Feb. 23, 1954 H. E. LA BOUR 2,669,938

IMPELLER AND SHAFT CONSTRUCTION

Filed Feb. 19, 1953

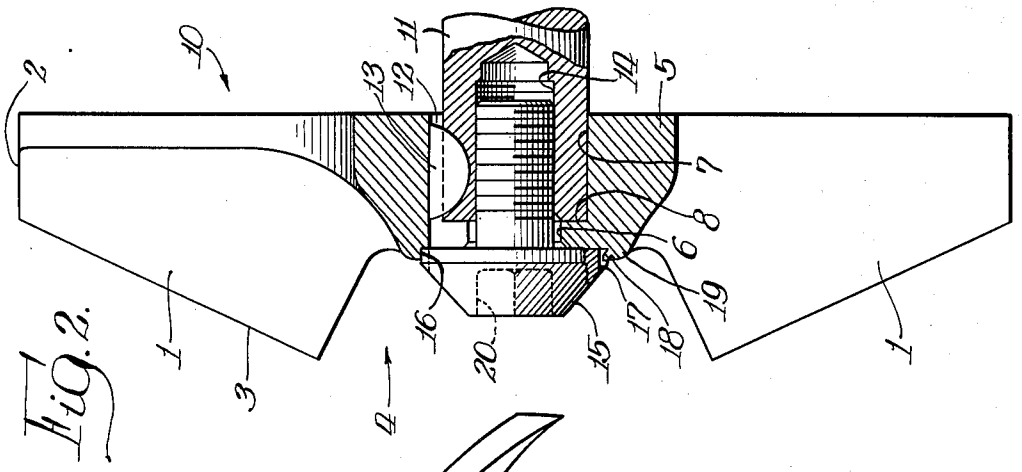



Fig. 2.

