PROCESS AND APPARATUS FOR COINING SINTERED ARTICLES


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3 Claims. (Cl. 29—34)

1. An object of this invention is to provide a durable, comparatively inexpensive restrict re or coining die for the final sizing of parts fabricated from powdered metals.

2. A further object of this invention is to provide a restrict or coining die built up from a plurality of laminae.

3. A further object is to provide a restrict die in which the actual forming is done by members identical in all respects with corresponding members which serve as guides for the ejection punch.

4. Other objects will become apparent as the description proceeds.

5. A die structure will be described particularly with reference to an involute oil pump gear although the invention is by no means so limited, but is applicable to any form capable of production by extrusion.

6. In the drawing, the figure designates a restrict die assembly intended to be bolted upon a die shoe which has been indicated diagrammatically. The die structure is assembled within the die retainer 1 and firmly secured to the die shoe by means of bolts through bolt holes 9.

7. The divers components of the die structure are assembled within the die retainer 1. The first member to be placed within the die retainer is locator 2, the interior of which is shaped to conform to the gears to be produced. This locator is provided with an outside diameter sizing ring 3, preferably made of tungsten carbide, or other similar wear resistant material. In gear pump manufacture, it is important that the outside diameter of the gear be held to rather close tolerances, and this outside diameter sizing ring serves to accurately establish this dimension. This ring is best inserted in locator 2 by pressing while the ring is at a low temperature. The locator is also provided with a bevel indicated at 10. Thus, it will be seen, that locator 2 serves as a carrier for the outside diameter sizing ring 3 and also by means of bevel 10 to guide the gear and sizing punch into the die.

8. Next is inserted retaining ring 4. This retaining ring carries involute forming die 4 which is also made of hard and wear resistant material such as tungsten carbide. The retaining ring lends mechanical support to the forming die 4 and restrains it against radial expansion. The interior surface of this die is provided with a serrated working surface which actually imparts to the gear teeth their final form and size.

9. Adjacent the retaining ring and locator is placed the die body 5. The interior of this die body is also contoured to conform to the shape of the gear being formed.

10. Below die body 5 is placed a retaining ring structure 6 equipped with an involute forming die 4 and a locator 2 equipped with an outside diameter sizing ring 8. This lower involute forming die 4 and outside diameter sizing ring 8 serve to align angularly and axially, respectively, an ejection punch inserted from below to eject pressed gear from the die body. This punch will of course have an exterior conforming to that of the gear being produced. It will be noted that these lower members 2, 3, 4 and 8 are identical with the similarly numbered upper parts and are arranged in the die so as to be a mirror image thereof. Correct alignment of all parts is assured by the use of locator pins 7. Filler ring 13 completes the assembly which, in use, is supported by die shoe 14.

11. In use, a gear 11 which has been formed from powdered metal and sintered is placed in the position shown. By means of a punch the gear is forced down into locator 2. The interior form of this locator assures that the gear and die cavity are concentric and also that the teeth on the work are angularly aligned with the corresponding depressions in the die.

12. The gear is then forced down past the outside diameter sizing ring 8 which causes the gear to assume the desired outside diameter. This may be done by plastic deformation or actual shearing of the metal or a combination of both actions.

13. The gear is next forced past involute forming die 4 which imparts to the gear teeth their final form and dimensions other than the outside diameter. The gear comes to rest upon the top of ejection punch 12 after its entire exterior has been shaped by outside diameter sizing ring 8 and involute forming die 4. In this position the gear is enclosed everywhere except at the top by die body 5 and ejection punch 12. Heavy pressure is now applied to the top of the gear by a punch conforming in contour to the gear. This pressure is sufficiently heavy to size the gear for length and to densify it to the desired degree. The densified gear is now expelled by withdrawing the pressing punch and raising ejection punch 12.

