

Dec. 28, 1965

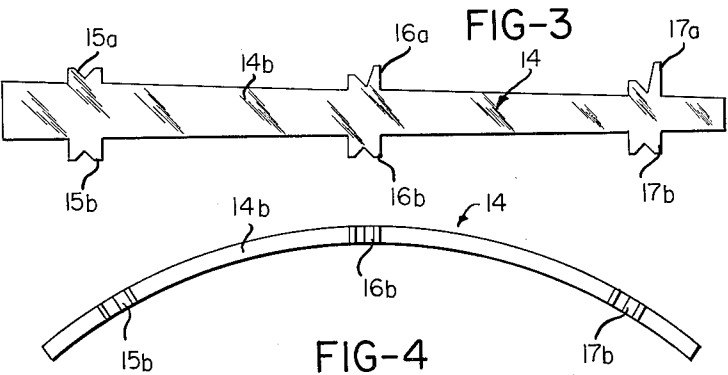
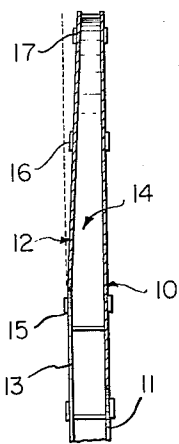
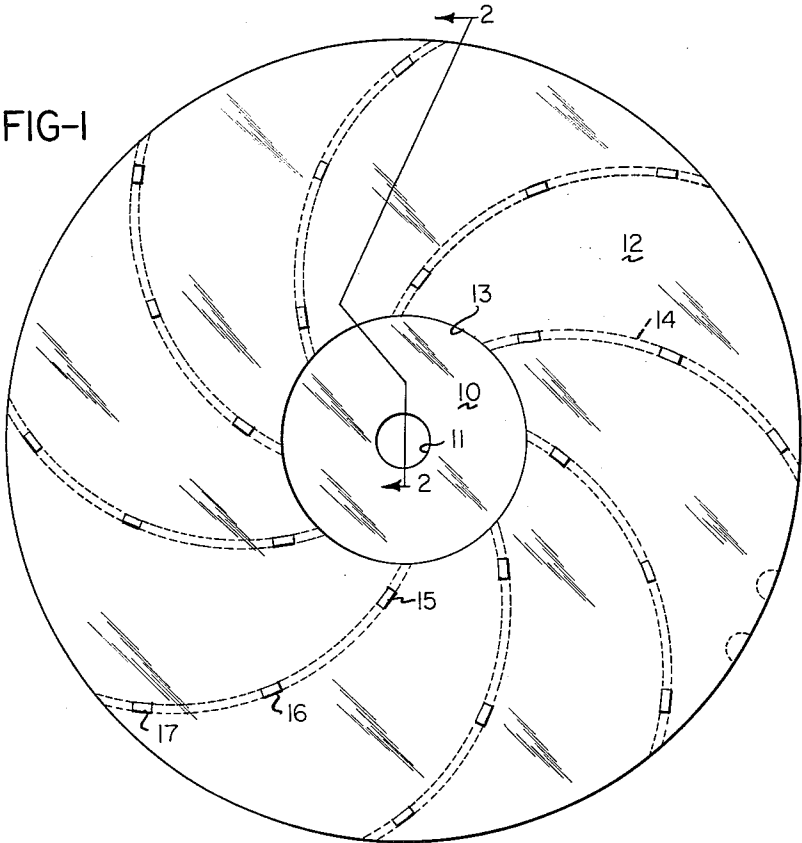
A. L. SEBOK

