Sept. 22, 1964 F. H. THELEN 3,149,378

APPARATUS FOR ASSEMBLING IMPELLER ELEMENTS

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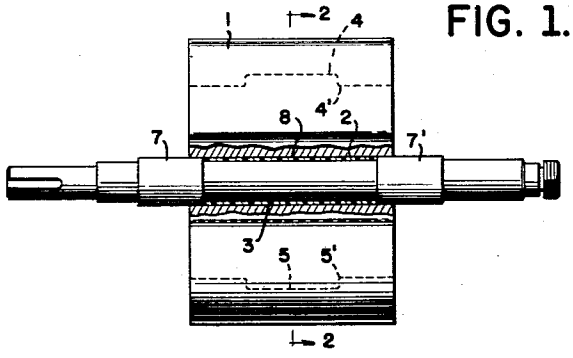
FIG. 1.



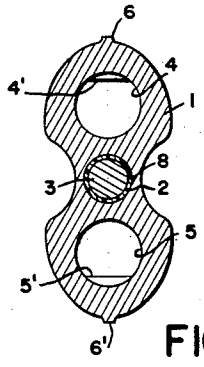




FIG. 2.

FIG. 3

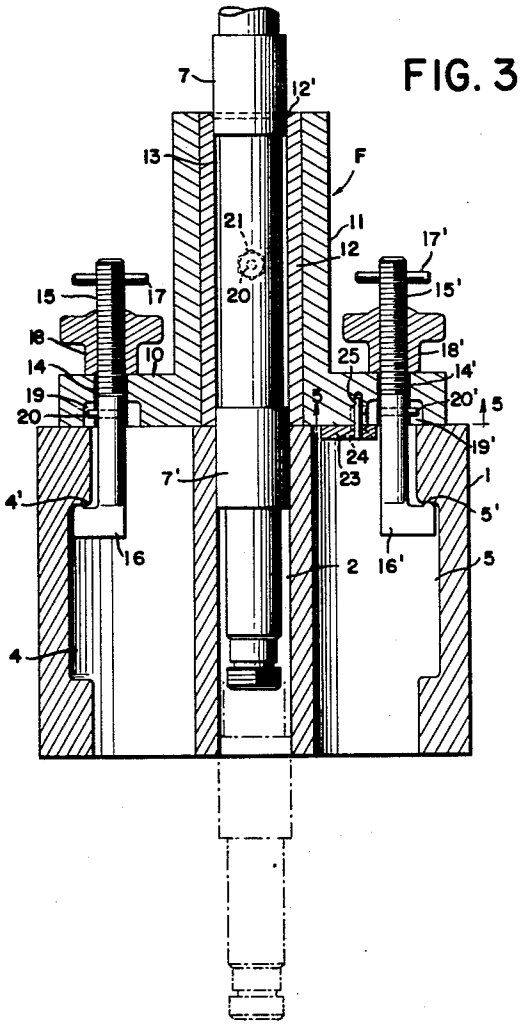
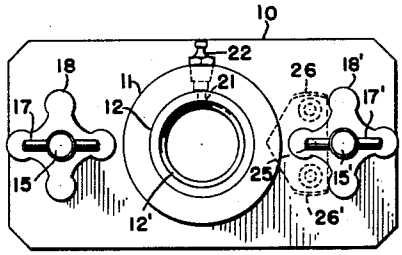



FIG. 4.



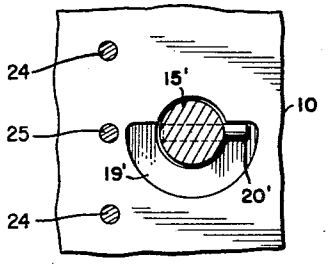




FIG. 5.

INVENTOR
FRANCIS H. THELEN

BY Dennis Edwards
Merlin Barnes & Taylor

ATTORNEYS

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# APPARATUS FOR ASSEMBLING IMPELLER ELEMENTS

Francis H. Thelen, Tujunga, Calif., assignor to Fuller Company, Catasauqua, Pa., a corporation of Delaware

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The present invention relates to an apparatus for assembling impeller assemblies in which the drive shaft is adhesively bonded to the impeller element. Heretofore it has been common practice to secure the impeller element to the driving shaft by a so-called interference fit in which a shaft of slightly greater diameter than the bore of the impeller element is forced into the bore of the impeller element, and the impeller element then keyed to the shaft. However with the use of larger shafts, such as those used in a high-pressure, high-speed impeller, such means of securing the impeller element is not satisfactory since the increase in the shaft diameter necessarily requires an increase in the bore diameter through the impeller. This reduces the wall thickness of the impeller at the shaft bore and weakens the impeller at that point so that the stress resulting from the usual interference type of assembly will either break the impeller or stretch the metal beyond its elastic limit.

