CENTRIFUGAL PUMP IMPELLER

Fig. 1.

PRIOR ART

Fig. 2.

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This invention relates to centrifugal pumps, compressors, superchargers and like apparatus and more particularly to an impeller for such devices having a rotary diffuser wherein the impeller blades are directly welded onto a hollow shaft.

In the field of rotary diffusers and impellers, it has been the general practice to construct such devices by fabricating a structure comprised of a hub, a plurality of impeller blades mounted on said hub and enclosed within a disc and a shroud member and diffuser sections. Thereafter such structure as a unit was mounted on a solid shaft. Usually the disc and front shroud were hammered and machined in one piece and welded onto the impeller blades.

In accordance with the conventional manner, the impellers were shrunk fitted onto the shaft, resulting in an expensive and laborious operation. Also the machinings of the various parts were numerous. By way of example, the shaft and the hub were entirely machined separately; thereafter, the hub had to be machined again after the mounting thereof onto the shaft.

The solid shaft had to be designed to accommodate the weight of the impeller and its own weight. This led to very large shaft diameters and to disadvantages from the aerodynamics point of view because of the area occupied by the shaft and hub in the inlet.

The rotary diffuser impeller of the present invention as hereinafter described obviates such disadvantages by employing a hollow shaft and further, by attaching the impeller blades directly onto such hollow shaft, thereby eliminating the hub.

It is therefore an object of the present invention to provide a new and improved impeller for centrifugal pumps, compressors, superchargers and like apparatus.

Another object of this invention is to provide a new and improved impeller of the rotary diffuser type for centrifugal apparatus which is simple in construction, reduced in weight, reliable in operation and easy to manufacture.

A specific object of the present invention is to provide a new and improved impeller of the rotary diffuser type which is provided with a hollow shaft for obtaining impellers lighter than the conventional ones operative at the same critical speed.

Still another specific object of the present invention is to provide a new and improved impeller of the rotary diffuser type having a hollow shaft and wherein the impeller blades are directly attached to such hollow shaft for precluding the necessity of a hub.

These and other objects and advantages of this invention will become readily apparent upon consideration of the following description and drawings in which:

FIGURE 1 is an axial sectional view of a rotary diffuser having an odd number of impeller blades constructed in accordance with the principles of this invention;

FIGURE 2 is an axial sectional view of a rotary diffuser constructed in the conventional known manner;

FIGURE 3 is an axial sectional view of another embodiment of the rotary diffuser taken adjacent the impeller blades;

FIGURE 4 is an axial sectional view of a modified hollow shaft having a prestressed rod therein; and

FIGURE 5 is a composite illustration showing a further embodiment of the hollow shaft in axial section and in end elevation.

Referring to the drawings and particularly to FIGURE 2, it will be noted that a rotary diffuser constructed in accordance with the known conventional manner comprises a solid rotatable shaft 2 journalled at its outer ends respectively in suitable bearings 4 and 6. A hub 8 is rigidly secured onto shaft 2 as for example by shrink fitting. Since the right side of the construction shown in FIGURE 2 is identical to the left side and symmetrical thereto about a plane passing through the line indicated as A—A normal to the axis of shaft 2, only the right side will be described. Rigidly secured on hub 8 as for example by welding are a plurality of impeller blades 10 enclosed between disc 12 and outer shroud member 14. The impeller blades 10 extend from the radially inward edges of disc 12 and outer shroud member 14 respectively and terminate in outer end portions 16. Portions 18 and 20 of disc member 12 and outer shroud member 14, respectively, extend outwardly beyond the outer end portions 16 of blade members 10 and are slightly axially divergent to form a rotary diffuser.

In FIGURE 1 there is shown a rotary diffuser constructed according to the principles of this invention comprising a hollow shaft 22 having reduced end portions 24 and 26 journalled in bearings 28 and 30 respectively. Shaft 22 is rotated by a power means (not shown) in a manner well known in the art.

