A method and apparatus are disclosed for forming dish-shaped articles from a circular blank by spinning operations. Spinning rollers having large radius shoulders are guided by template control means along a first path to spin the blank to form a curved intermediate shape at a first high speed operation. The intermediate shape is then subjected to a draw spin operation with a smaller radius shoulder guided by a second template control means along a second path distinct from the first path. The speed of operation for the second path is controlled to uniform deformation energy for the second run.

7 Claims, 1 Drawing Figure
METHOD AND APPARATUS FOR PRODUCING DISH-SHAPED ARTICLES

The present invention relates to a method of producing dish-shaped articles by a spinning or draw spinning operation whereby a circular disc or roinde is drawn on a spinning chuck, and a draw spinning machine for performing such method.

The method and the apparatus according to the invention serve to produce dish-shaped bodies or articles, especially wheel discs or dishes for e.g. trucks, by a non-cutting shaping operation.

It is known to produce wheel dishes by deep drawing in a press, whereby the edge of the circular disc or roinde used must be rolled in advance to a tapering configuration in a disc rolling mill at forging temperature.

Accordingly, this method of production is uneconomically expensive, and the wheel dishes produced thereby, moreover, are not true to shape or size, respectively.

Furthermore, it is known first to spin wheel dishes on a spinning lathe according to the published German Patent application No. 1,285,436 in one pass of operation on a fixed spinning die, and then to draw the wheel dishes by means of a trailing roller. It is of disadvantage that this principle does not permit the use of materials of higher strength because spin shaping of high strength materials is not possible in one single pass from a roinde or circular disc to a wheel dish shape due to the inherent strength, since this would result in breakage of the material. Besides, this method results in that the final wheel dish expands resistively to greater degree, so that it is not sufficiently exact to shape and size. The expansion or swelling of the finally shaped wheel dish is approximately proportional to the preceding spinning work.

In contrast with this method, it is the object of the invention to provide a method and a draw spinning machine for producing dish-shaped articles and especially wheel discs or dishes, by means of which even materials which are difficult to shape may be shaped with their wall thickness reduced to any desired degree, whereby it is contemplated that the finished workpiece has maximum accuracy to size or shape, that a uniform structure is formed in the material used, that the shaping energy to be applied remains low, and that it is possible in particular to perform the production in economical, safe, trouble-free and rapid manner and fully automatically.

In the method outlined at the beginning, this object is solved according to the invention that this said roinde is first shaped into a dish-shaped intermediate form or temporary shape by a spinning operation, and thereafter brought into the final shape by a draw spinning operation with continuous deformation energy.

By means of the small proportion of spinning and shaping work in the second pass of operation, it is obtained according to the invention that the spring-back resilience of the finished wheel dish is maintained within very narrow limits, so that high accuracy to shape of the wheel dish is obtained. Likewise, the springback resilience is reduced to a minimum in dependency of the tolerances of the stock or starting material which actually cannot be compensated by influencing the tool and the mode of control.

Advantageously, the shaping into the temporary shape or intermediate form can be performed by spin shaping in air, i.e. without abutment, and the temporary shape can be formed in one or more passes of the spin roller. In order to speed up the shaping process, the spinning of the temporary shape can be effected at substantially higher shaping rates than the production of the final shape, and the spinning and/or draw spinning can be effected in any position of the roller pass, while permitting accommodation of the respective shaping requirements, with a rate of shaping (speed of advance) adjusted as desired.

As a further advantageous feature, the finished workpiece may be clamped between the ejector and the headstock spindle and, while avoiding damage to the spinning chuck, may be pushed off the spinning chuck.

Advantageously, the draw spinning machine according to the invention and having two or more draw spinning rollers is characterized in that each roller comprises a separate copying system consisting of a main template and a copying cylinder, for the control thereof. Advantageously, in the draw spinning machine according to the invention each main template may have associated therewith a movable auxiliary template facilitating the production of the temporary shape by spinning in air, i.e. without abutment, whereby each auxiliary template may have associated therewith a moving element displacing the contour of the auxiliary template behind the contour of the main template, while, furthermore, the main and auxiliary templates of the individual roller units advantageously may be formed with different configurations for adjusting any desired any different path of travel of the rollers.