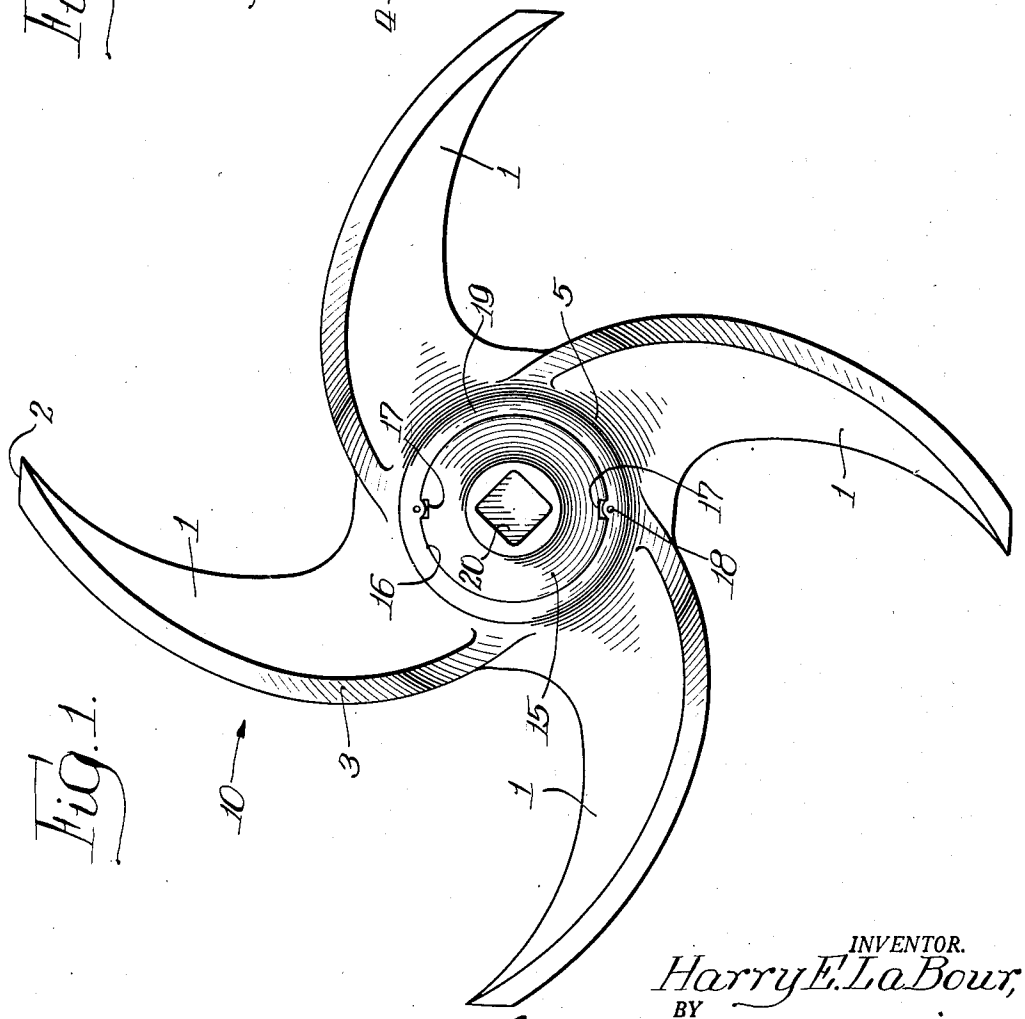



Fig. 1.

INVENTOR.
Harry E. La Bour,
BY
Brown Jackson Boettcher Dienner
Attys.
78

Patented Feb. 23, 1954

2,669,938

# UNITED STATES PATENT OFFICE

2,669,938

## IMPELLER AND SHAFT CONSTRUCTION

Harry E. La Bour, Elkhart, Ind., assignor to The La Bour Company, Inc., Elkhart, Ind., a corporation of Indiana

Application February 19, 1953, Serial No. 337,750

1 Claim. (Cl. 103—115)

1

The present invention relates to the construction of an impeller and its drive shaft, particularly for use in pumps handling corrosive liquids. While the present construction constitutes the solution of a problem in impellers for pumps employed in handling corrosive liquids or so called acid service, it is applicable to pumps handling liquids which are not corrosive. Furthermore, it solves, in addition to the main problem, subsidiary problems, as will be apparent from the following specification.

A pump for acid service requires an impeller made of corrosion resistant metal and a connected supporting and driving shaft, a section of which must also be made of corrosion resistant metal. A common practice is to cast the corrosion resistant section of the impeller shaft integral with the body of the impeller, and then to machine both parts to the required dimensions.

Aside from the difficulties which are encountered in casting integral an impeller shaft section and an impeller body, there is the requirement for a wide range in the dimensions and characteristics of the impellers, and a variation in the desired dimensions of the supporting shafts. The casting of an impeller and shaft section of corrosion resistant metals is difficult because of the relatively thin section involved, and the extent of the same. Such metals usually have a high degree of shrinkage and it is difficult to keep the mould filled.

It is old to make a shaft independently of the impeller body, particularly in metals which are not corrosion resistant, and to join the two together by projecting the end of the shaft through the hub of the impeller and threading the end of the shaft to receive a clamping nut which holds the impeller against a radial shoulder on the shaft, as shown, for example, in Figure 2 of my Patent No. 2,286,425, of January 16, 1942. I have found that under the effects of chemical attack and the mechanical action of stopping and starting, the nut on the threaded stud will sometimes become loose and permit loosening of the impeller on the shaft.

A further difficulty which the aforesaid construction involves is the relatively small radial extent of the shoulder against which the impeller is drawn, with consequent likelihood of misalignment of the impeller with the shaft.