3,225,422

METHOD OF FABRICATING CENTRIFUGAL FAN IMPELLERS

Filed March 9, 1962

2 Sheets-Sheet 1



INVENTOR.
ALBERT L. SEBOK

BY *Williams, Tilbury & Holick*

ATTORNEYS

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2 Sheets-Sheet 2

FIG-5

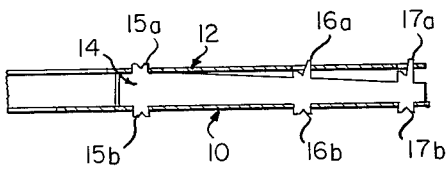
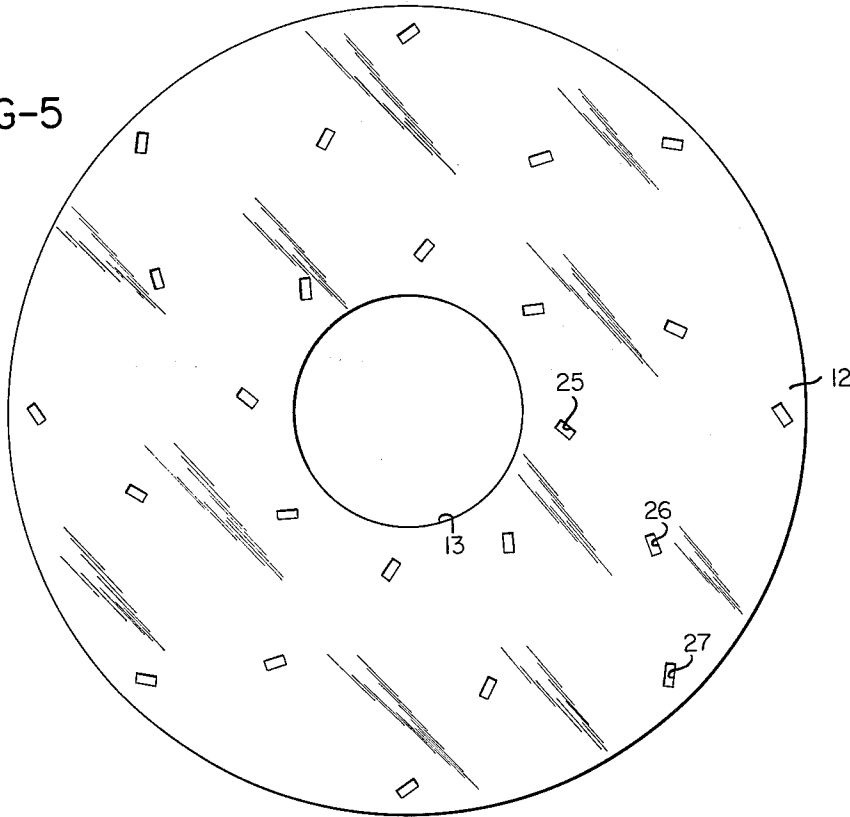


FIG-6

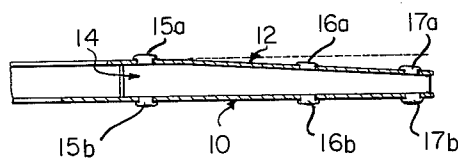


FIG-7

INVENTOR.
ALBERT L. SEBOK

BY *Williams, Tilbury & Holrick*

ATTORNEYS

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METHOD OF FABRICATING CENTRIFUGAL FAN IMPELLERS

Albert L. Sebok, Tallmadge, Ohio, assignor to Ametek, Inc., New York, N.Y., a corporation of Delaware

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5 Claims. (Cl. 29-156.8)

The present invention relates generally to centrifugal pumps and fans, and more particularly to impellers for centrifugal devices, and specifically to a method of fabricating an impeller for a centrifugal fan or pump and the resultant impeller.

In many centrifugal fans or pumps, there is used an impeller or a set of impellers having more or less radially extending spaced end walls with straight, or more usually curved, blades therebetween defining fluid flow passageways from a central inlet opening of at least one wall. These passages have a space between corresponding points of adjacent blades continually increasing from the inlet to the external tips of the blades, usually at the impeller periphery. Often enough the constant axial dimension or spacing between parallel end walls or end plates results in impeller performance satisfactory for intended purposes of the fan or pump. However, for increased efficiency or performance it is often desirable that the axial dimension of each passage between adjacent blades, therefore the spacing between the end walls, diminish from the center inlet towards the peripheral discharge. In some impeller constructions, the more desirable "tapered" passageway construction is readily enough obtained at not too great additional expense; for example, with a cast impeller by suitable mold forms and coring, or in other types of fabrication by appropriate modification of techniques used where the width of the blades is constant, with little increase in cost or, in any event, at a cost nonetheless acceptable because of the very importance of high impeller efficiency and importance of the pump function.

