Feb. 19, 1957 W. F. BLADERGROEN ET AL 2,781,849

METHOD OF FORMING SMALL APERTURES IN THIN METAL PLATE-SHAPED ARTICLES

Filed Jan. 29, 1953 2 Sheets-Sheet 1

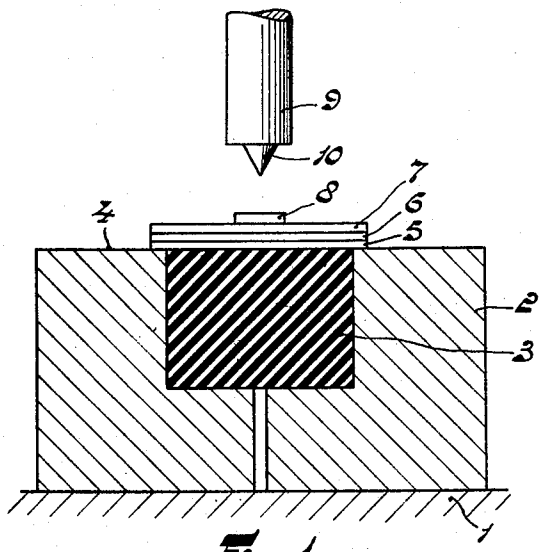


Fig. 1

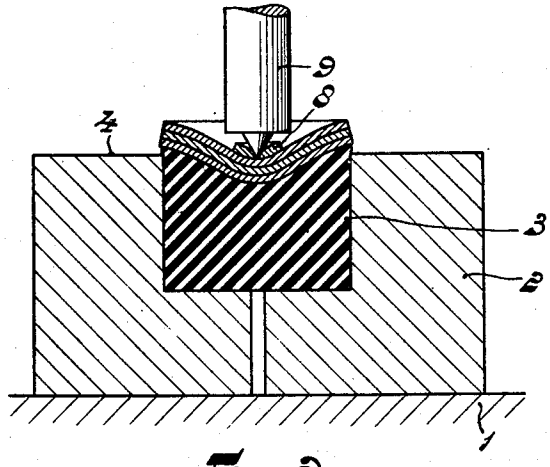


Fig. 2

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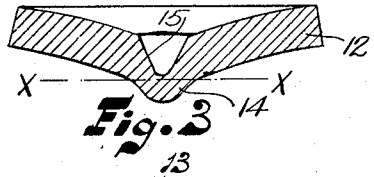


Fig. 3

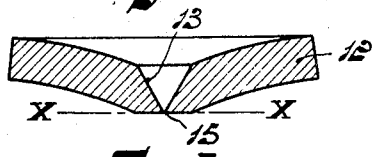


Fig. 4

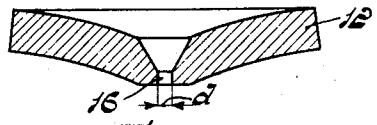


Fig. 5

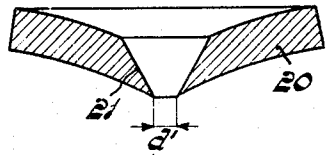


Fig. 6

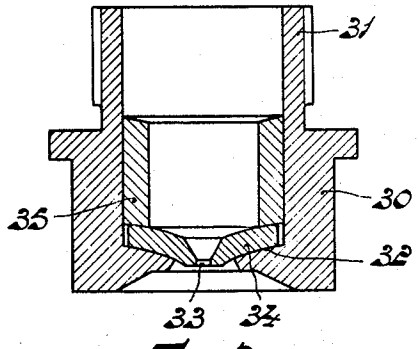


Fig. 7

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METHOD OF FORMING SMALL APERTURES IN THIN METAL PLATE-SHAPED ARTICLES

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Application January 29, 1953, Serial No. 334,054

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2 Claims. (Cl. 164—125)

When thin plate-shaped articles made of comparatively hard materials, such as steel, more particularly stainless steel, are to be provided with apertures of small diameter, for example of the order of from 0.2 to 0.4 mm., the usual methods are found to give rise in practice to serious difficulties. Breaking of the drills often occurs and it has been found that even increasing the speed of the drilling spindle to high rates (for example 12,000 revolutions per minute) does not result in appreciably reducing these difficulties. These disadvantages are particularly manifest, when apertures are required to be made with a conical profile and also when the article is made of stainless steel. In these cases the problem arises that during drilling the material hardens increasingly under the point of the drill.

The invention provides a solution of this problem by using a punch on a mandrel which is pressed into the article to be provided with an aperture, special measures being taken to prevent breaking or cracking of the material of the article.