In another advantageous embodiment, the draw spinning machine according to the invention may include contact elements for the adjustment of the continuous shaping operation, which contact elements are adapted to be set during the working passes to any desired rates of advance which join each other with continuous transition on the control desk.

In order to simplify the draw spinning machine according to the invention, it may be operated with combined spinning and draw spinning rollers, whereby the front peripheral region of the combined draw spinning rollers may form a spinning roller having a large radius while a smaller drawing radius may join the spinning shoulder of the roller, which smaller radius is active during the final shaping process. The individual draw spinning rollers may have different peripheral contours and may operate in different positions.

In the following, an exemplary embodiment of the invention is explained in greater detail by means of a drawing showing schematically the shaping portion of a draw spinning machine according to the invention.

The method according to the invention cannot readily be compared with the known method according to the abovementioned published German Patent application No. 1,285,436, because the spinning and drawing or stretching operation on a wheel disc or dish of readily deformable steel may be performed in one single run of operation and with one pair of rollers only.

According to the invention, a second run of operation within the same clamping period of the workpiece precedes the final draw spinning operation. In such preceding run, a temporary shape is formed by spinning in air, i.e. without abutment, which temporary shape is
then brought into the final shape by a draw spinning operation by employing a continuous shaping work, so that even materials which are difficult to shape, may be shaped within one clamping period.

By the use of continuous shaping work during the final draw spinning operation, a uniform structure or texture is obtained in the workpiece, whereas heretofore the most various types of structure were present within the workpiece. The continuous shaping work for obtaining the final shape may comprise, on the one hand, a shaping work by spinning (urging the material against the chuck) or by draw or stretch spinning (reduction of the wall thickness by means of spinning rollers) or, on the other hand, the addition of the two shaping operations. In this case, it has to be noted that a small amount of shaping work for the draw spinning results with a high amount of shaping work for the spinning operation and vice versa.

The first pass for spinning the workpiece in the air, i.e. without abutment against the spinning chuck, can be effected in extremely rapid manner. In this way, it is obtained in a manner being surprising to the expert that the complete shaping operation does not take more time than in conventional machines, although a dual pass (over the workpiece) is made. In view of the fact that substantial shaping energy has been applied in the first spinning operation, the second draw spinning operation may be performed faster than in the known methods, too.

Also, it is surprising to the expert that the provision of a continuous shaping work in the final shaping or deformation step results in an entirely uniform structural arrangement of the wheel dish, and that virtually no spring-back resiliency of the wheel dish occurs even when using materials of maximum strength and of unfavorable shaping properties, so that the adjusted shape can be maintained most exactly. Furthermore, it is surprising that the workpiece produced in accordance with the method of the invention has an extremely smooth surface, while substantial scoring occurred in the known method.

Additionally, due to the fact that a limited portion of the shaping work only has to be exerted in the second run or operation, a wall thickness reduced as desired can be obtained even in the case of workpieces which are difficult to shape, so that this provides in the field of wheel construction for automotive vehicles, the possibility of producing wheel dishes having reduced wall thickness and, therefore, lower unsprung masses by employing materials of high strength. Further, the uniform structure or texture of the finished wheel dish, in a manner surprising the expert, results in uniform strength of the wall thickness of the wheel dish regardless of the degree of shaping. The abovementioned, reduced spring-back resiliency of the finished part which is obtained by the smaller proportion of the draw spinning work in the second run of operation, allows to substantially improve the spring-back resiliency and, thus, the accuracy to size in comparison with conventional wheel dishes, even in the case of materials which are difficult to shape.

With known construction, the draw spinning machine according to the invention comprises two or more shaping rollers. The feed or advance of the rollers is effected, in known manner, by a hydraulic copying device each; however, each feed cylinder of each roller has provided thereon a separate copying device. A leading auxiliary template protruding beyond the contour of the main template, controls the spinning rollers in order to produce the temporary shape in the first pass over the workpiece. For the second pass or run, the auxiliary template is withdrawn behind the main template so that the latter may be scanned for the subsequent draw spinning operation.

