

May 8, 1962

L. I. WEBB
WHEEL MANUFACTURE

3,032,864

Filed April 29, 1958

2 Sheets-Sheet 1

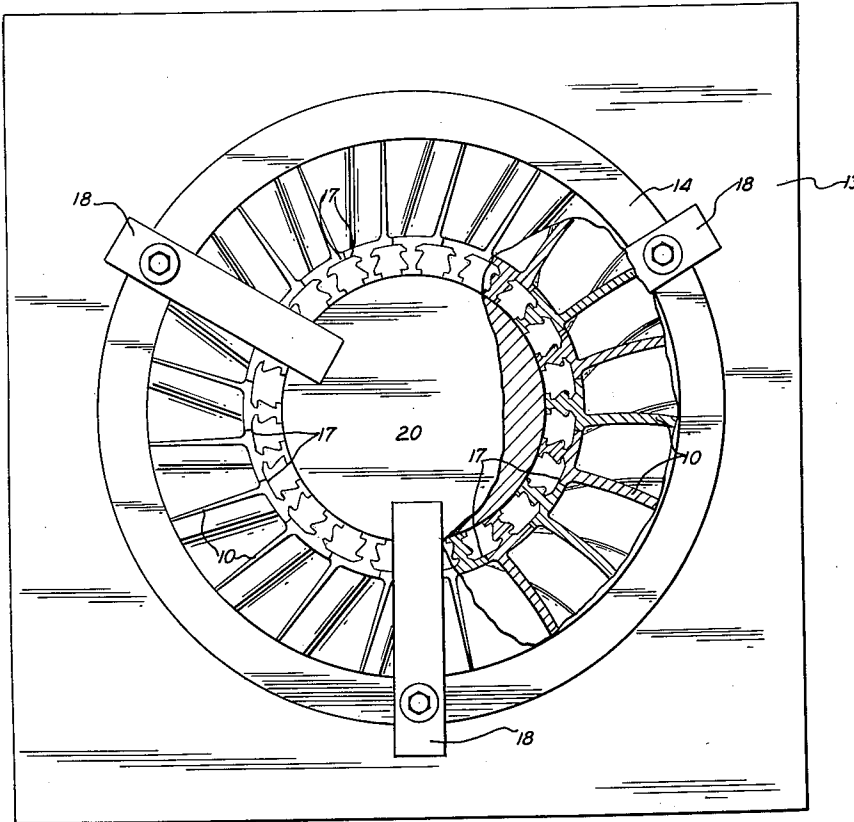


FIG. 2

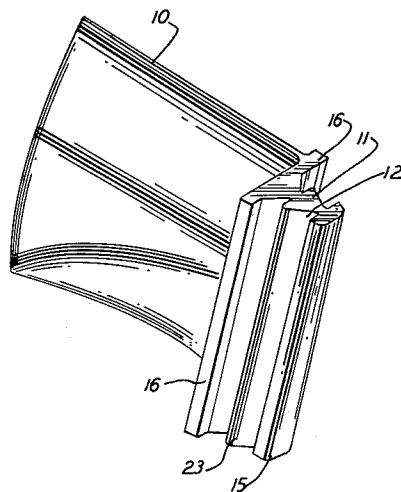


FIG. 1

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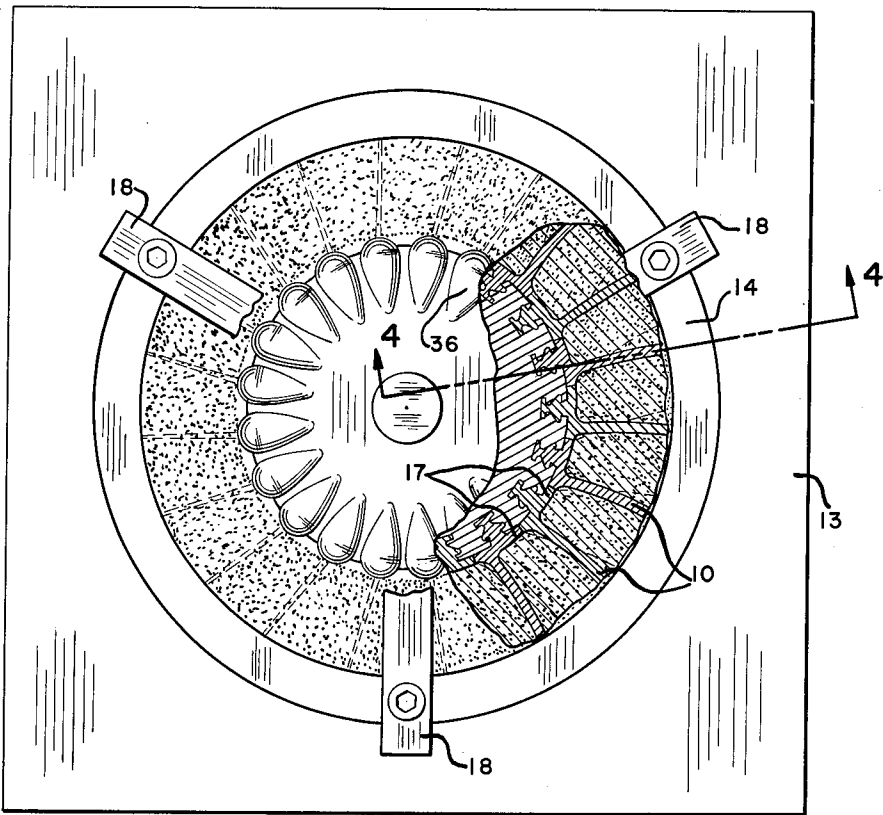


