Dec. 9, 1947. S. C. WATSON 2,432,185

METHOD OF MAKING TURBINE WHEELS

Filed May 18, 1944

Fig. 2

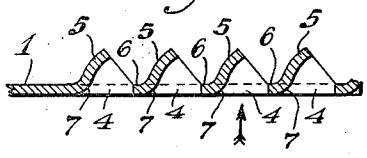


Fig. 4

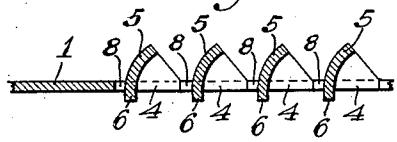


Fig. 1

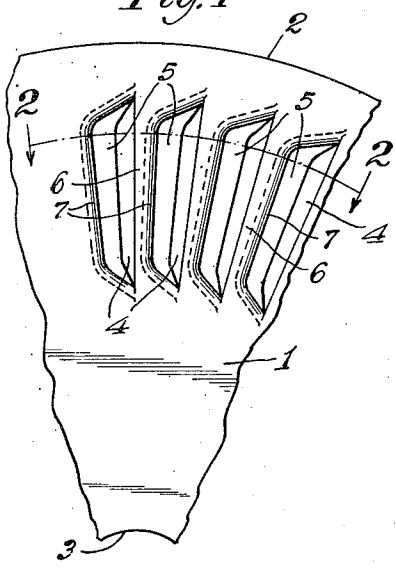


Fig. 3

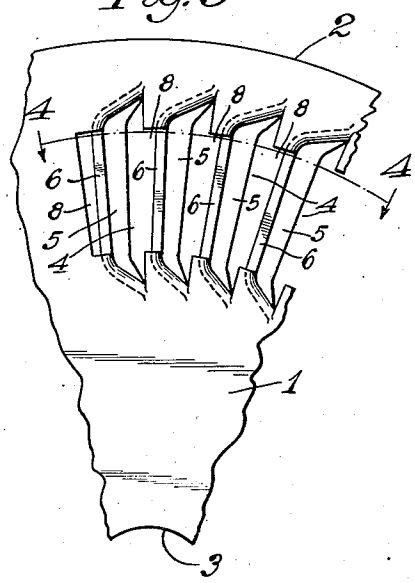


Fig. 6

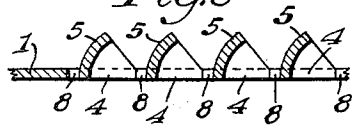


Fig. 7

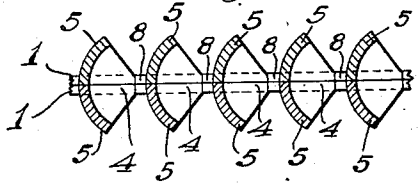
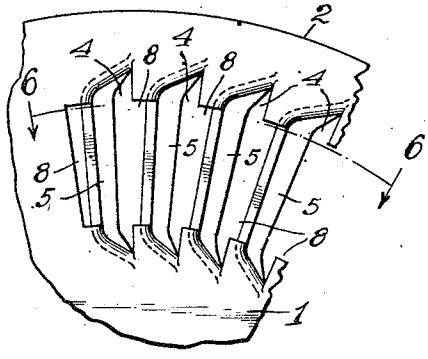


Fig. 5



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METHOD OF MAKING TURBINE WHEELS

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10 Claims. (Cl. 29—156.8)

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This invention relates to a turbine wheel and particularly to the method of forming it. It has for one object to provide a method of forming a turbine wheel by stamping—that is to say, by the operation of dies—and in particular, one of its objects is to provide a method of forming by dies two mating or cooperating members and of forming them in such manner that each member has formed in it a series of members each of which forms one-half of a vane or bucket.

A further object is to form the members by the method in question in such manner that when two are joined together, they produce vanes or buckets of a continuous curve, without interruptions or depressions or irregularities.

Other objects will appear from time to time throughout the specification and claims.

One application of the method is illustrated in the accompanying drawings, wherein:

Figure 1 is a plan view of a portion of a turbine rotor after the first punching or forming operation;

Figure 2 is a sectional view taken at line 2—2 of Figure 1;

Figure 3 is a plan view generally similar to Figure 1 showing the rotor after a second punching or forming operation;

Figure 4 is a sectional view taken at line 4—4 of Figure 3;

Figure 5 is a plan view generally similar to Figure 3 and showing the same side as that shown in Figure 3, after the final severing operation;

Figure 6 is a sectional view taken at line 6—6 of Figure 5;

Figure 7 is a sectional detail showing two of the wheel-forming members in the condition of Figure 5 secured together to form a series of complete vanes or buckets.

