PATENT SPECIFICATION (11) 1 572 645

1 572 645

(21) Application No. 10018/77 (22) Filed 9 Mar. 1977

(31) Convention Application No. 2611568 (32) Filed 19 Mar. 1976 in

(33) Fed. Rep. of Germany (DE)

(44) Complete Specification Published 30 Jul. 1980

(51) INT. CL.[3] B21H 1/06

(52) Index at Acceptance
B3M 17X 1 2 E
B3A 85

(19)

(54) METHOD AND APPARATUS FOR PRODUCING ANNULAR WORKPIECES WITH A PROFILED CROSS-SECTION

(71) We, THYSSEN INDUSTRIE AG, a German Company of 4300 Essen, Am Rheinstahlhaus 1, Federal Republic of Germany, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:-

The present invention relates to a method and apparatus for producing annular workpieces with a profiled cross-section.

Annular workpieces with a strongly profiled cross-section, such as weld-on flanges or the like, can be produced by forming ingot-shaped or bar-shaped blank workpieces, heated to forging temperature, on die forging presses or hammers and then piercing them and trimming the flash and also sizing them if appropriate. This method of production requires very considerably forming forces, requiring correspondingly expensive machines. The considerable tool costs and the waste of material produced in piercing and trimming flash are also disadvantages.

It is also known to produce such finished workpieces by machining with removal of material from ring blanks, which are bent from bar-shaped pieces and butt-welded, cut by torches from thick plates, or rolled on ring rolling mills. Such flanges or the like are expensive owing to the high cost and long duration of machining operations involving cutting, and also because of the considerable waste of material in the form of cutting chips.

It is also known to produce weld-on flanges or similar workpieces in a ring rolling process. For this purpose, ingot-shaped or bar-shaped blank workpieces heated to forcing temperature are upset on a press or a hammer, pre-profiled and pierced, then rough rolled on a ring rolling mill between mandrel roll and profiled disc roll with an increasing diameter and further approximation to the finished profile, and then finish rolled in another pass of the disc roll or on a special finishing rolling mill with the same operating principle. To improve the shape and the dimensional precision, and also the surface quality, finish rolling can be carried out in a pass ring. With this production method, only relatively small pressure force is required for the production of the blank, and the waste of material in piercing is small. It is however a disadvantage that satisfactory workpieces can be obtained only if the pre-profiling of the pressing and the rough rolled ring has been very carefully optimised, which normally requires expensive, tedious series of tests. Also the profiled pressing and rough rolling tools are expensive, and they rapidly become worn due to the material friction which takes place in the tool profile, and they also add to the amount of driving power required.

According to the present invention, there is provided a method in which a blank workpiece heated to forging temperature is upset and pierced, then rough rolled by a force acting at least on the external periphery and the internal periphery of the rotating blank, to obtain a ring having an approximately rectangular cross-section, whose internal diameter is equal to or slightly larger than that of the finished workpiece, and then profiled and finish rolled to the final diameter by a force acting on the end faces of the rotating ring.

In order to allow the cross-section of the rough rolled ring to be adapted easily to particular requirements, it is preferred that during the rough rolling process forces are made to act at the same time on the peripheral surfaces and on the faces of the rotating blank. The initial blank workpiece can for example be ingot-shaped or bar-shaped.

In the interests of allowing further treat-

ment with as advantageous cost conditions as possible by good dimensional precision in the important workpiece surfaces, during the finish rolling process the flow of material in the rotating ring is preferably restricted in the radial direction.

In order to allow advantages of the present method to be obtained with as little outlay as possible, it is proposed that for finish rolling there is used a rolling mill having two rollers which can be applied towards one another in an axial direction, and of which at least one is driven, one roller having on its face a negative of a portion of the profile of the finished workpiece and the other roller, whose axis is inclined relative to the axis of the first roller by a small angle, having on the generated surface of an obtuse-angled cone the negative of the other portion of the profile of the finished workpiece. Such rolling mills are known per se for the rolling of disc-shaped workpieces such as solid railway wheels or the like, from pre-profiled blanks (for example U.S. Patent 965,039) but they have not yet been used for the rolling of annular strongly profiled workpieces as proposed by the present invention.

A particular embodiment of the invention will now be described by way of example only with reference to the accompanying diagrammatic drawings, in which:-

Figure 1 shows the starting material,
Figure 2 illustrates upsetting,
Figure 3 illustrates pre-piercing,
Figure 4 shows finish piercing
Figure 5 shows rough rolling
Figure 6 shows finish rolling

A method of producing a strongly profiled annular workpiece 15 from a blank workpiece 3 will now be described.