In order that the two abovementioned operations may be carried out during one clamping period or cycle of the workpiece, combined spinning rollers are used. The combined spinning rollers according to the invention comprise a pair of peripheral radii of different size and arranged in tandem, whereby a larger radius for spinning is provided in the front region of the roller, which is followed by a smaller radius for the draw or stretch spinning operation. The first smaller radius is mainly active in the first operation cycle, i.e. "production of the preform", while the second, smaller drawing radius becomes active in the second step of operation, i.e. "drawing into the final shape". In view of the fact that in the first step of operation the roinde is still positioned perpendicularly to the machine axis, when the spinning rollers are advanced, the larger spinning radius thereof will first engage the roinde and effect the shaping in the spinning cycle. It is not before the second run over the workpiece when the roinde already shows a great component directed parallel to the machine axis, that the smaller drawing radii at the outer sides of the spinning rollers come into engagement with the workpiece, while the roinde is already turned over inwardly relative to the larger spinning radius.

Since a separate control means is provided for each of said spinning rollers, both pinning rollers may operate in different positions and may be moved in different peripheral contours. Also, it is possible to employ differently shaped spinning rollers.

Furthermore, since the auxiliary template is formed as a pivotable template, the preform can be shaped in a plurality of shaping runs if the shaping properties of the material employed are of very unfavorable nature. The use of a combined spinning roller having two different shaping radii, provides the advantage that two principally different shaping processes can be performed with one and the same rollers during one clamping cycle of the workpiece.

For the adjustment or control of the continuously applied deformation energy in the final shaping operation, it is advantageous if the shaping speeds can be selected continuously and as desired during the run over the workpiece. To this end, contact elements control the speed of advance of the spinning rollers in every position of advance thereof, whereby the degree of the speed of advance for both shaping operations can be preselected at a control desk. The different speeds join each other with continuous transition.

Now, in all of the shaping operations, especially in the draw spinning operation, the shaping speed is selected in such way in relation to the position of the spinning rollers that uniform deformation energy is exerted for every increment of travel. In addition to the formation of a uniform structure of texture, this ensures that the draw spinning machine is loaded uniformly and without any load peaks, and the energy consumption takes place likewise without any peak values. Apparently, the machine may thereby be designed with more favorable connected load (value), and the draw spinning machine is subject to less wear, which means
that this machine may be of correspondingly lighter construction and of improved economy. Accordingly, the method according to the invention for the production of wheel discs or dishes, on the whole, provides a number of advantages which could not be foreseen by the expert. Rather, the expert would assume that the performing of two roller passes or runs in the method is disadvantageous in economical respects.

As shown in the FIGURE, the draw spinning machine according to the invention is provided with a pair of oppositely arranged spinning rollers 6 which are concentrically positioned with respect to the spinning chuck 2 and the pressing spindle 3. The ronde or circular disc 1 to be shaped is clamped between the spinning chuck 2 and the pressing spindle 3, whereby the centering of the ronde is effected by means of a stud 4 on said pressing spindle 3. The turning tool or spinning chuck 2 is rotated, in known manner, by an electric motor through a transmission gear, while the spinning rollers 6 and the pressing spindle are likewise moved by hydraulic means, in known manner.

In order to shape the ronde 1 into the intermediate form or temporary shape 5, the spinning rollers 6 which are mounted within roller bearings 7, are moved along the contour of the auxiliary template 8 by means of a hydraulic copying system 9. In this operation, the spinning shoulder 10 of the spinning rollers 6 is in contact with the ronde 1 or 5, respectively, because the ronde which extends perpendicularly from the machine axis, apparently, engages the front face of the spinning rollers at 10.