Like parts are indicated by like characters throughout the specification and the drawings.

In the particular form of the invention shown herewith, the method is carried out upon members which are designed to be used to form turbine rotors. As thus shown, a generally sheet-like member 1 may be given a rounded shape which is defined in a round periphery indicated at 2. If desired, the member may be centrally perforated to form a perforation indicated at 3.

The forming operation may be carried out to form a plurality of vanes or buckets at a single stroke, or the operation may be repeated once for each stroke, and thus the several vanes or buckets shown in Figures 1 and 2 may have been formed simultaneously, or may have been formed

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one after the other. The steps of formation of each bucket are, however, the same, whether one is formed at a time or several are formed at a time.

In the initial forming operation, a punch is moved in the direction of the arrow in Figure 2 and for each bucket or vane it forms a perforation for and displaces a portion of the member 1 to form what is, in effect, one-half of a vane or bucket, as indicated at 5. Between each two buckets or vanes a portion 6 remains, and it will be noticed in Figure 2 that between each portion 5 and its corresponding portion 6 is a curved fillet-like portion 7. If now two members with vanes shaped, as shown in Figure 2, were put face to face; the curved fillet-like portions would form a depression in the center of each bucket, and this would be unsatisfactory for the flow of the fluid which contacts the wheel. The further steps in the method are to avoid this result.

After the vanes or buckets have been shaped, as shown in Figure 2, another punch is forced through the member 1 and each of the portions 6 is severed and carried downwardly, as shown in Figure 4, to form a continuation of the member 5, and a cut-away portion or slot 8 is thus formed behind each bucket. This cut-away portion communicates with and in effect forms an extension of the cut-away portions 4.

With the parts in the form shown in Figures 3 and 4, it would obviously be impossible or unsatisfactory to try to form a composite rotor by placing two such wheels together. Hence it is desirable to remove the members 6 so that the inner ends or sides of the buckets formed by the parts 5 are flush with one face of the member 1. To accomplish this, the portions 6 are cut off flush with the lower face of the member 1, as shown in Figure 6. With the parts formed now as they are in Figures 5 and 6, two mating members 1 with the rounded buckets or vanes 5 may be placed face to face and they will thus form a rotor including generally two of the members 1 and a series of completed buckets or vanes will be formed, each bucket or vane being formed by two of the members 5, and since the fillet-like curve 7 has been removed by the displacement of the members 6 from the position of Figure 2 to the position of Figure 4, and since finally the projecting ends of the members 6 have been severed when the parts are put together, each pair of members 5 join to form a complete vane or bucket without substantial depressions or irregularities anywhere within it.

While the method as illustrated herewith has

produced a series of radially spaced vanes or buckets, it is to be understood that the method can be carried out to produce these members whether they are radially positioned or not, and they may of course be of many different shapes and profiles. The steps of the method are not limited, therefore, and the method itself is not limited to the production of the article exactly as shown herewith. The method will be substantially the same, also, whether one bucket is formed at a time or whether several are formed, and for many purposes it will be desirable to punch all of the buckets in a given rotor at the same time, and the die would then be so made as to have in it suitable parts to carry out simultaneously the forming operation of Figure 2 on every bucket. Similarly, the punch and die which form the operation in Figure 4 would be made to carry out the step, and so all of the buckets in a given rotor and the projecting portion 6 would be severed generally in a single operation by means of a single cutter.

It is to be understood, of course, that the exact details of the dies will depend upon the type of product necessary and desirable. If a great many rotors are to be made, economy would dictate more elaborate dies than would be necessary if only a few rotors are to be made.

Although I have shown an operative form of my invention, it will be recognized that many changes in the form, shape and arrangement of parts can be made without departing from the spirit of the invention, and my showing is therefore to be taken as, in a sense, diagrammatic.

The initial forming step illustrated in Figures 1 and 2 may be carried out at a single operation or where the thickness or analysis of the metal or other material make it desirable, this initial forming operation may be carried out in two steps—the first step severing and partially forming the buckets and the second step giving them their final form. This particular first operation, therefore, need not be carried out in any particular number of steps. One, two or more steps may be used in producing the form of the article as shown in Figures 1 and 2.

The severing and moving operation illustrated in Figures 3 and 4 may be carried out in a single step or in more than one step. With certain metals and other materials the severing operation in which the portion 6 is forced downwardly to the position of Figures 3 and 4 may result in a slight distortion of the member 5. Should that occur one or more of the steps carried out in bringing the article into the position shown in Figures 1 and 2 may be repeated to remove whatever distortion may have been brought about in the shape of the member 5 by the operation which moves the member 6 to the position of Figure 4.

