US 20010035036A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2001/0035036 A1**

Monahan et al. (43) **Pub. Date: Nov. 1, 2001**

(54) **HUB WITH BLIND BORE AND METHOD OF FORMING**

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(21) Appl. No.: **09/843,483**

(22) Filed: **Apr. 26, 2001**

Related U.S. Application Data

(63) Non-provisional of provisional application No. 60/199,890, filed on Apr. 26, 2000.

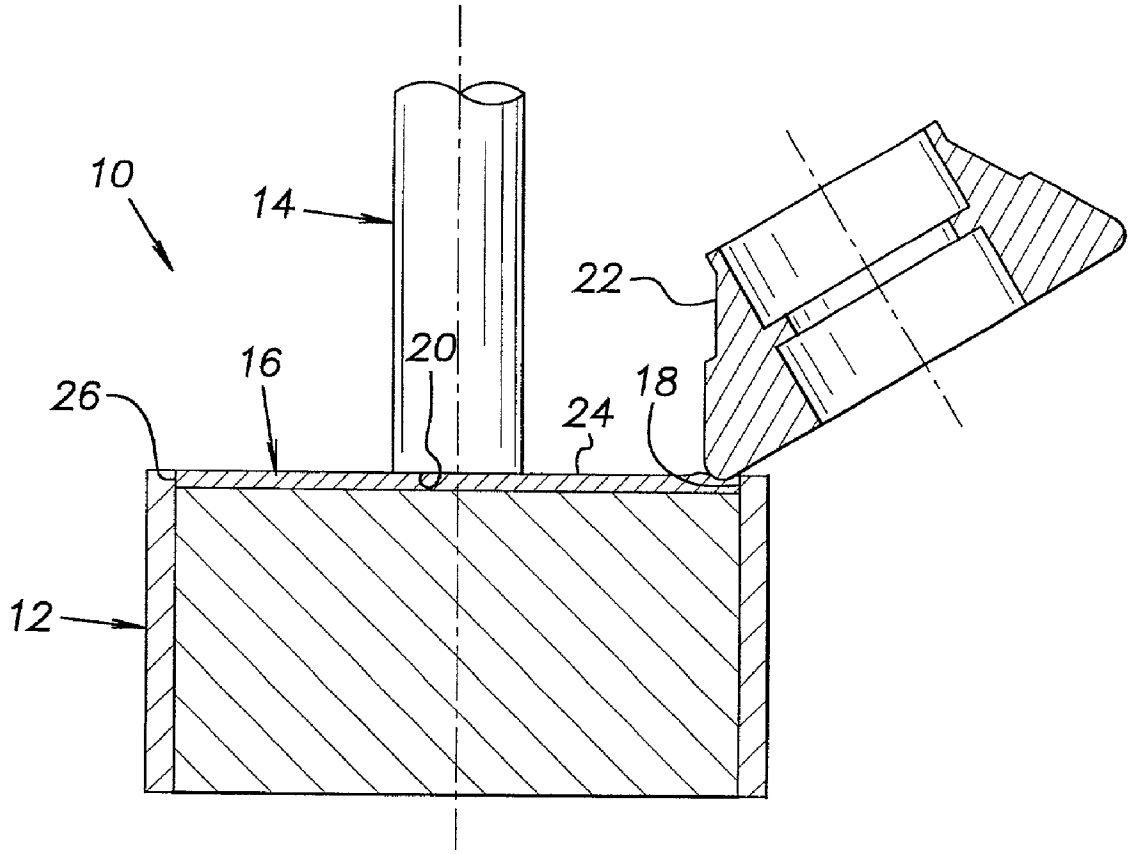
Publication Classification

(51) **Int. Cl.**[7] **B21H 1/00**

(52) **U.S. Cl.** **72/71**; 72/82; 29/894.362

(57) **ABSTRACT**

A method for forming a hub having blind bore is provided. The blind bore hub is formed integrally with a solid circular disc by displacing metal radially inward from the upper surface toward the center of the disc to form a hub, and then punching a bore opening through the center of the hub to provide a blind bore therein. A blind bore hub formed by the foregoing method is also provided.