Directly attached to the rotatable hollow shaft 22 as for example by welding are a plurality of flat impeller blades 32 which are equally circumferentially spaced about hollow shaft 22. As in the case of FIG. 2, only the right side of the structure shown in FIG. 1 will be described since it is identical and bilaterally symmetrical to the left side. A disc segment 34 and a shroud segment 36 are disposed between each circumferentially successive pair of blades 32 and are rigidly secured thereto as for example by welding to form an inner and outer shroud, respectively. The segments 34 and 36 have coaxial surfaces of revolution and outer peripheries 38 of equal radius. Impeller blades 32 extend from the periphery of hollow shaft 22 and terminate in outer end portions 40 substantially inwardly from the outer periphery 38 of segments 34 and 36. Portions 42, 44 of the segments 34 and 36 respectively extend outwardly beyond the outer end portions 40 of the impeller blades 32 and are preferably slightly axially divergent to form a rotary diffuser. Portions of the segments 34 and 36 nearest to the hollow shaft 22 are radially spaced to form an inlet opening 46. The rotatable hollow shaft 22 is rotated by power means (not shown) in a manner well known in the art.

In operation of this device the shaft along with the impeller mounted thereon is rotated at a predetermined speed within a suitable impeller casing in a manner well known in the art. Such casing is so designed that a suitable supply of air is available at the inlet opening 46 between each pair of blades and a suitable path for exit of the air from the impeller is provided adjacent the outer periphery 38. It is readily apparent that in eliminating the hub by attaching the blades directly onto the shaft as in the present invention while maintaining the same basic dimensions of the inlet opening as in the case of an impeller having a hub, an increase of flow area of the inlet is obtained.

Another advantage residing in the use of an impeller of this invention is apparent in obtaining impellers lighter than the conventional ones for the same critical speed design. Accordingly, an appreciable reduction in weight and cost is realized. Moreover, the reduction in weight lightens the loads on the bearings and stands, thereby resulting in a longer life span of these elements. Further-
more, the elimination of the massive hub and the elimination of weight within the shaft proper results in a reduction of WR or W2 in the total rotating assembly whereby less expensive motors can be employed. Still another advantage obtained in the impeller of the present invention is due to the utilization of a hollow shaft which is more rigid than a solid shaft because its area of moment of inertia increases at a greater rate than shaft weight. Thus, it has a greater ratio of moment of inertia to shaft weight than a solid shaft of the same diameter.

A further advantage residing in the impeller of this invention is that during the fabrication of the instant impeller, the shaft may be preheated internally to facilitate the blade welding process. In service, the hollow shaft design maintains cooler operating temperatures in the area of both the impeller and the bearing journals which is a particularly desirable feature when handling hot gases.

An additional advantage in eliminating the hub is obtained in applications where the rotor is subjected to large temperature changes in a short time interval, such as on startups by way of example, in the conventional devices whereby the hub is heated at a faster rate than the shaft. This condition creates a looseness between the hub and shaft, resulting in a temporary unbalance of the rotor assembly. Of course, by eliminating the hub, such condition is precluded.

Still a further advantage resides in fabricating the shrouds in segments, thus resulting in a substantial cost reduction as compared to those shrouds formed by hammering and machining.

FIG. 3 shows another embodiment of the impeller of this invention comprising a circular disc 48 having a central, circular opening 50 therethrough for receiving a hollow shaft 22'. Disc 48 is suitably, rigidly attached to the hollow shaft 22' as by means of welding. A portion of the disc near its periphery is tapered radially outwardly to form inner walls 52 and 54 of a double inlet rotary diffuser.

The embodiment of FIG. 3 has an advantage over the embodiment first described in that a single disc member 48 is effectively employed to provide inner walls or shroud members for a double inlet rotary diffuser, thus facilitating the fabrication thereof and providing strength without reducing the flow area of the respective inlets.

FIG. 4 illustrates a second embodiment of the hollow shaft of the present invention comprising a constant diameter hollow shaft 22''. An elongated metallic prestressed member 68 extending along the longitudinal axis of shaft 22'' is received in bores 60 and 62 respectively, extending longitudinally therethrough. Tip members 56 and 58 are provided with circular flanges 64 and 66 respectively concentric with tip members 56 and 58 respectively, for abuttingly engaging the opposite end faces of shaft 22''. An elongated metallic prestressed member 68 extending along the longitudinal axis of shaft 22'' is received in bores 60 and 62 respectively and is provided with threads at its opposite end portions. Internally threaded nuts 70 are adjustably, releasably secured to the opposite end portions of prestressed member 68. Such an arrangement not only effectively secures the tip members 56 and 58 to the constant diameter hollow shaft 22'', but also provides the added advantage of employing the prestressed member for influencing stresses acting on the hollow shaft of the impeller.