I have discovered that it is possible to overcome the aforesaid difficulties by the construction which constitutes the present invention, and which involves disposing a separate shaft section in a counterbore in the impeller which counterbore provides a radial shoulder near the front end of the impeller hub, and the employment of a headed screw which extends from the intake side of the hub telescopically inside the end of the propeller shaft. The head of the screw closes the outer end of the bore and counterbore, and it is locked against rotation by deformation of a circular wall of the impeller hub surrounding the periphery of the screw head and fitting into a recess in the same. The results flowing from this construction are surprisingly advantageous. Aside from the advantages of separate manufacture of the impeller and of the shaft, the specific mode of attachment permits the shaft to retain its full diameter in the counterbore, whereby a larger area of guidance of the shaft in the counterbore is provided. A greater radial depth of the interfitting shoulders of the hub and of the shaft is thereby obtained; and a much longer hold of the screw on the shaft is secured by the telescopic arrangement of the parts. The circular head of the screw closes off any possible opening between the front of the impeller hub and the back of the same, particularly along the keyway, and loosening of the screw in the shaft is obviated by the radial indentation or plastic displacement of the metal at the periphery of the screw head.

2

Now in order to acquaint those skilled in the art with the manner of constructing and operating a device embodying my invention, I shall describe, in connection with the accompanying drawings, a specific embodiment of the same.

In the drawings:

Figure 1 is a front end view of an impeller embodying my invention; and

Figure 2 is a side elevational view of the same, partly in section, to show the details of the connection between the shaft and the impeller hub.

While the present invention is particularly suitable for open type impellers, it may be used as well in semi-open or closed impellers. The open type impeller is more generally used in self-priming pumps of the type covered by my Patent No. 1,578,236, and involving peripheral re-entry of priming liquid, and where acid service is encountered.

The blades may be substantially radial, as shown, for example, in my aforesaid patent, or they may be substantially straight along the major part of their length and curved at the tips, as illustrated in my prior Patent No. 2,134,254, or the blades may be curved throughout, as shown in my prior Patent No. 2,184,349, or may take any other desired form. The im-

peller which I have shown herein employs curved blades, but the particular form of the blades is optional. The space in the pump casing occupied by the impeller here shown is generally cylindrical. The impeller 10 herein shown is of the type which substantially fills the casing with only the usual running clearance, although this also is optional. The blades may run in the channel or outside it. The edges 3 of the blades 1 are disposed in a generally conical surface, the axis of the cone being coaxial with the impeller 10 and the shaft 11. The impeller has at its center on the inlet side, which is on the left of Figure 2, a recess 4, which opens into the intake passageway of the pump casing not shown. The edges of the blades 3 on the shaft side lie in a plane at right angles to the axis of the shaft 11. The hub 5 has an axial bore 6 and a counterbore 7 separated by a radial shoulder 8. The end face of the round shaft 11 is squared off at right angles to the axis of the shaft and fits closely in the counterbore 7 with the said squared off end engaging the radial shoulder 8 in the impeller hub. A keyway 12 is cut in the hub radially of the counterbore and of the bore 6, and a key 13 set in the shaft 11 projects into the keyway 12 and keys the shaft and the hub 5 together.

The end of the shaft 11, which extends into the counterbore 7 is axially bored and threaded to provide the threaded socket 14 for receiving the threads of the circular headed screw 15. The screw 15 has a head, the periphery of which is substantially cylindrical, and adapted to fit fairly closely in the cylindrical recess 16 in the hub 5. The periphery of the head has one or more recesses 17 into which the metal of the hub is deformed, as by a prick punch or other tool for battering over the metal of the surrounding rim of the hub to prevent turning of the screw except under force great enough to displace the battered-over metal above described. The inner face of the head of the screw 15 is preferably radial, that is, lies in a plane substantially at right angles to the axis of the shank of the screw, and it extends a slight distance beyond the outer edge of the keyway 12, so that when the screw 15 is threaded tightly into the socket 14, the head of the screw will close off communication between the intake side and the shaft side of the impeller. The head of the screw 15 axially beyond the cylindrical portion 16 is generally conical, with the outer end terminating in a generally radial surface with a non-circular (in this case square) socket 20 for receiving a wrench whereby the screw may be turned on its threads.