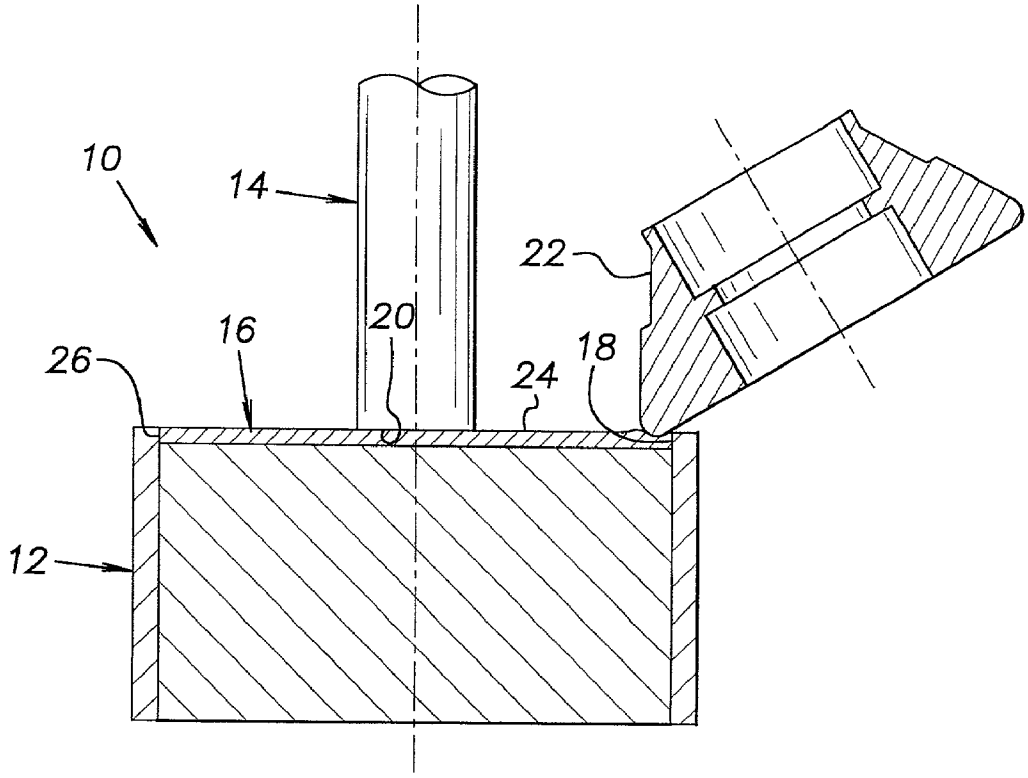


FIG. 1

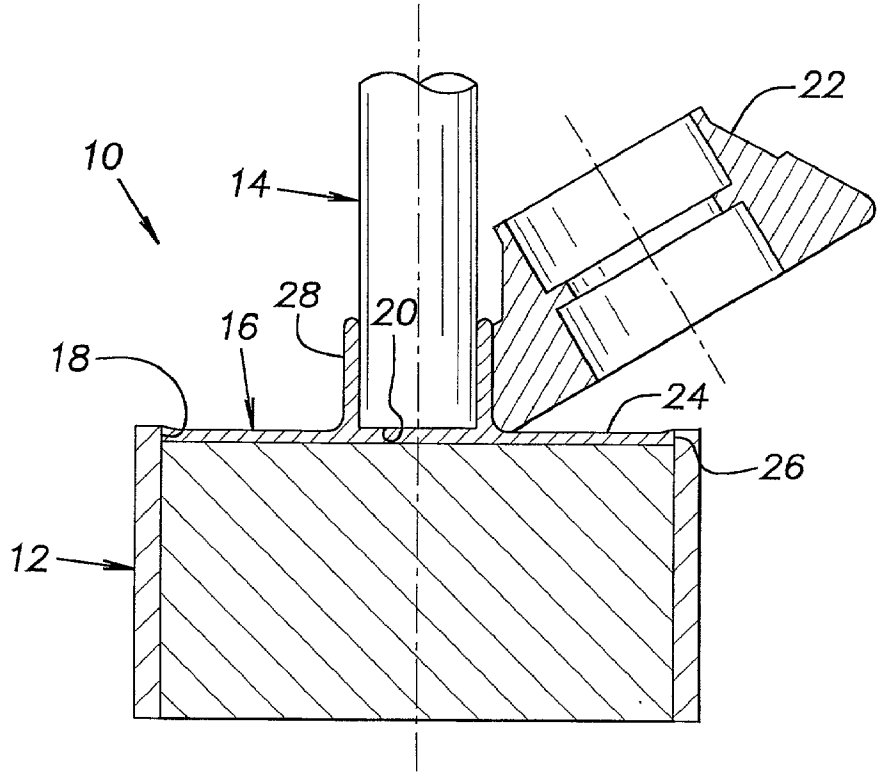


FIG. 2

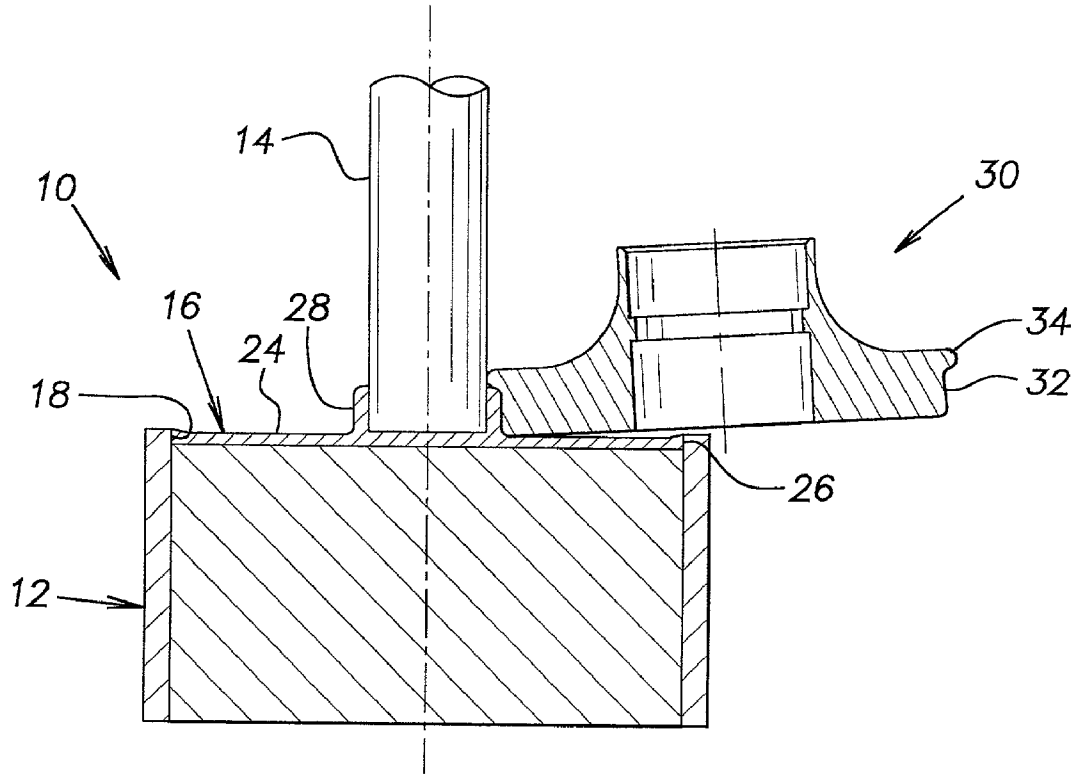


FIG. 3

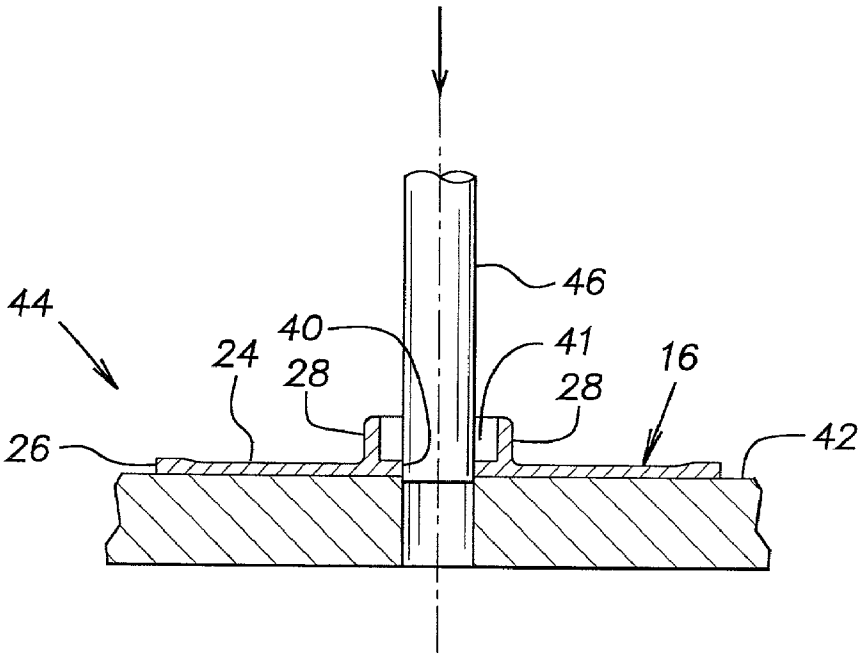


FIG. 4

HUB WITH BLIND BORE AND METHOD OF FORMING

[0001] This application claims the benefit of U.S. Provisional Patent Application Ser. No. 60/199,890 filed Apr. 26, 2000.