The present invention, however, is more concerned with the production of an improved centrifugal impeller having tapered passages for uses in pumps or fans which cannot carry a cost greatly increased over the ordinary non-tapered type or in which the provision of the improved taper type at the little or no great increases in cost would provide a great competitive advantage.

As an example of the application, we may consider the use of this invention in an impeller for a vacuum cleaner motor-fan unit such as that which is described in detail hereinafter.

By present practice, such impellers are usually fabricated from sheet metal, generally aluminum, comprised of two parallel disks between which are disposed a series of equally spaced identical sheet metal blades having straight or curved body portions of constant width from one end to the other. The blades, whether straight or curved in the final impeller, are stamped out of the sheet metal with riveting lugs or ears projecting from each side of the body in longitudinally spaced and opposed paired relation; and the impeller disks, identical except for a large central aperture providing an air inlet to the impeller in one in contrast with a small shaft receiving aperture in the other, are provided with spaced sets of corresponding apertures to receive the blade lugs. Particularly for curved blades three pairs of opposed lugs are generally present.

With suitable jiggling, a set of blades is located with riveting ears projecting through the apertures of one disk; the second disk is positioned over the ears along the opposite blade edges; and the projecting, lug ends are deformed or "riveted" against the respective disks

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to provide a final substantially rigid assembly with parallel end plates and therefore "untapered" interblade passages of constant axial dimension from the inlet to the discharge or end of each.

With this general type of construction and fabrication, attempts have been made to achieve a tapered or radially convergent passageway by the use of blade body portions tapering from a broad inlet end towards the outer end, one or both of the impeller disks being preformed at least approximately complementary to the blade shape to correspond to the desired final passageway taper. This has been done either by dishing a plate by a stamping or pressing operation or by a rolling operation progressing around the disk. Due to spring-back of the metal in the initial operation, to variances in the character or gauge of different sheet metal lots, or to a gradual recovery of shape in storage, when the preformed disks are not immediately assembled into a final impeller, considerable difficulties have been encountered in obtaining reliable consistent production, resulting either in a large number of rejects, or in successful operations entailing considerably more care or special tooling for the assembly, and therefore greatly increased costs.

By the present invention it is proposed to provide substantially identical flat disks fabricated according to the usual practice for non-tapered impellers, but to use blades with a tapered body and having an extreme width measured between the riveting lug ends which is constant from pair to pair. Thus when a series of the blades is disposed between the two flat parallel plates ready for riveting, all lugs are located in and projecting through respective apertures of the parallel plates. Thus during the riveting, however carried out, the disks and blades are held in proper relation to each other by the initial disposition of the ears in respective plate apertures. A relative approach of the disks towards each other increasing from center towards edge is attained with certainty in a symmetrical final rigid structure. Thus are obviated the expense of an operation preforming one or both of the disks, and also the uncertainties of production hitherto attendant upon such attempts. In general there is then obtained an impeller having tapered passageways with no marked, if any, increase in production costs over the prior non-tapered impellers.

This blade form also is of particular value and importance since it has been found that the blade is best formed to the requisite curvature through a rolling operation subsequent to blanking rather than simultaneously with the blanking because of the factors adverted to as adverse in preforming the end disks. Now where tapered blades are made with rivet lugs of uniform length according to prior practice but with tapered bodies, since the blades do not have, as here, for guidance purposes the effect of a rectangular outline, they are not readily fed in and retained in proper orientation in a rolling machine to obtain a curvature having a proper or even consistent orientation on the body. This difficulty is overcome by the use of the blank having projections as here described.

A general object of the present invention is then to provide a centrifugal impeller of improved characteristics by known general fabrication operations and equipment. Another object is to provide a taper-blade impeller at lower cost. Another object of the present invention is to provide an improved method for producing from sheet metal centrifugal impellers with interblade passageways decreasing in axial dimension from the central inlet region towards the peripheral or discharge region of the impeller. A still further object of the present invention is to provide an improved construction in sheet metal centrifugal impellers. Other objects and advantages will

appear from the following description and the drawings wherein:

FIG. 1 is a face or end view of a centrifugal impeller fabricated according to and embodying the structure of the present invention;

FIG. 2 is a fragmentary edge view corresponding to FIG. 1;

FIG. 3 is a detail view of a blade blank;

FIG. 4 is a side edge view of a curved blade resulting after forming the blank of FIG. 3 into a longitudinally circularly arcuate shape;

FIG. 5 is a face view of a disk 12 ready for assembly into an impeller;

FIG. 6 is a fragmentary detail view showing the relationship of a blade to the opposed flat impeller end disks assembled thereon but before riveting; and

FIG. 7 is a view corresponding to FIG. 6 showing the relation of the impeller end disks to each other and to a blade after riveting in the finished impeller.