The method according to the invention of providing a small aperture in a thin metal plate-shaped member is characterised in that a metal disk is arranged on a non-compressible plastic mass, such as rubber, which is surrounded by a rigid rim in a manner such that the central part of the disk rests upon the plastic material and that the edge of the disk rests upon the rigid rim surrounding the mass, and in that at least one additional metal disk is arranged on the said disk and that the article to be provided with an aperture is arranged on the uppermost disk, the article and the disks all having thicknesses of the same order and the adjacent surfaces of these disks and of the article preferably being provided with a small amount of lubricant. A mandrel having a preferably conical point or punch is then pressed into the surface of the article to be apertured so as to provide a through-hole after the surface of the article more remote from the mandrel, is subjected, if required, to a shaving operation.

When the point of the mandrel engages with the upper surface of the article it penetrates into the article through a small distance without appreciable deformation of the latter. However, as soon as the point or punch has obtained sufficient pressure area in the article the latter tends to become plastically deformed while being guided by the disks arranged beneath it and by the plastic material provided under the undermost disk. The article to be apertured is thus more and more forced in conically but it is protected from breaking by the disks arranged under it, which in turn assume a more or less conical form and thus envelop the article to a greater or less extent.

It is possible for the point of the mandrel to be arrested when a bulge of the material is formed locally on the surface of the article more remote from the mandrel directly opposite the point of the mandrel. When said bulge is removed by a shaving operation,

for example by means of a small grinding stone, it is found that the article has formed in it a very small aperture which is truly circular when the mandrel is of truly circular cross-section. According to an alternative embodiment of the invention if such an aperture should be too small for the purpose in view it may be reamed by means of a thin drill without any difficulty until the diameter of the aperture thus produced exhibits the required value.

However, according to the invention, as an alternative, the point of the mandrel may be pressed into the material of the article so far as to produce a through-hole in the material of the article. Such aperture will generally be wider than in the use of the above-mentioned method whereby the aperture in the article is not formed until after the local bulge on the surface of the article is removed by a shaving operation.

The method according to the invention lends itself particularly for the formation of substantially tapering apertures having diameters of from 0.02 to 0.6 mm. in articles of low thickness, that is to say a thickness less than 5 mms., and made of hard material, such as steel, more particularly stainless steel. As found according to the invention, this ensures a method of manufacturing which can be carried out by simple means and the results of which are found to be always satisfactory. Results differing in accordance with the choice of the material of the washers and of their thickness may be achieved by means of the same press. As mentioned hereinbefore, the thickness of the washers will be made of the same order as the thickness of the articles but the diameter of these plates must exceed the diameter of the article, since this enables the washers to envelop, as it were, the article at its edge during the plastic deformation of the article. Plate-shaped waste material may suitably be used as material for the washers, the only requirement to be satisfied by this material being that at the obtaining pressures it should be enabled by its ductility to assume the required deformation.

The invention will now be described with reference to the accompanying diagrammatical drawing, given by way of example, in which:

Fig. 1 is a longitudinal sectional view of a device for carrying out the method according to the invention and shown in a position in which the mandrel is at some distance above the article to be provided with an aperture.

Fig. 2 is a longitudinal sectional view of the same device, the mandrel, however, occupying a position in which it has been substantially pressed through the article to be provided with an aperture.

Figs. 3, 4 and 5 show three successive stages of an article, the mandrel not being pressed entirely through the article, but being retracted at the moment at which a bulge of the material is produced on the surface of the article more remote from the mandrel (Fig. 3), said bulge having been ground off in Fig. 4, whereas in the stage shown in Fig. 5 the aperture provided in the stage shown in Fig. 4 has been reamed.

Fig. 6 shows an embodiment of an article in which the aperture is produced by pressing the mandrel so far into the article that its point has left the article on the opposite side.

Fig. 7 is a longitudinal sectional view of a nozzle for use in a burner, the mouthpiece of the nozzle being constituted by the object shown in Fig. 5.

The device according to Figs. 1 and 2 comprises a thickwalled metal pot 2 which is arranged on a table 1 and contains a supply 3 of plastic non-compressible material, the material being rubber in the case shown. As may be seen from Fig. 1 the upper surface of the

mass 3 is in the same plane as the upper rim 4 of the pot 2. The surface of this mass has a disk 5 about 1.2 mm. in thickness arranged on it in a manner such that the edge of the disk rests upon the upper rim 4 of the pot whereas the central part of the disk is supported upon the material 3. This disk has two additional superposed disks 6 and 7 arranged on it both of which have approximately the same thickness as the disk 5.

A steel plate 8 which is to be provided with an aperture and has a thickness of approximately 1.5 mm. is arranged on the upper surface of the disk, and, as may be seen from the figure, has an appreciably smaller diameter than the disks 5, 6, and 7. Arranged over the article 8 is a mandrel 9 which has a conical point or punch 10 and is secured in a hand press (not shown).