BACKGROUND OF THE INVENTION

[0002] This invention relates to pulleys and, more particularly, to pulleys having integral hubs that are formed from sheet metal blanks. There are a variety of techniques employed in the fabrication of pulleys having hubs. One such technique involves spin forming the web and rim from a sheet metal blank, machine forming a hub, and attaching the hub to the web by welding or brazing. While this technique facilitates the formation of a hub having a complete shape, the separate operations involved add significant costs to the pulley.

[0003] More recent techniques involve radial displacement of metal from an annular sheet metal disc to integrally form a hub having a blind bore therein. Such a technique is described in U.S. Pat. No. 5,987,952. According to that patent, a sheet metal disc having a center hole therethrough is provided. The disc is placed on a powered headstock mandrel having a vertical center pin which extends through the center hole of the disc. A stepped mandrel having an axial bore therein is telescoped over the headstock pin so that the end face of the mandrel engages an annular portion of the disc immediately surrounding its center hole. A shaping roller is pressed against a face of the spinning annular disc and is moved progressively radially inwardly to displace a portion of the metal in the form of a traveling annular wave while thinning the disc. The annular wave is pressed against the rotating stepped mandrel. The wave which is pressed against the mandrel forms the hub, and the annular inward portion held by the mandrel becomes a blind bore for the hub.

[0004] A disadvantage of the above technique is that the tooling and the initial hole size in the metal blank dictate the diameter of hubs produced thereby, thus limiting the process to production of blind bore hubs having a single set of given dimensions; i.e. hub diameter and bore opening diameter. If it is desired to change the size of the hub and/or the diameter of the blind bore opening, it is necessary to blank out the disc initially with the desired blind bore diameter and/or change the mandrel tooling. It is therefore desirable to provide a technique for producing a pulley hub having a blind bore wherein the diameter of the hub can be set by a simpler and less expensive change of tooling, and wherein the diameter of the bore opening of a blind bore can be adjusted without having to provide sheet metal blanks with center openings of varying diameter to accommodate different diameter blind bore openings.

SUMMARY OF THE INVENTION

[0005] This invention provides a method of forming a hub having a blind bore integrally with a solid circular disc that can be used to form a pulley. The internal diameter of the hub and the internal diameter of the blind bore opening can be easily varied. According to this invention, a solid circular disc is provided. The disc is placed in a recess in a headstock mandrel and is held at its center by a hub-forming mandrel having an outside diameter corresponding to the inside diameter of the hub to be formed. The disc is spun by the headstock mandrel while a shaping roller engages an edge portion of the disc and is moved progressively radially inwardly toward the center of the disc. The roller is also moved downwardly at a slight angle to move metal in the form of a wave toward the center of the disc. The wave is pressed against the hub-forming mandrel to form the hub.

[0006] The shaping roller is removed and a final finishing roller is pressed against the hub to finish forming the hub. The disc containing the integrally formed hub is removed from the headstock mandrel and a center hole is punched to conform to the desired bore opening diameter of the blind bore.

[0007] Thus it should be appreciated that a wide variety of hub diameters can be produced by replacement of a single, relatively inexpensive hub-forming mandrel, and that a wide variety of bore opening diameters can be incorporated therein by using punches of varying diameters.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] **FIG. 1** is a schematic illustration of a hub and blind bore formation operation at an initial stage.

[0009] **FIG. 2** is a schematic illustration similar to **FIG. 1**, but showing the operation at a later stage.

[0010] **FIG. 3** is a schematic illustration similar to **FIG. 2**, but showing the operation at a still later stage.

[0011] **FIG. 4** is a schematic illustration showing the final stage of operation.

DETAILED DESCRIPTION OF THE INVENTION

[0012] As used herein, the term "solid circular disc" means a circular metal disc of solid material having no holes therein or therethrough.

[0013] Referring now to the drawings, there is illustrated a spin-roll forming machine **10**. The machine **10** includes a headstock mandrel **12** and a hub-forming mandrel **14**. A solid circular disc **16** of sheet metal is positioned within a circular recess **18** on the headstock mandrel **12** and is securely clamped thereto by an end face **20** of hub-forming mandrel **14**. With the mandrel pressed firmly against the center of the disc **16**, but being permitted to spin about its longitudinal axis, a shaping roller **22** is brought into contact with an upper face **24** of the disc **16** at a position proximate the edge **26** of disc **16**. The headstock mandrel **12** is driven in a circular direction and the shaping roller **22** is moved inward toward the center of the disc **16** while being pressed against upper face **24** at a slight downward angle as is known in the art and as disclosed in U.S. Pat. No. 5,987,952. As the shaping roller **22** moves in this fashion toward the center of the disc **16**, metal displaced from face **24** of the disc is forced into contact with the cylindrical sidewall of hub-forming mandrel **14** to form a hub **28**, as may be seen in **FIG. 2**.