The general finished form of an impeller constructed according to the present invention may be gathered from FIGS. 1 and 2 as comprised of a disk 10 having a central shaft receiving aperture 11; a second disk 12 having a large central aperture 13 providing a central impeller air inlet; and interposed therebetween a series of equi-spaced identical curved impeller blades (here eight) extending substantially from the inner periphery of the disk 12 defining the aperture 13 outwardly to the periphery of the disks. It should be here noted that some exaggeration of metal thickness and slot sizes is used for clarity of the drawings.

Each blade is secured at three locations along its length to each disk 10 and 12 in the usual riveted type connection resulting from riveting or heading down, against the outer face of each disk, paired opposite ears projecting through corresponding apertures of the disks at the time of assembly, as at 15, 16 and 17 on the face of disk 12. As thus far described, the structure is similar to that of impellers commonly known and used today for example in vacuum cleaner motor fan units, wherein the impeller is constructed from sheet aluminum.

However, a marked difference from corresponding impellers of the prior art, wherein the two end disks are both generally flat and parallel and thereby result in "non-tapered" interblade passageways, is shown in FIG. 2 where the axial dimension decreases from center towards edge of the impeller. Here the disk 10 is substantially flat as usual but the disk 12 has a slightly conical shape, in consequence of a tapered blade body shape.

The shape of the blades 14 before assembly may be gathered from FIGS. 3 and 4. The blades 14 are blanked out by usual procedures to the preferred form shown in FIG. 3 having a body portion 14b tapering from the large inner left end, to the right as shown, and having substantially equally longitudinally spaced pairs of opposed riveting ears or lugs 15a-15b, 16a-16b, and 17a-17b; shown all being equal in width, and the corresponding sides of the lugs in each pair being substantially in alignment and perpendicular to the bottom edge of the body 14b which will engage or abut against the disk 10. The bottom ears or lugs 15b, 16b, 17b are here shown identical in form with an end notch to facilitate heading and of a length, of course, to extend through the plate 10 and afford sufficient projecting metal for a ready and adequate riveting engagement.

The opposite long side of the body 14 then is in effect a sloping side running obliquely rather than perpendicularly to the sides of the ears 14a, 16a, 17a, the ear 15a being substantially identical to 15b, but the lugs or ears 16a and 17a having the right side or prong thereof extending outwardly beyond the inclined top edge of the body a distance such that the total width of the blade at all three pairs is equal; that is, the lengths of the long sides of 16a, 17a extend out to a line parallel to the bottom body edge and passing across the end of 15a. The form

of the notch in 16a and 17a is such that the left or shorter side of each projects outwardly beyond the upper edge of the body substantially the same distance as 15a. The final form of blades 14 may then be seen from FIG. 4 where the blade is formed out of the plane of the flat blank into a longitudinally arcuate form. The finally formed blades may be produced by any suitable means, but preferably by progressive die techniques for mass production operations.

The disks 10 and 12, identical except for the relative sizes of the central apertures, are punched out of sheet aluminum stock not only with the central apertures therein, but also with eight equally spaced sets of elongated or rectangular slots corresponding in width and length to the blade thickness and ear width. The finished disks readied for assembly in the final impeller are substantially flat, there being no attempt to shape either out of flat condition into any form corresponding to the ultimate shape to be assumed in the finished impeller.

In a suitable assembly jig or fixture, a set of eight blades is positioned with the bottom body edges abutting against the inner face of the disk 10; and with the ears 15b, 16b, 17b projecting through slots corresponding respectively to 25, 26, 27 shown in FIG. 5 for the disk 12; the disk 12 is then placed upon the positioned blade series with the ears 15a, 16a, 17a extending through corresponding slots 25, 26, 27 (see FIG. 6). At this point of assembly the plate 12 being flat abuts against the inner ends of the blades 14 with an increasing spacing relation towards the outer ends due to blade taper. Nonetheless not only the lug 15a on the inner end of the blade, but also the lugs 16a and 17a are engaged and projecting through corresponding slots due to the constant extreme blade width at the lugs, i.e., to the increased length of the latter two lugs. Where the lugs on one side of the blades are not opposite those on the other, the two disks will, of course, correspondingly differ in location of the slot patterns therein. However, the overall method of impeller manufacture will remain basically the same as for the impeller described above in detail.

