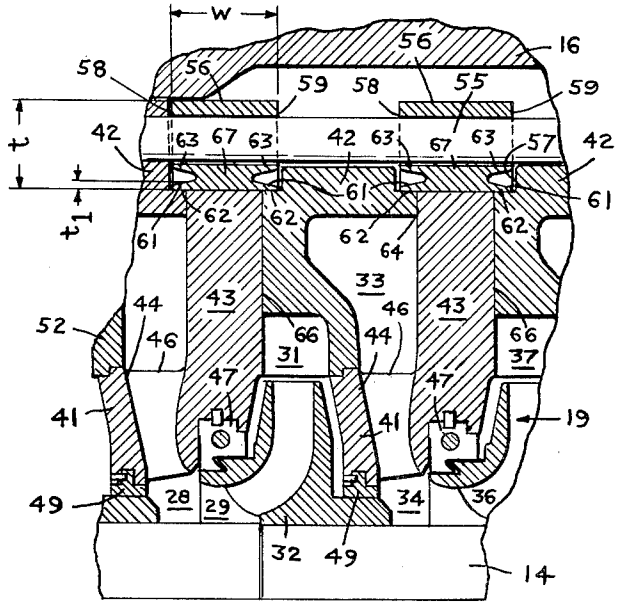


FIG. 2

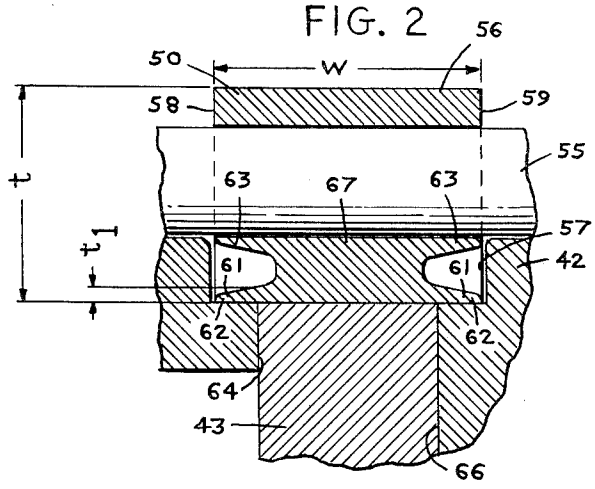


FIG. 3

PETER C. ZUMBUSCH
INVENTOR.

BY David H. Bobis
Atty.

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SEGMENTED CASING FOR MULTISTAGE CENTRIFUGAL FLUID MACHINES

Peter C. Zumbusch, Upper Montclair, N.J., assignor to Worthington Corporation, Harrison, N.J., a corporation of Delaware

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5 Claims. (Cl. 103—108)

This invention relates to centrifugal machines and more particularly to segmented casings for use in multistage pumps.

In multistage pump fabrication it is conventional practice to force fit and dynamically balance a plurality of impellers on a common shaft. Segmented members permit the assembly of an inner casing about the assembled and balanced rotor. The rotor and inner casing are then inserted as a unit into a housing or outer casing having a closure means at one end which serves as a bearing support for the inner casing.

The segmented members of the inner casings include interstage elements and volute defining shells. Each interstage element is formed by two components which are joined about the rotor to define interstage passages. The volute defining shells and the interstage elements nest alternately relative each other to form a plurality of fluid energizing chambers arranged in flow series.

The present invention is an annular means especially suited to be mounted about split interstage elements to hold segmented casing elements in assembled position.

Basically, this annular means serves as a clamp and offers improved longitudinal alignment for multistage centrifugal machine casings. It also facilitates the manufacture, inspection and repair of these machines.

These and other advantages will be seen more fully from the specification and claims viewed in conjunction with the accompanying drawings of a preferred embodiment of the device in which:

FIGURE 1 is a longitudinal section of a four-stage boiler feed pump embodying the present invention.

FIGURE 2 is an enlarged portion of part of the section shown in FIGURE 1.

FIGURE 3 is an enlarged section of the annular ring showing groove details.

The improved clamping device is particularly suited to assemble the casing of a multistage centrifugal fluid machine such as the four-stage centrifugal boiler feed pump 11 shown in the drawings which receives water in the suction inlet of the pump from upstream line 12, energizes it and discharges it through the discharge outlet to downstream line 13. The pump 11 comprises shaft 14 rotatably mounted in housing 16. Shaft 14 penetrates housing 16 via seals 17 and 18 and is operatively connected to a suitable driving means which is not shown. The shaft 14 has a plurality of impellers 21 mounted thereon in spaced relation and the shaft and impellers form the rotor generally designated 19.

Rotor 19 energizes fluid within centrifugal fluid energizing chambers 22 of the pump, which chambers are arranged in flow series. Fluid is received from upstream line 12 into first radial inflow means 23 of first chamber 24, is energized by first impeller 26 on shaft 14, passes around first volute 27 and out first discharge means 28. First discharge means 28 of first chamber 24 communicates with second radial inflow means 29 of second chamber 31 wherein the fluid is further energized by the action of second impeller 32, passes around second volute 33 and passes out second discharge means 34. Second discharge means 34 of second chamber 31 communicates with third radial inflow means 36 of third chamber 37. In like manner, the fluid traverses third chamber 37 and fourth chamber 38 and is expelled through the discharge outlet to downstream line 13.