Between plane upsetting dies 1, 2 of a press or a hammer, an ingot-shaped or bar-shaped work-piece 3 heated to forging temperature is upset, then is pre-pierced with pre-piercing tools 4,5 and pierced through with finish piercing tools 6,7. The hole which is made in the pierced blank 8 is slightly larger than the diameter of a mandrel roller 9 of a preliminary ring rolling mill. The preliminary ring rolling mill has a driven disc roller 10 acting on the external diameter of the blank, a mandrel roller 9 which can be adjusted towards the disc roller and acts on the internal diameter of the blank, and the two frustoconical axial rollers 11,12 which act on the end faces of the rotating blank and at least one of which is driven and which are adapted to be fed in towards one another. 13 designates the rough rolled ring which at the end of the rough rolling process has a rectangular cross-section, a slightly reduced height as compared with the pierced blank 8, and an internal diameter which is slightly larger than the internal diameter 14 of the finished flanged workpiece 15. A finishing rolling mill has a driven lower roller 16 which has a negative of the lower workpiece face 17, the internal diameter 14 and the external diameter 18. The upper roller 19 is also driven and is adapted to be applied in the direction of the axis of rotation 20 of the lower roller 16 towards the said lower roller. The axis of rotation 21 of the upper roller 19 is slightly inclined relative to the axis of rotation 20 by an angle 22 which usually amounts to between 2° and 20° depending on the workpiece diameter. The lower and inner surface 23 of the upper roller 19 has on a truncated conical face a negative of the remaining workpiece surfaces 24, 25 which are to be rolled, in such a manner that the narrowest rolling gap between the lower roller 16 and the upper roller 19 corresponds to the cross-section profile of the finished flange 15. In the finishing rolling process, by application movement of the upper roller 19 material is displaced from the region of the upper external diameter of the rough rolled blank 13 and material is displaced into the region of the large external diameter of the finished workpiece 15, and at the same time the internal diameter is given its final size. The arrows not designated with any reference numerals in the drawings indicate the directions in which the various forces act and the directions of movement.

In comparison with the prior art methods described, the present method as described above permits the production of weld-on flanges or similar workpieces with low costs of machines, tools, material wastage and driving energy, whilst maintaining very good dimensional precision and shape-retaining qualities, and also with good surface quality in the final workpieces. The invention is based on the realisation that by using plane upsetting surfaces or dies for the preparation of the blank, use of smooth rolling tools for rough rolling and by finish rolling with little slip and wear in spite of using profiled tools, the aforesaid aim can be reached.

WHAT WE CLAIM IS:-

1. A method of producing an annular workpiece with a profiled cross-section wherein a blank workpiece heated to forging temperature is upset and pierced, then rough rolled by a force acting at least on the external periphery and internal periphery of the rotating blank to form a ring with a substantially rectangular cross-section whose internal diameter is equal to or slightly larger than that of the finished workpiece, and then profiled and finish rolled to the final diameter by a force acting on the end faces of the rotating ring.

2. A method according to claim 1 wherein during the rough rolling process

forces act at the same time on the peripheral surfaces and on the faces of the rotating blank.

3. A method according to claim 1 or claim 2 wherein during the finish rolling process the flow of material of the rotating ring in the radial direction is restricted.

4. A method according to any one of the preceding claims wherein the profiling and finish rolling is carried out on a rolling mill having two rollers which can be applied towards one another axially and at least one of which is driven, one roller having on its face a negative of a portion of the profile of the finished workpiece and the other roller, whose axis is inclined relative to the axis of the first roller by a small angle, has at the generated surface of an obtuse-angled cone the negative of the other portion of the profile of the finished workpiece.

5. A method according to claim 1 substantially as herein described with reference to the accompanying drawings.

6. Apparatus for carrying out a method as claimed in claim 4 including apparatus having plane upsetting surfaces for upsetting and piercing the blank, a ring rolling mill for rough rolling the blank to a ring and a rolling mill having two rollers which can be applied towards one another axially and at least one of which is driven, one roller having on its face a negative of a portion of the profile of the finished workpiece and the other roller, whose axis is inclined relative to the axis of the first roller by a small angle, has at the generated surface of an obtuse-angled cone the negative of the other portion of the profile of the finished workpiece.

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Printed for Her Majesty's Stationery Office,
by Croydon Printing Company Limited, Croydon, Surrey, 1980.
Published by The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.

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