Upon completion of the first working operation, the spinning rollers are returned into their starting position by means of an automatic switch-over means. The auxiliary template 8 is withdrawn behind the contour of the main template 12 by means of a feed device 11, and in the subsequent second operation, the respective spinning roller 6 is caused to follow the contour of the main template 12 by the hydraulic copying system 9. In the course of this second working operation, the machine mainly performs a stretching or smoothening work so that the thick wall thickness of the temporary shape 5 is drawn to the reduced wall thickness of the final shape 13 of the wheel. During this operation, the drawing shoulder 14 having a relatively small radius on the spinning roller 6 is in engagement with the intermediate shape 5 and the metal is now displaced primarily inwardly to the spinning chuck. As best seen in the drawing, the drawing shoulder 14 has a curvature formed with a smaller radius than the curvature for the spinning shoulder 10 which is formed with a larger radius. Of course, the larger radius shoulder 10 is located closer to the spinning axis than is the smaller radius shoulder 14.

By means of a central control desk which provides all of the control pulses necessary for automatic operation, the shaping speed can be varied in continuous manner in the course of the two working operations. The change of speeds is effected by means of a limit switch control which is operated during the respectively successive shaping operations. The different shaping speeds may be preselected on the control desk in known manner.

Upon completion of the shaping process, an ejector urges the finished wheel disc or dish 13 from the spinning chuck 2 against the pressure exerted by the headstock spindle 3. The ejector stops in the ejection position. Thereafter, the headstock spindle 3 moves back still further, and the finished wheel dish 13 drops onto a discharge device. In this way, damage to the spinning chuck during the ejection of the finished dish 13 is avoided because the wheel dish drops only in a position beyond the plane wherein the outermost outline of the spinning chuck is within the extension of the flanges of the wheel dish.

What we claim is:

1. A method of producing dish-shaped articles from a circular blank comprising the steps of: clamping the blank to a spinning chuck, spin shaping the blank into a curved intermediate shape in air without abutment against said chuck at a first predetermined speed by moving spinning rollers along a first predetermined path for the spinning operation, changing the speed of the spinning rollers during a draw spinning operation and imparting uniform deformation energy for the increments of travel of the spinning rollers during the reduction in cross-sectional thickness of the blank, and moving said spinning rollers along a second discrete path and draw spinning of the blank to the final shape at speeds less than said predetermined speed.

2. A method in accordance with claim 1 including the step of reversing the direction of travel of said spinning rollers between traveling along said first and second paths.

3. A method in accordance with claim 1 including the step of ejecting the finally-shaped article from the spinning chuck while avoiding damage thereto.

4. In a draw spinning apparatus, a rotatable drawing chuck having a contoured surface thereon, means for clamping a circular-shaped blank to said chuck, means for drawing the outer peripheral portion spaced from said contoured chuck surface, at least two draw spinning rollers each having spinning shoulders for engaging the outer peripheral portion of said blank and for shaping by spinning the outer peripheral portion to the curved intermediate shape during a first run, first control means including a first template means for controlling the movement of said spinning rollers along a first path during the spinning of said blank to said intermediate shape, draw spinning shoulders on each of said spinning rollers for drawing and spinning the intermediate shaped blank against said contoured surface while reducing the cross-sectional thickness of said blank and re-shaping the intermediate shape into a final shape, and second control means including a second template means for controlling the movement of said spinning rollers and said draw and spinning shoulders along a second path distinct from said first path for forming of the blank into a final shape from said intermediate shape.

5. An apparatus in accordance with claim 4 in which each of said spinning shoulders has a larger radius than the radius of said draw spinning shoulders, said draw spinning shoulders being located radially outwardly of said spinning shoulders from a rotational axis for said spinning roller.

6. An apparatus in accordance with claim 4 in which said first template means for controlling the path of the spinning operation is located adjacent said template means for controlling the path of the spin drawing operation and in which means are provided for displacing one of said template means to allow use of the other one of said template means.

7. An apparatus in accordance with claim 4 in which said spinning rollers are rotated at a higher speed for the spinning operation and at a slower speed for the draw spinning operation, the latter operation being conducted with uniform deformation energy.

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