14. Due to inevitable inaccuracies in the interior contour of die body 5, the heavy densifying pressure will cause some radial distortion of the gear. However, this radial distortion will of necessity be corrected when the gear is driven past involute forming die 4 and outside diameter sizing ring 8 on the way out of die body 5.
It will be seen that this die structure effects economies in at least four distinct aspects. First, those parts of the die subject to the most severe duty; that is, the part of the cutting or forming surface which first contacts the incoming gear and which can be made of very hard and durable material such as tungsten carbide and made readily replaceable. Second, fewer parts need be manufactured since the wearing parts on each side of the die body are identical and interchangeable; that is, the lower ring 8 which serves to guide and center the lower punch is interchangeable with the upper outside diameter sizing ring 8 and the lower angular die guide 4 is the same as upper involute forming die 4. A third economy flowing from this structure is the case with which both the outside diameter sizing ring 8 and the involute forming die 4 can be produced in comparison with the complications encountered when an attempt is made to make a single forming member shape and size all surfaces of the teeth. The outside diameter of these gears is critical, but is determined by that surface of the die which is very difficult to work because of its position between the teeth of the die. A perfectly plain ring is easily formed and eliminates the necessity for precise machining of this difficult location. Fourth, this structure does away with the necessity for meticulous accuracy in the shaping of the working surfaces of the die body. The precise grinding of a comparatively long inside tooth form is in itself an expensive and time-consuming operation. In the present structure, a reasonably exact contour in the interior of the die body will suffice, since the die body serves only to prevent undue deformation of the gear during pressing. Any minor inaccuracies caused by the die body are of course corrected as the gear is ejected through the involute forming die 4 and the outside diameter sizing ring 8.

Some changes may be made in the arrangement, construction, and combination of the various parts of our improved device and it is intended to cover by the subjoined claims such changes as may reasonably be included within the scope thereof.

I claim as my invention:
1. In a restrike or coining die for the manufacture of formed articles from sintered powdered metal compacts, a locator member having a beveled edge to guide preformed articles into the die, a hard wear resistant outside diameter sizing ring mounted in the locator, a hard wear resistant contour forming member mounted in a retaining ring, a die body, an angularly aligning member substantially identical with the contour forming member mounted in a retaining ring and serving to angularly align the ejection member with the die member, an axial aligning member substantially identical with the outside diameter forming ring and mounted in a locator and serving to axially align the ejecting member with the die body, all of the above members being vertically concentric, the die body, contour forming member and angularly aligning member having an interior contour corresponding to the article being formed, and all these members being so assembled that those portions located above a plane bisecting and normal to the vertical axis of the die form a mirror image of the section below such a plane.

2. A process for coining or restriking articles fabricated from sintered powdered metal compacts comprising forcing a sintered and roughly formed compact through an annular ring to establish an outside diameter, forcing the compact so sized through an annular contour forming member to impart to the compact the desired exterior contour other than the outside diameter, passing the sized and contoured compact into a restraining die member immediately adjacent the annular contour forming member and in this die member subjecting it to heavy axial pressure to densify the compact and establish the final axial dimension, and finally forcing the densified compact out of the die through the annular contour forming member and annular ring to correct any minor inaccuracies which may have been formed during the densifying step.

3. The process of densifying and shaping a sintered powdered metal gear comprising densifying the gear by axial pressure in a die having a cavity roughly corresponding to the finished gear, sizing the gear teeth except as to the tooth tips by passing it through an involute forming ring immediately adjacent the die cavity, and sizing the teeth tips by passing it through an annulus immediately adjacent the involute forming ring.

ELBERT EDWIN ENSIGN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>472,664</td>
<td>Bliss</td>
<td>Apr. 12, 1892</td>
</tr>
<tr>
<td>521,178</td>
<td>Porter</td>
<td>June 12, 1894</td>
</tr>
</tbody>
</table>

FOREIGN PATENTS

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<thead>
<tr>
<th>Number</th>
<th>Country</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>516,674</td>
<td>France</td>
<td>Dec. 6, 1920</td>
</tr>
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