The fluid energizing chambers are defined by a segmented inner casing generally designated 39 assembled about rotor 19 and inserted into housing 16. Inner casing 39 includes a plurality of interstage elements 41 and a plurality of one-piece volute complementing shells 42. The interstage elements 41 are split along a diameter thereby forming two superposed components which are substantially alike and are conveniently referred to as the interstage element 41. Longitudinally, the interstage elements include upstream partitions 43 and downstream or interstage partitions 44 joined by longitudinal struts 46. Interstage elements 41 are stationarily mounted about rotatable shaft 14. The volute complementing shells 42 nest alternately with interstage elements 41 to effect the closure of fluid energizing chambers 24, 31, 37 and 38. Bearings 47 for upstream partitions 43 and bearings 49 for downstream partitions 44 accommodate the turning of rotor 19.

To permit the assembly of inner casing 39 about rotor 19, interstage elements 41 when assembled extend radially outside impellers 21 so that volute complementing shells 42 may be made in one piece to be slipped longitudinally over rotor 19. Sealing of the fluid energizing chambers 24, 31, 37 and 38 is facilitated by the unitary fabrication of one piece volute complementing shells 42.

In the preferred form of the interstage elements 41 they are each transversely dividable along a diameter and are aligned and restrained by peripheral clamping. The upstream partitions 43 abut against shells 42. Downstream partitions 44 and shells 42 are restrained by an annular means 50 mounted about said interstage elements 41 to radially restrain the entire casing 39 assembly.

Inner casing 39 has an upstream holding member 51 which embraces first volute complementing shell 52 and downstream rim 53 integrally formed with last volute defining shell 54. Holding member 51 and rim 53 are connected by bolts 55 which pass through annular means 50 to draw the inner casing assembly into tight longitudinal fit.

Annular means 50 are deformable metal hoops 56 which fit into annular pockets 57 formed by interstage elements 41 and adjacent shells 42. Shrinkage of hoops 56 hold interstage elements 41 in assembled position. Hoops 56 are substantially uniform in overall thickness "*t*" along their hoop width "W." As is best seen in FIGURES 2 and 3, upstream end faces 58 and downstream end faces 59 are substantially normal to the longitudinal axis of shaft 14. Annular recesses shown as U-shaped grooves 61 define internal 62 and external 63 end cantilever lips around the hoops 56.

End faces 58 and 59 with internal and external cantilever lips 62 and 63 overlap joints 64 and 66. On the cooling of the shrink hoops 56, the internal end cantilevers 62 are more susceptible to radial strain than the intermediate section 67 of hoop 56. This is because of the lesser thickness t_1 of the internal lip than the overall "*t*" of hoop 56. The U-shape of the annular recess improves the bearing and stress distribution properties of shrink hoop 56. Thus the internal end cantilever lip 62 is able to flare like a bell mouth or neck down to maintain contact with the adjacent volute complementing shell thereby sealing transverse joints 64 and 66. The sealing action is also useful under a variety of operating conditions.

It will be understood that changes may be made in the details of construction and in the correlation of the various elements of this invention to accomplish the same results without departing from the scope of the invention defined in the claims.

What is claimed is:

1. A multi-stage centrifugal fluid machine having a high pressure fluid passing therethrough comprising:

(*a*) a shaft rotatably disposed in said machine and connected to a source of power,

(*b*) a plurality of impellers mounted on said shaft in

spaced relationship to each other and adapted to energize the fluid in said machine on rotation of said shaft,

(*c*) a segmented inner casing disposed about said impellers to form a plurality of spaced chamber means thereabout in series flow communication with each other whereby a plurality of stages is formed in said machine,

(*d*) said segmented inner casing including a plurality of volute shell means and a plurality of partition means formed by two complementing components to permit said chamber means to be formed with said impellers mounted on said shaft,

(*e*) each of said partition means having one of said volute shell means on either side thereof and in abutment thereto,

(*f*) each of said volute shell means having a larger inner diameter than the outer diameter of said impellers whereby said volute shell means can be longitudinally slipped over said impellers on assembly thereof,

(*g*) an interstage partition means formed with said partition means in spaced relationship therewith and fixedly connected thereto,

(*h*) said volute shell means to nest on said interstage partition means to define said chamber means inboardly thereof and a passageway outboardly thereof leading to the next stage whereby on assembly thereof said two complementing components of said partition means are joined and separate adjacent chamber means,

(*i*) an annular means mounted about each partition means to permit assembly thereof and to engage said volute shell means on either side of said partition means to form a seal therebetween whereby a leak proof operative assembly is obtained,

(*j*) an outer casing having an inlet means and an outlet means for said fluid,

(*k*) means fixedly connecting said inner casing to said outer casing with said inlet means communicating with said first chamber means and said outlet means communicating with said last chamber means.

2. The combination claimed in claim 1 wherein said volute shell means and said interstage partition means nesting in a plane substantially normal to the axis of said shaft.

3. The combination claimed in claim 1 wherein

(*a*) said annular means including shrink hoop means,

(*b*) said shrink hoop means having circumferentially spaced axial openings therein,

(*c*) means passing through said openings and engaging said outer casing to draw said inner casing into assembled longitudinal position.

4. The combination claimed in claim 3 with said shrink hoop having an intermediate section and at least cantilever lip of smaller cross section formed on the end face thereof, said cantilever lip extending over the joint and in engaged relationship with said interstage element and said complementing shell on either side thereof, said cantilever lip substantially more resilient than said intermediate section and deflecting responsive to movement of either said interstage element or said complementing shell to maintain the engaged sealed relationship therebetween.

5. The combination claimed in claim 4 with said shrink hoop comprising at least one end face having an annular groove thereon, a cantilever lip having an upper edge inclined outwardly downward formed on said shrink hoop adjacent and immediately below the annular groove, and said cantilever lip making the annular groove substantially U-shaped.

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