The relatively long guiding surface 7 which the hub provides for the shaft 11, the long engagement of the screw 15 and the shaft 11, and the substantial radial depth of the shoulder 8 permit the shaft 11 and the impeller 10 to be brought into and maintained in accurate alignment. The screw extends telescopically of the end of the shaft, and hence the length of threads which may be employed is independent of the projection of the head of the screw into the stream of liquid passing through the impeller. The flat underside of the head of the screw 15 bears against the flat face of the seat on the front face of the hub, and the flat end face of the shaft is pulled against the flat radial shoulder 8 inside the hub with the benefit of the relatively long and large diameter bearing of the shank of the screw in the socket 14 in the shaft. This holds the impeller accurately and strongly in place in a plane at right angles to the longitudinal axis of the shaft. Also because of such concealed thread, and the greater length of thread, the action of a corrosive liquid upon the cooperating threads is much less pronounced. In other words, the structure has longer useful life. This form of impeller and shaft construction makes it unnecessary to cast the impeller and shaft in one piece, as has been generally found necessary for acid service. Where a shaft and impeller are cast as one piece, a defect in either the shaft or in a blade will require repairing which is expensive, and sometimes unsatisfactory, or rejection of the casting, which is more likely. According to the present construction, the separate formation of the impeller and the shaft section provides a combined shaft and impeller which from a practical standpoint is substantially as good as the integral construction, and offers the very pronounced advantage of greater flexibility of production. Various lengths of shaft and diameter of shaft may be provided on various diameters of blade and curvatures and shapes of blades by assembling suitable components. This requires a much lower inventory of stock to meet the requirements of the trade. The renewal of impellers and connected shaft sections in acid service is an important service required of a manufacturer.

The construction fulfills the requirements of interchangeability with integral impellers which are in existing pumps, so that the present construction may be a satisfactory repair part. The impeller and shaft section must be corrosion resistant for acid service. The parts must be capable of accurate assembly without too great care or difficulty. The shaft and impeller must be positively tight against reverse operation or unscrewing under any conditions of operation. The attachment of the shaft to the impeller must avoid projecting or irregular parts which would produce inefficiency in the operation of the pump. Also, the attaching means should avoid leakage axially of the joint between the two parts. All of these requirements are fulfilled by the above described construction.

The thread between the screw and the shaft is preferably so related to the direction of rotation, which in Figure 1 is counterclockwise, that the threads would tighten on the application of motor torque to the shaft member 11. The shaft section 11 which is required to be corrosion resistant for acid service must be long enough to extend through the packing gland or shaft seal which is provided to keep a tight joint between the casing and the rotatable shaft. The connection of the shaft section 11 to the motor shaft in a direct drive pump may be made as per the arrangement shown in my Patent No. 2,599,333, or it may be made otherwise.

I claim:

An impeller having a shaft side and an inlet side, and having a central hub portion with impeller blades extending outwardly substantially in a plane at right angles to the axis of the hub portion, said hub portion having a bore extending axially through the same, and having a cylindrical counterbore which extends through the main part of the axial length of the hub and provides a cylindrical guiding surface for a driving shaft, said hub having at the junction of said bore and said counterbore an annular radially extending shoulder disposed substantially in a plane at right angles to the axis of the hub, said hub having a keyway which extends along the length of the inside surface of the hub, said hub

having on its inlet side an annular seat disposed substantially in a plane parallel to the plane of said annular shoulder and recessed into the face of the hub, a driving shaft received into said counterbore and guided on said cylindrical surface, said shaft having a key recessed into the same, said key projecting into said keyway, the end surface of the shaft being disposed substantially in a plane at right angles to the longitudinal axis of the shaft and engaging on its full diameter endwise against said annular shoulder, said shaft having an axial socket screw threaded to receive a fastening screw, and a fastening screw having a threaded shank threaded into said socket and having a head provided with a substantially flat annular clamping face of greater



radial extent than the radial extent of the shaft for engaging said annular seat, said head being circular and having a peripheral recess into which metal of the hub is projected by plastic displacement.

HARRY E. LA BOUR.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 1,743,348 | Hollander | Jan. 14, 1930 |
| 2,166,436 | Harlow | July 18, 1939 |
| 2,331,310 | Damonte | Oct. 12, 1943 |
| 2,613,609 | Buchi | Oct. 14, 1952 |
| 2,635,548 | Brawley | Apr. 21, 1953 |