The apparatus of the invention is particularly adapted for use in assembling impeller elements onto drive shafts where the portion of the drive shaft on which the impeller is mounted is relieved, or is of slightly less diameter than the diameter of the bore of the impeller element except for lands adjacent the opposite sides of the impeller element. Such portion of less diameter provides a space between the lands for receiving a layer of the adhesive agent of appreciable thickness.

The apparatus for assembling the impeller element and driving shaft comprises a fixture having a base having one face to be attached to the impeller element and an extension or bushing extending from the other face. The extension or bushing has a bore to receive the relieved portion of the shaft. An injection fitting for injecting an adhesive agent into the relieved portion of the shaft, while it is in the bore of the bushing, passes through the wall of the fixture and has its inner end communicating with the bore of the fixture.

In assembling the impeller element and drive shaft, the fixture is secured to one side of the impeller element with its bore in exact axial registry with the bore of the impeller element. The shaft is then placed in the fixture in such position that the lands thereon are located at opposite sides of the injection fitting. The adhesive for bonding the impeller element to the shaft is then forced under high pressure through the injection fitting until the space around the shaft, between the lands, is completely filled with the adhesive under pressure. The shaft is then forced axially through the fixture and into the bore of the impeller element until the space containing the adhesive is centrally positioned, axially, in the bore of the impeller element In this position the lands at the opposite ends of the layer of adhesive lie within the end portions of the bore of the impeller element and prevent leakage of the adhesive axially along the shaft. The adhesive is then allowed to set, or is cured, if it is of the heat-curable type, to form a strong bond between the impeller element and the drive shaft.

The invention will be further described in connection with the accompanying drawings in which:

FIG. 1 is an elevational view, partly in section, of an impeller element-driving shaft assembly assembled using the apparatus of the present invention;

FIG. 2 is a vertical sectional view of the assembly of FIG. 1 taken on line 2—2 of FIG. 1;



FIG. 3 is a sectional view showing the assembling fixture attached to an impeller element, with the drive shaft positioned therein;

FIG. 4 is a plan view of the assembling fixture; and

FIG. 5 is a detailed sectional view taken on line 5—5 of FIG. 3.

Referring to the drawings, and first to FIGS. 1 and 2, the impeller element-drive shaft assembly comprises an impeller element **1**, which may be of any type, but as shown is a lobe of a conventional type of a two-lobe impeller. It generally is of a figure 8 shape in transverse section and has a central bore **2** for a conventional drive shaft **3** and axially extending bores **4** and **5** in each end. In order to facilitate the assembly of the impeller element onto the drive shaft, as herein described, the portions of these bores remote from the bore for the drive shaft are undercut to provide inner shoulders **4'** and **5'** (FIG. 3).

The opposite sides of the impeller element have projections **6** and **6'** extending radially outwardly for a slight distance. In operation the lobe cooperates in meshing engagement with a like lobe in the impeller housing in a well known manner, the projections **6** and **6'** making a close fit with the impeller housing and the surface of the cooperating lobe.

The drive shaft is provided with lands **7** and **7'** which are spaced apart a distance slightly less than the length of the impeller element at the hub thereof so that, when assembled, the lands will extend into the bore of the impeller element a slight distance at each end, as shown in FIG. 1. The lands **7** and **7'** extend outwardly from the main diameter of the drive shaft a distance of from about 0.001 to 0.003 inch, and preferably about 0.002 inch. This provides a space or relieved portion on the shaft of that width between the drive shaft and the impeller element for an annular layer of an adhesive bonding agent **8** of that thickness. The diameter of the lands is slightly greater, up to about 0.002 inch greater, than the diameter of the bore **2** of the impeller element so that it has a pressed fit with the impeller element.