FIG. 3

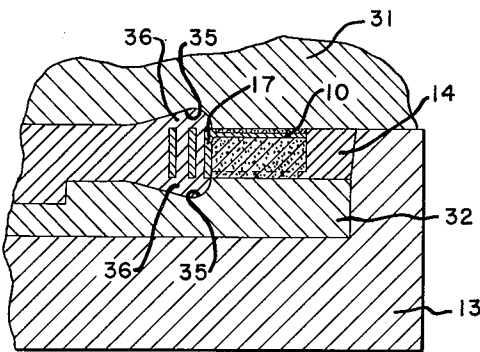


FIG. 4

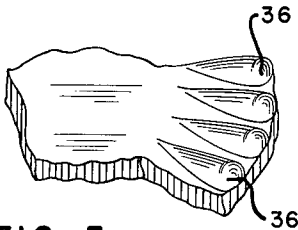


FIG. 5

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WHEEL MANUFACTURE

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2 Claims. (Cl. 29—156.8)

This invention relates to the metal working art and is more particularly directed to a method for economically and repetitiously producing wheels employable either as compressor or turbine wheels.

This invention is intended as an improvement over the invention disclosed in my copending application Serial No. 672,220 filed July 16, 1957, now Patent No. 3,000,081 for Wheel Manufacture. The invention in my copending application is directed to a method of manufacturing turbine or compressor wheels in which a plurality of radial blades are arranged in positions corresponding to their final position in the finished wheel, with the bases of the blades forming a substantially continuous band concentric with the wheel. The blades are then rigidly secured in this position. A highly heated metallic hub blank is placed within the band formed by the blade bases, and a heavy axial pressure is applied to the blank to cause the metal therein to flow radially into contact with the blade bases thereby securing the blades firmly to the blank which forms the central hub of the wheel. Although perfectly satisfactory turbine wheels can be manufactured according to this process, it has been found that metal of the hub blank will fill substantially more of the space between the blade bases if the dies used in applying the axial pressure are relieved in a plurality of positions adjacent the blade bases. When the dies are so relieved, the metal of the hub blank flows radially into these relieved portions and then flows axially into the spaces between the blade bases as the dies are forced into their final positions while simultaneously flowing radially into the spaces from the main body of the hub blank.

This invention will be explained in connection with the drawings in which

FIGURE 1 is a perspective view of a typical turbine blade;

FIGURE 2 is an elevational view of a turbine wheel at an early stage of manufacture;

FIGURE 3 is a similar elevational view partially in section of a turbine wheel prior to removal from the fixture.

FIGURE 4 is a cross section taken along the lines 4—4 of FIGURE 3 showing a portion of the wheel prior to removal from the fixture and in addition showing both of the dies used in forming the wheel; and,

FIGURE 5 is a perspective view of a portion of the wheel showing the shape of the metal left by the relieved portions of the dies.

In the manufacture of turbine wheels according to this invention a large number of identical blades of appropriate chemical analysis and air foil configuration are first produced. In FIGURE 1 the blade is denominated generally as 10 and the blade base as 11. It will be seen that the blade 10 takes a conventional air foil shape. Blade base 11 is shown in a so-called dendritic or fir tree configuration including one or more depressions 12 and one or more elevations 23 which serve to prevent radial detachment of the blade from the hub under heavy centrifugal stress.

The fir tree configuration shown is given by way of example only. Any mechanically strong base structure resistant to displacement in all directions and particularly resistant to centrifugal stress may be employed.