When the mandrel 9 is lowered, as indicated in Fig. 2, the punch of the mandrel will initially penetrate into the material of the article through a small distance without appreciable plastic deformation of the article 8. On further movement of the punch 10 of the mandrel 9 the plate tends to become plastically deformed and is thus embossed conically, as may be clearly seen from Fig. 2. The disks 7, 6 and 5 will thus also become deformed, all of them assuming a more or less conical shape. The fact that the material enclosed between the reverse side of the article 8 and the surface of the rubber mass 3 is stratified due to the disks 7, 6 and 5 permits of the layers sliding relatively during the pressing operation. This allows deformation of this intermediate material without cracking or breaking and thus enables the intermediate material to protect the article to be apertured against breaking or cracking. As may be seen particularly from Fig. 2, the material of the disk 7 envelops as it were the edge of the article 8 during its deformation.

During the plastic deformation of the disk 5 the upper surface of the mass 3 is also conically forced in, but owing to the fact that this material, though plastic, is not compressible the more outward parts of the supply of rubber 3 rise so that the bottom of the disk 5 invariably finds sufficient support throughout its surface. The edge of the disk 5 which originally rested on the upper rim 4 of the metal pot 2 to find sufficient support during the lowering of the punch, becomes gradually detached from this rim, as may also be seen from Fig. 2, so that at the termination of the pressing operation the bottom of the edge of the disk 5 becomes located at a short distance above the upper rim 4 of the metal pot 2. To enable the material of the article and of the disks to become deformed under the action of the pressing power it is advantageous for the pressing speed to be low.

When the pressing operation is stopped the punch 9 is raised and the article 8 may be removed from the press. The disks 5, 6 and 7 are subsequently removed. The upper surface of the rubber material 3 has resumed its flat shape immediately upon release of the pressure, new disks are placed in position, a new article is arranged on the disk 7 and pressing may restart.

With respect to the machining operations of the article shown in Figs. 3, 4 and 5 the following should be noted. As may be seen from Fig. 3, the article 12 shown in this figure exhibits a more or less conical shape comprising centrally the depression 13 caused by the conical point 10 of the mandrel. The top of this aperture lies in a plane X—X indicated in Fig. 4. Under this plane there is a local bulge of material 14.

At the stage shown in Fig. 4 this bulge 14 has been removed by a shaving operation, for example, by grinding the article 12, a very narrow aperture 15 being thus formed in the plane X—X. This aperture is generally too small for practical use.

Hence, as may be seen from Fig. 5, this aperture is reamed by means of a thin drill so as to form a cylindrical aperture 16, the diameter d of which may be chosen in accordance with the requirements to be satisfied. In contradistinction to the case mentioned in the first few paragraphs hereof, reaming the aperture already provided is not beset with difficulty, since the core of the drill is not required to do any work. The diameter d of the reamed hole may be very small, for example, 0.05 mm., but obviously appreciably greater as an alternative, in accordance with the use of the apertured article.

In the embodiment shown in Fig. 6 the article 20 has an aperture 21 formed in it being pressed by the point 10 of the mandrel 9 through the material of the article 20 to such an extent that during the pressing operation the point 10 of the mandrel has disengaged from the article 20 at the reverse side. Also in this case the diameter d_1 may be variable in accordance with the requirements to be satisfied. The method illustrated in Fig. 6 will generally be chosen to form apertures of slightly greater size, for example of the order of from 0.3 to 0.6 mm. Any burrs that may be left at the lower edge of the aperture 21 after this aperture is pressed can readily be removed by the usual means.

The nozzle shown in Fig. 7 for use in a burner comprises a cylindrical case 30 which at the end 31 is threaded to enable the nozzle to be secured in a support. The case 30 comprises in its bottom part a conically tapering stop surface 32 which fits the apertured article 34. This article 34 acts as a nozzle with the aid of the aperture 33 formed in it. After the conical outer edge (visible in Figs. 3 to 6) of the article 34 is removed and a cylindrical outer surface has thus been produced the article is secured internally of the case 30 by means of a pressed-in cylindrical sleeve 35.

What we claim is:

1. A method of forming small apertures in a thin metal, plate-shaped article comprising placing a non-compressible plastic mass in a metal receptacle, positioning a metal disk having the periphery of a surface thereof abutting said metal receptacle and another portion of said surface abutting said plastic mass, arranging said plate-shaped article on said metal disk, said article and said disk having thicknesses of the same order, pressing a punch into a surface of said article, to thereby form a small through-aperture in said article and shape said article conically.

2. A method of forming small apertures in a thin metal, plate-shaped article comprising placing a non-compressible plastic mass in a metal receptacle, positioning a metal disk having the periphery of a surface thereof abutting said metal receptacle and the remainder of said surface abutting said plastic mass, arranging said plate-shaped article on said metal disk, said article and said disk having thicknesses of the same order, forcing a punch through said article to thereby form a small through-aperture therein.

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