The actual assembly of disks and blades up to this point may be carried out in much the same way as in the prior art which is here improved, suitable spacers being used therefor if desired to maintain the blades 15 in upright position and equi-spaced relation whereby the plate 12 is readily brought onto corresponding lugs on the top blade edges.

Thereafter the riveting is readily effected by known techniques. This can be accomplished depending upon the complexity of tooling acceptable; by way of examples, by (a) bringing oppositely acting punches into engagement simultaneously with all opposed ears 15a, 15b, or at each pair with indexing, then doing likewise at opposed lugs 16a, 16b, and finally so also at 17a, 17b; the whole radial extent of the blade 12 being thus progressively brought down into conforming contact with the top edges of all the blades; or (b) with both plates 10 and 12 suitably supported to prevent either from springing off the projecting ear lugs, the assembly may be indexed to bring blade after blade under a riveting station where opposed oppositely acting punches first head simultaneously the 15a, 15b pair, then the 16a, 16b pair and finally the 17a, 17b pair; or (c) simultaneously riveting all lugs by punches acting from both sides of the assembly.

I claim:

1. A method of manufacturing a centrifugal impeller for a fan, pump or the like comprised of two sheet metal end disks and formed sheet metal blades secured therebetween, said method including the steps of: blanking out a set of like impeller blades from sheet metal having a body portion tapering in width from a broader inner end to a narrower outer end and having longitudinally spaced ears on each longitudinal edge of the body, the total width of the blank between the ends of the ears on one

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edge to a line through the ends of the ears on the other edge being at least as great as such width at the innermost ears as is required to provide a heading projection of each innermost ear beyond a corresponding said disk; blanking out a first flat sheet metal disk having a small central shaft receiving aperture and a second flat sheet metal disk having a larger aperture than the first to serve as a central air inlet, said disks having a series of spaced sets of blade ear receiving slots; assembling a corresponding set of blades between said flat disks in undeflected condition with larger ends adjacent the center region of the disk and with said ears extending through corresponding slots; and heading said ears into rivet-like engagement with said disks progressively from the innermost to the outermost ears and thereby bringing the disks into conforming engagement with the blade edges.

2. In a method as described in claim 1, wherein the said total width is equal among all ear pairs of each said blade.

3. A method as described in claim 2 including forming said blades to a shape longitudinally curved out of the original plane of the sheet metal stock after blanking out.

4. A method as described in claim 2 wherein said blades are blanked out with said ears perpendicular to one longitudinal blade body edge.

5. A method of manufacturing an article comprised of two sheet metal end disks and formed sheet metal blade-like elements secured therebetween, said method including the steps of: blanking out a first sheet metal disk having a small central shaft receiving aperture and a second sheet metal disk having a larger aperture than the first said aperture, said disks having a series of spaced sets of slots for receiving the hereinafter recited ears; blanking out from sheet metal a set of like blade-like elements having a body portion decreasing in width from a

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broader inner end to a narrower outer end and having on each side edge a plurality of longitudinally spaced ears each with a length at least as great as is required to provide a heading projection beyond a corresponding said disk when the disk is in longitudinal engagement with the corresponding side edge of the blade-like element, and the ear lengths on at least one side edge from the inner to outer end of the blade-like element progressively increasing by an amount sufficient to provide engagement of the ears in corresponding disk slots when the blade-like elements are located between the end disks for assembly; assembling a corresponding set of blades between said disks with larger ends adjacent the center region of the disks and with said ears extending through corresponding slots; and heading said ears into rivet-like engagement with said disks from the innermost to the outermost pairs and thereby bringing the disks into conforming engagement with the blade edges; said disks as produced in the first described step having a general shape non-conforming to the edges of said blades.

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WHITMORE A. WILTZ, *Primary Examiner*.

JOSEPH H. BRANSON, JR., *Examiner*.