In the forming operations it is ordinarily preferable to hold the disk 1 between a pressure plate and a die block. These engage and grip the disk before the forming or severing or punching operations take place. When the disk is thus held by the pressure pad and the die block and tightly gripped between them, distortion of the disk is prevented. it is held flat and the area within which stretching of the metal can occur during the severing and forming operations is limited. For most purposes it is advantageous to carry out the forming method in this manner.

I claim:

1. The method of forming a turbine wheel comprising forming a sheet metal member, forming a cut through said member, bending the metal of said member in the region of said cut out of the plane of the member to form on one face thereof an outstanding arcuate vane, forming a second cut through said member adjacent to the base of the vane, bending the metal which remains between the second cut and the base of the vane out of the plane of the member and up from the opposite face thereof to form a vane wall portion in general continuation of the vane wall projecting from said one face of the member, then shearing off flush with said opposite face the metal upset by said second mentioned bending operation, and assembling two such sheet members in back-to-back, contacting relationship, the outstanding vanes of each sheet being in abutting and continuous, arcuate relation with those of the other sheet.

2. The method of forming a turbine wheel comprising forming a sheet metal member, forming a cut through said member, bending the metal of said member in the region of said cut out of the plane of the member to form on one face thereof an outstanding vane of generally arcuate cross-section, forming a second cut through said member adjacent to the base of the vane, bending the metal which remains between the second cut and the base of the vane out of the plane of the member and up from the opposite face thereof to form an arcuate vane wall portion generally conforming to the curvature of the vane wall projecting from said one face of the member and shearing off flush with said opposite face the metal upset by said second mentioned bending operation, and assembling two such sheet members in back-to-back, contacting relationship, the outstanding vanes of each sheet being in abutting and continuous, arcuate relation with those of the other sheet.

3. The method of forming a turbine wheel comprising forming a circular disc of sheet metal, forming a radial cut through said member, bending the metal of said disc in the region of said cut out of the plane of the member to form on one face thereof an outstanding vane, of generally arcuate cross section, forming a second radial cut through said member adjacent to the base of the vane, bending the metal of the disc which remains between the second cut and the base of the vane out of the plane of the member and up from the opposite face thereof to form an arcuate vane wall portion conforming generally to the curvature of the vane wall projecting from said one face of the member, then shearing off flush with said opposite face the metal upset by said second mentioned bending operation, and assembling two such sheet members in back-to-back, contacting relationship, the outstanding vanes of each sheet being in abutting and continuous, arcuate relation with those of the other sheet.

4. The method of forming a turbine wheel comprising forming a sheet metal member, forming a cut through said member, bending the metal of said member in the region of said cut out of the plane of the member to form on one face thereof an outstanding arcuate vane, forming a second cut through said member adjacent to the base of the vane, bending the metal which remains between the second cut and the base of the vane out of the plane of the member and up from the opposite face thereof to form a vane wall portion in general continuation of the vane wall projecting from said one face of the member, then shearing off flush with said opposite face the metal upset by said second mentioned

bending operation, forming a second vaned sheet metal member in accordance with the previously recited steps with the vane members of the second sheet metal member projecting from the opposite face of said sheet, and then securing the vaned members together in back to back relation with the edges of the sheared wall portions of the two vanes abutting and said vanes cooperating to define a bucket having smooth inner and outer surfaces of continuous, arcuate contour.

5. The method of forming a turbine wheel comprising forming a circular disc of sheet metal, forming a radial cut through said member, bending the metal of said disc in the region of said cut out of the plane of the member to form on one face thereof an outstanding vane, of generally arcuate cross section, forming a second radial cut through said member adjacent to the base of the vane, bending the metal of the disc which remains between the second cut and the base of the vane out of the plane of the member and up from the opposite face thereof to form an arcuate vane wall portion conforming generally to the curvature of the vane wall projecting from said one face of the member, then shearing off flush with said opposite face the metal upset by said second mentioned bending operation, forming a second vaned disc member in accordance with the previously recited steps and with the vanes projecting from the opposite face of said disc, and then securing the vaned disc members together in back to back relation with the edges of the sheared wall portions of the two vanes abutting and said vanes cooperating to define a bucket having smooth, continuous inner and outer surfaces of arcuate contour.