[0014] Next, referring to **FIG. 3**, the shaping roller **22** is removed and a hub finishing roller **30** is positioned so that a tapered surface **32** thereof is pressed against the hub **28** such that the surface **32** is substantially parallel to the hub-forming mandrel **14**. An annular ridge **34** of the finishing roller **30** shapes the terminal edge of the hub **28**.

[0015] Referring now to **FIG. 4, a** blind bore opening **40** is formed in the hub **28** by removing the disc **16** with integrally formed hub **28** from the headstock mandrel **12**, placing it on the bed **42** of a stamping press **44**, and driving a punch **46** through the center of the hub **28**. The diameter of punch **46** is smaller than internal diameter of hub **28**, and is selected to form a bore opening **40** of a blind bore **41** having a desired diameter.

[0016] Alternatively, the headstock mandrel can have a hole or opening at its center to accommodate a punch. In this embodiment, solid circular disc **16** is placed on the headstock mandrel **12** and spun as before, and the hub **28** formed as above described. After the hub-forming operation has been completed, hub-forming mandrel **14** is replaced with a punch **46** having a smaller diameter than mandrel **14**. Punch **46** is then driven through the center of the hub **28** into the center hole or opening of headstock mandrel **12** to form the blind bore opening **40** of blind bore **41**. Optionally, the hub-forming mandrel **14** can have a through bore at its center with an opening at the base adjacent to the circular disc **16**. The through bore is adapted to slidably receive a punch therein. Once the hub has been formed as described above, the punch in the through bore of the mandrel **14** is driven through the circular disc **16** at the center of the hub **28** via known means.

[0017] It will be understood by one skilled in the art that hubs having a range of internal diameters can be provided according to the method of the invention by selecting a hub-forming mandrel having a diameter corresponding to a desired diameter of a hub to be formed. Likewise, blind bore openings having a range of diameters can be provided by selecting a punch having a diameter corresponding to that of a desired bore opening. Therefore, a blind bore hub according to the invention can be provided having an extremely wide variety of hubs having various internal and bore opening diameters. A spin-roll forming machine adapted to make a hub according to the present invention has significantly greater utility than prior forming machines, because such prior machines were capable of producing only a single size hub, having a single size blind bore opening.

[0018] Once the hub **28** has been formed, the disc **16** incorporating said hub can be further worked, machined, shaped, or combined with other elements as well known in the art to form a pulley that incorporates or comprises the hub **28** with a blind bore according to the invention.

[0019] While the invention has been shown and described with respect to particular embodiments thereof, those embodiments are for the purpose of illustration rather than a limitation and other variations and modifications of the specific embodiments herein described will be apparent to those skilled in the art, all within the intended spirit and scope of the invention. Accordingly, the invention is not to be limited in scope and effect to the specific embodiments herein described, nor in any other way that is inconsistent with the extent to which the progress in the art has been advanced by the invention.

What is claimed is:

1. A method of forming a hub having a blind bore therein comprising the steps of:

a) providing a solid circular disc having an upper face;

b) forcing metal from said upper face radially inwardly toward the center of said disc to form a hub; and

c) punching a bore opening at the center of said hub, said bore opening having a smaller diameter than the inside diameter of said hub to form a blind bore therein.

2. A method according to claim 1, wherein said hub is spin-roll formed from metal displaced radially inward from said upper surface of said disc.

3. A hub formed by a method according to claim 1.

4. A method of forming a hub having a blind bore comprising the steps of:

a) providing a solid circular disc having an upper surface thereof;

b) placing said disc in a recess in a headstock mandrel and holding said disc at its center by a hub-forming mandrel, said hub-forming mandrel having an outside diameter corresponding to a desired inside diameter of a hub to be formed;

c) spinning said disc;

d) engaging said disc with a shaping roller at a downward angle and moving said shaping roller progressively radially inward from a position proximate the edge of said disc along said upper surface thereof, thereby displacing metal from said surface as a traveling annular wave toward the center of said disc;

e) pressing said annular wave against said hub-forming mandrel to form a hub; and

f) punching a bore opening at the center of said hub, said bore opening having a smaller diameter than the inside diameter of said hub to form a blind bore therein.

5. A method according to claim 4 further comprising the step of pressing a finishing roller against said hub, said finishing roller having an annular ridge adapted to shape a terminal edge of said hub.

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