Dec. 27, 1966 L. DENIS 3,294,027

CENTRIFUGAL PUMP IMPELLER

Filed March 18, 1964 2 Sheets-Sheet 1

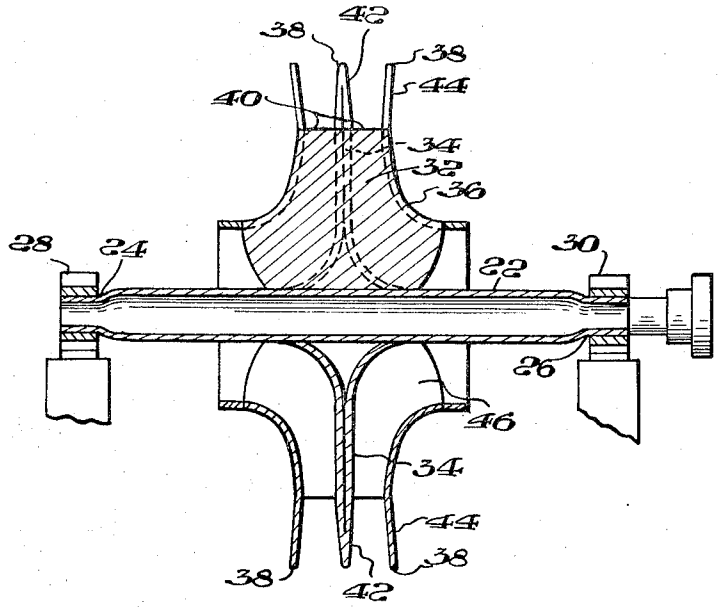
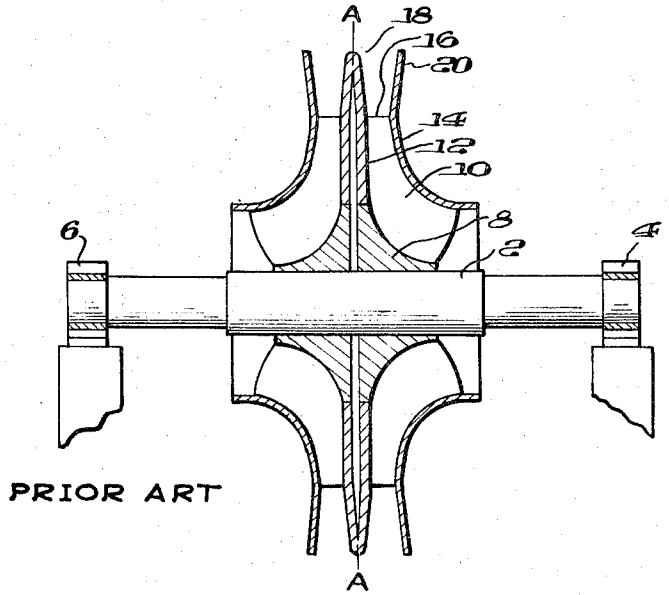


Fig. 1.



PRIOR ART

Fig. 2.

INVENTOR.
LOUIS DENIS.

BY
Edward W. Nypaver
his ATTORNEY.

Dec. 27, 1966 L. DENIS 3,294,027

CENTRIFUGAL PUMP IMPELLER

Filed March 18, 1964 2 Sheets-Sheet 2

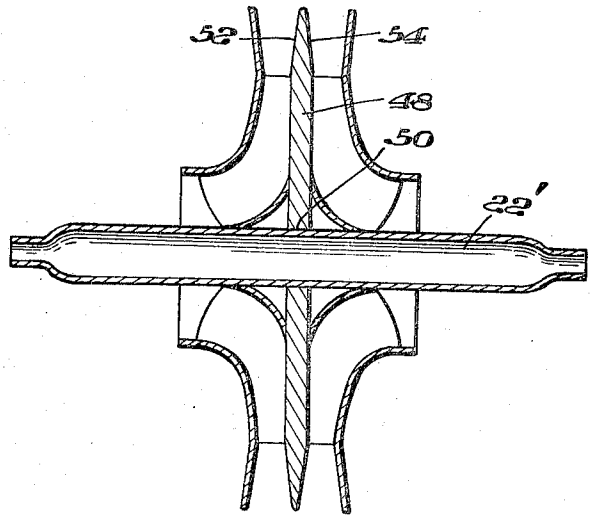


Fig. 3.

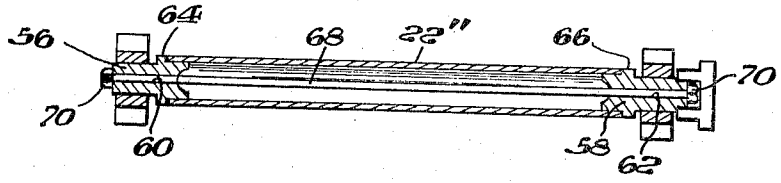


Fig. 4.

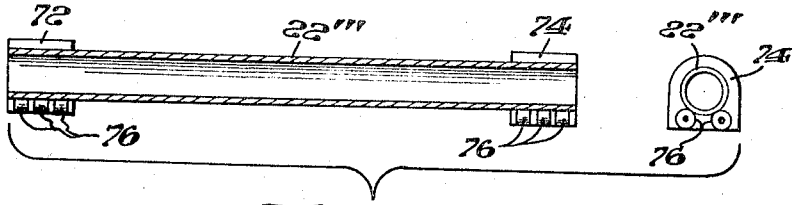


Fig. 5.

INVENTOR.
LOUIS DENIS.

BY
Edward W. Nypaver
his
ATTORNEY.

United States Patent Office 3,294,027 Patented Dec. 27, 1966

3,294,027

CENTRIFUGAL PUMP IMPELLER

Louis Denis, Neuilly-sur-Seine, France, assignor to Societe Anonyme des Etablissements Neu, Lille (Nord), France, a corporation of France

Filed Mar. 18, 1964, Ser. No. 352,835
Claims priority, application France, Mar. 29, 1963, 18,197
9 Claims. (Cl. 103—115)

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 diffuster 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^2 or WK^2 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 start-up 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''**. Elongated tip members **56** and **58** extend axially outwardly from the opposite ends of shaft **22''** and have central axial 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 expanse 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 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 expanse 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.

References Cited by the Examiner

UNITED STATES PATENTS

1,953,064	5/1934	Dowson	103—115
2,337,619	12/1943	Miller	230—134
2,344,444	3/1944	Malczewski	230—134
2,402,204	6/1945	Phelan et al.	103—115
2,443,411	6/1948	Wolfe	230—134
2,697,589	12/1954	Davey	103—115

2,807,871	10/1957	Wagner et al.	29—156.8
3,038,699	6/1962	Kaplan	253—78
3,074,151	1/1963	Kroeckel	29—156.8
3,077,297	2/1963	Clarke	230—134
3,107,627	10/1963	Clarke et al.	103—115
3,139,265	6/1964	Lindquist	230—134
3,166,295	1/1965	Szewalski et al.	253—78

FOREIGN PATENTS

936,366	2/1948	France.
545,628	3/1932	Germany.
942,107	4/1956	Germany.
632,475	11/1949	Great Britain.

MARK NEWMAN, *Primary Examiner.*

HENRY F. RADUAZO, *Examiner.*