6. The method of forming a turbine wheel comprising forming a sheet metal member, forming a series of spaced cuts through said member, bending a portion of the metal between said cuts out of the plane of the member to form on one face thereof a series of spaced outstanding vanes separated from each other by strips of unsevered metal lying substantially in the plane of the member, forming a series of cuts through said separating strips, which cuts extend transversely of said strips at opposite ends thereof and intersect said first mentioned cuts, bending the metal of said strips between said transverse cuts out of the plane of said member and up from the opposite face of the member to form vane wall portions in general continuation of the vane walls projecting from the said one face of the member, and then shearing off flush with said opposite face the metal upset by said second mentioned bending operation, and assembling two such sheet members in back-to-back, contacting relationship, the outstanding vanes of each sheet being in abutting and continuous, arcuate relation with those of the other sheet.

7. The method of forming a turbine wheel comprising forming a sheet metal member, forming a series of spaced cuts through said member, bending a portion of the metal between said cuts out of the plane of the member to form on one face thereof a series of opposed outstanding vanes of generally arcuate cross section separated from each other by strips of unsevered metal lying substantially in the plane of the member, forming a series of cuts through said separating strips, which cuts extend transversely of said strips at opposite ends thereof and intersect said first mentioned cuts, bending the metal of said strips between said transverse cuts out of the plane of said member and up from the opposite face of

the member to form arcuate vane wall portions conforming generally to the curvature of the vane walls projecting from the said one face of the member, and then shearing off flush with said opposite face of the metal upset by said second mentioned bending operation, and assembling two such sheet members in back-to-back, contacting relationship, the outstanding vanes of each sheet being in abutting and continuous, arcuate relation with those of the other sheet.

8. The method of forming a turbine wheel comprising forming a circular disc of sheet metal, forming a series of spaced radial cuts through said member, bending a portion of the metal between said cuts out of the plane of the member to form on one face thereof a series of spaced outstanding vanes of generally arcuate cross section separated from each other by strips of unsevered metal lying substantially in the plane of the member, forming a series of cuts through said separating strips, which cuts extend transversely of said strips at opposite ends thereof and intersect said first mentioned cuts, bending the metal of said strips between said transverse cuts out of the plane of said member and up from the opposite face of the member to form arcuate vane wall portions conforming generally to the curvature of the vane walls projecting from the said one face of the member, and then shearing off flush with said opposite face the metal upset by said second mentioned bending operation, and assembling two such sheet members in back-to-back, contacting relationship, the outstanding vanes of each sheet being in abutting and continuous, arcuate relation with those of the other sheet.

9. The method of forming a turbine wheel comprising forming a sheet metal member, forming a series of spaced cuts through said member, bending a portion of the metal between said cuts out of the plane of the member to form on one face thereof a series of spaced outstanding arcuate vanes separated from each other by strips of unsevered metal lying substantially in the plane of the member, forming a series of cuts through said separating strips, which cuts extend transversely of said strips at opposite ends thereof and intersect said 1st mentioned cuts, bending the metal of said strips between said transverse cuts out of the plane of said member and up from the opposite face of the member to form vane wall portions in general continuation of the vane walls projecting from the said one face of the member, and then shearing off flush with said opposite face the metal upset by said 2nd mentioned bending operation forming a second vaned sheet metal member in accordance with the previously recited steps and with the vanes projecting from the opposite face of the sheet, and then securing the vaned members together in back to back relation with the several edges of the sheared wall portions of the two series of vanes abutting and the vanes of each series cooperating respectively to define a series of buckets having smooth inner and outer surfaces of continuous, arcuate contour.

10. The method of forming a turbine wheel comprising forming a central disc of sheet metal, forming a series of spaced radial cuts through said member, bending a portion of the metal between said cuts out of the plane of the member to form on one face thereof a series of spaced outstanding vanes of generally arcuate cross section separated from each other by strips of unsevered metal lying substantially in the plane

of the member, forming a series of cuts through said separating strips, which cuts extend transversely of said strips at opposite ends thereof and intersect said first mentioned cuts, bending the metal of said strips between said transverse cuts out of the plane of said member and up from the opposite face of the member to form arcuate vane wall portions conforming generally to the curvature of the vane walls projecting from the said one face of the member, and then shearing off flush with said opposite face the metal upset by said second mentioned bending operation, forming a second vaned sheet metal disc in accordance with the previously recited steps and with the vanes projecting from the opposite face of said disc and then securing the vaned discs together in back to back relation with the several edges of

the sheared wall portions of the two series of vanes abutting and the vanes of each series cooperating respectively to define a series of buckets having smooth inner and outer surfaces of arcuate contour.

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