While any suitable adhesive may be used to obtain an adhesive bond between the impeller element and the drive shaft, it has been found that heat-curable resinous epoxy compositions give an excellent bond. Examples of such compositions which have been used are as follows:

*Example I*

| | Parts by wt. |
|---|---|
| Furane Epocast No. 17A | 100 |
| Furane Hardener No. 909 | 8 |

This is a viscous liquid mixture having slow setting characteristics at room temperature. It was cured for 12 hours at a temperature between 375° and 400° F.

*Example II*

| | Parts by volume |
|---|---|
| Devcon A | 9 |
| Hardener | 1 |

This composition has the consistency of heavy putty. It was cured at room temperature, approximately 70° F.

*Example III*

| | Parts by wt. |
|---|---|
| Epocast No. 295 | 100 |
| Hardener No. 909 | 5 |

This is a thixotropic mixture. It was cured for 19 hours at a temperature between 375° and 400° F.

Referring now to FIGS. 3 to 5, the fixture F for assembling the impeller element onto the drive shaft comprises a base member **10** adapted to be clamped against one side of the impeller element during the assembling operation. The base member has extending therefrom at the side thereof opposite the side which is to be clamped

to the impeller element, an extension or bushing **11**. The bore of the bushing is lined with a material **12** having good wearing qualities and preferably having a low surface-friction coefficient. The diameter of bore **13** is 0.002 to 0.004 inch larger than the diameter of the lands **7** and **7'** of the shaft **3**. The end of the bore **13** is flared outwardly at **12'** to facilitate insertion of the driving shaft during an assembling operation, as hereinafter described.

The opposite ends of the base members **10** have unthreaded openings **14** and **14'** through which extend clamping bolts **15** and **15'** having laterally extending toe pieces **16** and **16'** extending therefrom at one end. Pins **17** and **17'** extend through the other or outer ends of the clamping bolts and form handles enabling the bolts to be located in proper position to engage behind the shoulders **4'** and **5'** when the assembling fixture is to be clamped to an impeller element.

The outer ends of the bolts are threaded and clamping nuts **18** and **18'** are threaded onto them. These nuts preferably have laterally extending protuberances so that they may readily be turned by one's hand to thread them along the bolts.

The surface of the base **10**, which is adapted to be clamped against the impeller element during an assembling operation, has crescent-shaped recesses **19** and **19'** circumjacent the openings **14** and **14'**. These recesses provide spaces for locating pins **20** and **20'** which protrude radially from the bolts **15** and **15'**. When the bolts are rotated in one direction until the locating pins engage one end of the crescent-shaped recesses, as shown in FIG. 3, the toe pieces of the bolts are brought behind the shoulders **4'** and **5'** of the bores **4** and **5** of the impeller element. When the bolts are rotated in the opposite direction, the toe pieces of the bolts are removed from behind the shoulders so that the fixture may be removed from the impeller element.

The bushing **11** and its liner **12** have a radially extending opening **21** into the outer end of which is fitted an injection fitting **22**, preferably of the check-valve type.

To assist in locating the fixture in proper position on one end of the impeller element, a guide or locating member **23** is secured to the face of the base member which is secured to the end of the impeller by machine screws **24**. This locating member has a projecting stud **25** to be received in an opening in the face of the base member to assure that the locating member is properly located to be received in one of the bores **4** or **5** of the impeller element. The sides **26** and **26'** of the member **23** are curved lengthwise and transversely. The width of the locating member transversely of the base member is substantially equal to the diameter of the bores **4** and **5**, being just sufficiently less to enable easy insertion of the member into one of the bores. The radius of curvature lengthwise of the sides **26** and **26'** is slightly less than the radius of curvature of the bores **4** and **5** so that there is only substantially linear contact between those edges of the locating member and bore **4** or **5**.

In assembling an impeller element onto a driving shaft, the bolts **15** and **15'** are rotated to a position where their respective clamping toe pieces **16** and **16'** extend to positions permitting the bolts to pass into the bores **4** and **5** of the impeller. The fixture then is placed against one end face of the impeller element, with the bore **13** thereof in exact axial registry with the bore **2** of the impeller element. The bolts are then turned in the opposite direction until the locating pins **20** and **20'** engage the outer ends of the respective crescent-shaped recesses **19** and **19'**. This positions the toe pieces **16** and **16'** of the bolts behind the shoulders **4'** and **5'** of the bores **4** and **5**. The clamping nuts **18** and **18'** are then turned to cause the bolts to move in a direction away from the impeller element and to cause the toe pieces to clamp tightly against the shoulders **4'** and **5'**. This effectively clamps the fixture tightly against the end face of the impeller. With