FIG. 5 shows another embodiment of the hollow shaft of the present invention comprising a constant diameter shaft 22''' having its opposite end portions journalled in bearings 72 and 74 respectively. Each of the bearings comprises six rollers 76 arranged in two rows of three rollers each, having their axes of rotation lying in a common horizontal plane parallel to and located below the longitudinal axis of shaft 22''''. With this arrangement, one of the rollers can be removed and replaced while the other rollers effectively support shaft 22''''.

Although a double inlet centrifugal impeller has been shown and described, it should be realized that a single inlet centrifugal impeller could be constructed in accordance with the principles of the present invention. Preferred embodiments of this invention having been described and illustrated, it is to be realized that modifications thereof may be made without departing from the broad spirit and scope of this invention. Accordingly, it is respectfully requested that this invention be interpreted as broadly as possible and be limited only by the prior art.

I claim:
1. A centrifugal pump rotor-impeller assembly comprising: an elongated hollow shaft rotatable about its longitudinal axis and supported for such rotation at longitudinally spaced journal portions thereof; a plurality of blades having forward, rearward, outer end, and inner end portions, said blades being rigidly secured at their inner end portions to said shaft and extending outwardly in spaced relationship from a circumferential section of said shaft; disc means rigidly secured with respect to said shaft and extending peripherally thereabout in abutting relationship with a substantial radial expansion of the rearward portions of said blades, said disc means being an integral continuous member; and a shroud comprised of shroud segment means extending between the forward portions of adjacent pairs of blades and spaced from said disc means and said shaft to define generally radially outwardly directed passageways having generally axially facing inlets and radially outwardly facing outlets adjacent the outer end portions of said blades.

2. A centrifugal pump rotor-impeller assembly as set forth in claim 1 wherein each of said shroud segments is rigidly secured to at least one blade of said pair of blades.

3. A centrifugal pump rotor-impeller assembly as set forth in claim 1 wherein said blades and said disc means are rigidly secured by welding.

4. A centrifugal pump rotor-impeller assembly as set forth in claim 1 wherein said shroud segments means are secured by welding.

5. A centrifugal pump rotor-impeller assembly comprising: an elongated hollow shaft rotatable about its longitudinal axis and supported for such rotation at longitudinally spaced journal portions thereof; a plurality of blades having forward, rearward, outer end, and inner end portions, said blades being rigidly secured at their inner end portions to said shaft and extending outwardly in spaced relationship from a circumferential section of said shaft; disc means rigidly secured with respect to said shaft and extending peripherally thereabout in abutting relationship with a substantial radial expansion of the rearward portions of said blades; a shroud comprised of shroud segments extending between the forward portions of adjacent pairs of blades and spaced from said disc means and said shaft to define generally radially outwardly directed passageways having generally axially facing inlets and radially outwardly facing outlets adjacent the outer end portions of said blades; and an elongated prestressed member within said shaft, said prestressed member extending longitudinally substantially end-to-end of said shaft and being supported within said shaft to exert a stress on said shaft directed from the ends of said prestressed member toward said blades.

6. A centrifugal pump rotor-impeller assembly as set forth in claim 5 wherein said disc means is comprised of segments extending between the rearward portions of pairs of adjacent blades, each of said disc segments being rigidly secured to at least one blade of said pair of blades.

7. A centrifugal pump rotor-impeller assembly as set forth in claim 5 wherein each of said shroud segment means is rigidly secured to at least one blade of said pair of blades.
8. A centrifugal pump rotor-impeller assembly as set forth in claim 5 wherein said blades and said disc means are rigidly secured by welding.

9. A centrifugal pump rotor-impeller assembly as set forth in claim 5 wherein said shroud means are secured by welding.

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