As a second step in the production of the turbine wheel

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the assembly shown in FIGURE 2 is produced. In FIGURE 2 a die block 13 encloses a locating ring 14. Within ring 14 are assembled in their final position the proper number of blades 10. Reverting to FIGURE 1, it is preferred to grind end faces 15 and edges 16 of blade base 11 to close tolerances to produce an exact assembly in ring 14. When blades 10 are assembled in ring 14 within die block 13, the edges 16 of the individual blade bases closely abut each other to form a band 17. Clamping members 18 are employed to temporarily hold the assembly together.

The assembled blades 10 are then temporarily but rigidly secured in their proper position to enable them to remain fixed during a subsequent operation. This is accomplished by filling the annulus defined by band 17 and ring 14 with a low melting and molten metal. This metal is then permitted to solidify at which time it securely binds all of the blades into the desired final position. While any suitable low melting metal may be used as the binding material it is preferred to use metals similar to the composition sold commercially as Kirksite. After this alloy has solidified, centering disk 20 (shown in FIGURE 1) may be removed and all of the blades 10 will be found to be firmly locked into place.

The assembly of blades, die block and Kirksite is now placed in a rapidly acting press preparatory to the forging of the hub about the bases 11 of blades 10. A hub blank which has been previously heated to forging temperature is now inserted in the space vacated by centering disk 20. This forging temperature will usually be at least 2100° F. and often is as high as 2350° F.

The rapidly moving press mentioned above includes a first die 31 and a second die 32 each of which is shown in FIGURE 4, have relieved portions 35 positioned therein in substantial axial alignment with the spaces between the blade bases. These relieved portions, as shown, are positioned both above and below the spaces between the blade bases. The shape of these relieved portions can be best understood by reference to FIGURES 3 and 5 and are substantially 1/2 of a spherical sector with the edges being rounded to permit the metal to flow more readily. Alternatively the relieved portions 35 may be described as rounded cuneiforms so that the metal which flows into the relieved portions forms a wedge shaped structure 36 with rounded edges as shown in FIGURES 3 and 5. As can be seen by reference to FIGURES 3 and 4, the relieved portions 35 of the dies 31 and 32 must not extend beyond the continuous band 17. By terminating the relieved portions 35 over this band the metal from the hub blank is excluded from the air foil portions of the blades.

During the forging operation, the metal from the highly heated hub blank fills the relieved portions 35 of the dies 31 and 32, so that the metal from the hub blank flows both radially and axially into the spaces between the blade bases as the upper die 31 moves into contact with the die block 13.

The above described process in which the metal from the hub blank flows both radially and axially into the space between the blade bases and into contact therewith substantially fills the space between the bases to form an integral turbine or compressor wheel which can be formed with ordinary production labor and facilities.

After the forging operation, the wheel is removed from the die block 13, the low melting point alloy is removed from the blades, and the wedge shaped pieces of metal 36 may be removed from the wheel if desired.

It will be understood that the invention is not to be limited to the exact construction shown and described, but that various changes and modifications may be made without departing from the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. In a process for manufacturing wheels including a plurality of radial blades secured to a central hub, the steps of arranging a plurality of blades in positions corresponding to their final position in the finished wheel and with the bases of the blades forming a substantially continuous band concentric with the wheel, rigidly securing the blades in this position, placing a highly heated metallic hub blank within the band formed by the blade bases and applying a heavy axial pressure to the blank by means of a die positioned on one side of the blank and another die positioned on the other side of the blank, one of said dies having relieved portions substantially in the form of disconnected partial spherical sectors, one of said sectors being positioned over each of the blade bases with the outermost portion of each of said partial spherical sectors being positioned over said substantially continuous band, the metal of said hub blank filling said relieved portions as the dies are brought together so that the metal of the hub blank flows both radially and axially into contact with the blade bases as the dies are brought to their final position thereby securing the blade bases firmly to the hub.

2. In a process for manufacturing wheels including a plurality of radial blades secured to a central hub, the steps of arranging a plurality of blades in positions corresponding to their final position in the finished wheel and with the bases of the blade forming a substantially continuous band concentric with the wheel, rigidly securing

the blades in this position, placing a highly heated metallic hub blank within the band formed by the blade bases and applying a heavy axial pressure to the blank by means of a die positioned on one side of the blank and another die positioned on the other side of the blank, at least one of said dies having relieved portions substantially in the form of disconnected partial spherical sectors, one of said sectors being positioned over each of the blade bases, the metal of said hub blank filling said relieved portions as the dies are brought together so that the metal of the hub blank flows radially and axially into contact with the blade bases as the dies are brought to their final position thereby securing the blade bases firmly to the hub.

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