the fixture clamped tightly against the end face of the impeller, and with the bore **13** of the fixture in exact axial registry with the bore **2** of the impeller element, the drive shaft **3** is inserted into the outer end of the bore **13** until the space between the lands **7** and **7'** of the shaft is wholly within the bore **13**, with the lands located at opposite sides of the injection fitting, as shown in FIG. 3. With the drive shaft in this position, the adhesive composition is forced through the injection fitting **21** under high pressure into the space defined by the driving shaft, the liner **12** and the lands **7** and **7'**, until the adhesive composition begins to leak out between the bushing liner and lands on the shaft. At this time all air will have been forced from the space and the space completely filled with the adhesive composition under high pressure. The shaft is then forced axially through the bushing and into the bore **2** of the impeller element until it reaches the position shown in dotted lines in FIG. 3, and in full lines in FIG. 1. A suitable tool may be used for this purpose.

As the shaft **3** and its coating of adhesive are forced into the impeller, both frictional resistance and the shearing action of the edge of the impeller through which the shaft passes, will peel-off a certain amount of the adhesive. However, since the bore **13** of the fixture is about 0.003 inch greater in diameter than the bore of the impeller, a slight excess of adhesive is available to prevent this peeling from robbing the required adhesive from the 0.002 inch relieved portion of the shaft.

Since the diameter of the lands **7** and **7'** is slightly greater than the diameter of the bore **2** of the impeller element, a concentric, interference fit will be obtained between the lands and the impeller element. The adhesive composition forms an annular layer, under pressure, between the drive shaft and the impeller element and is prevented from escaping by the interference engagement of the lands **7** and **7'** with the impeller element. This assures that there will be intimate bonding throughout substantially the entire area of the opposing faces of the impeller element and the shaft throughout the distance between the lands.

The adhesive composition is now permitted to set, or if it is of the heat-curable type, is subjected to the proper degree of heat for an adequate length of time to thoroughly cure it. If the adhesive composition is of the heat-curable type, and also is one which expands when heated, the expansion will cause an even more intimate and stronger bond between the impeller element and the drive shaft.

It is to be understood that various changes may be made in the specific form of the fixture described herein without departing from the invention or sacrificing any of the advantages thereof.

I claim:

1. A fixture for assembling an impeller element onto a shaft which comprises a base member having a face to be secured tightly to one end of an impeller element, an extension or bushing having a bore extending therethrough in a direction normal to said face of the base member extending from the opposite face of the base member through which a shaft to be attached to the impeller may be passed, means at opposite sides of said extension or bushing for securing the fixture to an impeller element, said extension or bushing having an opening extending through its wall and terminating at the bore thereof, and an injection fitting attached to the extension or bore and having the opening thereof communicating with the opening through the wall of the extension or bushing through which an adhesive to secure the impeller to the shaft may be passed.

2. A fixture as defined in claim 1, in which the means for securing the fixture to an impeller element comprises clamping bolts extending through openings in the base member, each of said bolts having a laterally extending portion adapted to engage behind a portion of an impeller

element to be assembled onto the shaft, and means for moving the bolts longitudinally through the holes in the base member in a direction to move said laterally extending portions towards said base member.

3. A fixture as defined in claim 2, in which the laterally extending portions of the bolts are toe pieces extending from the clamping bolts at one side thereof, and which includes means for locating said toe pieces in a predetermined position to engage behind a portion of the impeller element.

4. A fixture as defined in claim 3, in which said locating means comprises an arcuate-shaped recess in the base member circumjacent each of the openings through which the clamping shoulders pass and a projection extending laterally from said bolts and adapted to be located in the respective recesses, the ends of the respective recesses acting as stops for the projections when the projections are located in said recesses and the bolts are turned in opposite directions.

5. A fixture as defined in claim 4, in which the clamping bolts are mounted for rectilinear movement through the openings in the base member and for turning movement only to the extent of the free movement of the projections in said arcuate-shaped recesses, the end portions of the bolts extending from the face of the base member



opposite the face which engages the impeller element being threaded, and clamping nuts mounted on said threaded portions of the respective bolts.

6. A fixture as defined in claim 1 including a locating member protruding from the face of the base member which is to be secured to an impeller element, said locating member being adapted to be received in an opening in the impeller element.

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