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## (54) Ironing die for ironing press.

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DE-A-1 527 908
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## Description

The present invention relates generally to the manufacture of drawn and ironed containers and more particularly to an improved ironing die for reducing the sidewall thickness of a cup to produce a container that has an integral bottom wall of maximum wall thickness and a sidewall of minimum wall thickness.

In the formation of a "two-piece" container it has been customary to utilize a plurality of ironing assemblies that cooperate with a punch for converting circular metal discs into finished containers. Usually this is accomplished to two steps. A circular metal disc is originally drawn into a cup utilizing what is commonly referred to as a cupping machine. The cup is then transferred to a body maker or press wherein the cup is converted into the finished container by reduction in the thickness and increase in the length of the side wall of the cup. In the body maker the cup is passed through a plurality of ironing assemblies by means of a punch.

Ordinarily each ironing assembly comprises an ironing die mounted in a holder, for use with the punch to reduce the wall-thickness of the side-wall of a metal cup, comprising a body having a circular opening therein extending from a leading surface to a trailing surface which are substantially parallel to each other, said opening having a land spaced from said surfaces and defining a minimum diameter. Such an ironing die is described in DE—A—1 527 908.

In the past, it has been customary to form the ironing dies with a very narrow land located generally in the center of the ironing die opening substantially equally spaced from the leading and trailing surfaces of the ironing die, as viewed with respect to the direction of travel of the punch through the ironing die assembly. In order to substantially reduce the amount of friction developed, the land, which actually controls the wall thickness of the cup in cooperation with the punch, is usually made as narrow as possible and in most dies, the areas between the land and the respective leading and trailing surfaces are tapered outwardly slightly so as to further reduce the friction developed during an ironing process.

One of the areas that has received a remarkable degree of attention for obtaining accurate and acceptable containers is the uniformity of the sidewall thickness throughout the entire length and diameter thereof. It will be appreciated that in forming conventional beer or beverage containers, the stroke of the punch for the press or body maker must be fairly long and has heretofore created some problems in obtaining a very uniform wall thickness for each container when operating at commercial production rates.

Ironing is a carefully balanced steady state process up to the point where the edge of the cup enters the working portion of the die. Most of the time, this edge is uneven, in magnitude anywhere from a few hundredths of a millimetre to 6 to 12 millimetres. Obviously an uneven edge will disrupt this steady state ironing process and several types of failures or process shortcomings show up.

The unevenness of the upper free edge of the cup or can has two sources. One is the cupping operation itself, where it is sometimes caused by tooling inaccuracies or misalignments. The other source is misalignment of the drawing and ironing press. Misalignment causes an uneven wall thickness around its circumference. The free edge of the cup or can becomes longer in line with the thinner wall portion because of the accummulation of this surplus metal. The unevenness grows progressively worse as the container moves from one ironing stage to the next. How to cope with this disruptive imbalance caused by the uneven edge is a major difficulty in drawing and ironing.

One form of failure caused by the uneven edge is where the longer portion of the edge will tear off entirely. Tear-offs can cause jams of the succeeding cans.

Another very common form of failure is that the punch and die will be forced into a misaligned position due to the non-symmetric forces imposed by the uneven edge. The result is that the longer edge will remain heavier than the wall thickness prescribed by the undisturbed tool gap. In turn, this longer, heavier edge may tear off in the next ironing die.

Another form of failure caused by the uneven edge is dynamic in origin. Invariably the longer part of the edge is thicker than the can wall preceding it and therefore, since the can travels at a respectable speed, upon impact of this unsymmetric heavy edge on the die, a sudden tool deflection relative between punch and die occurs. This can cause either tear-offs of the longer edge, or smaller type "clip-offs" in the area of the shorter end of the can.

A further form of process failure is that due to the dislocation of the die in relation to the punch, the tools may become damaged. When the shorter edge of the cup moves from between the punch and the ironing die, they may shift sufficiently with respect to each other so that the area of the punch without a container wall thereon is actually in surface contact with the land on the ironing die.

In order to partially alleviate this problem, a pilot die concept has been developed to support the can-punch during the disruptive phase and force a certain degree of ironing of the longer edge but because of the very close tolerances that are required to obtain container walls of uniform thickness, this arrangement has been only partially successful in preventing "clip-offs" during a drawing and ironing operation.

As was indicated above, when utilizing an ironing die assembly with a very narrow land located generally in the center of the die, when a cup is formed with a non-uniform wall thickness or when the upper edge thereof is uneven, during the ironing operation, the shorter edge of the cup will move past the land on the ironing die and because of the extreme forces developed in the ironing operation, the punch and ironing die will move radially with respect to the axis of the punch and can cause tear-offs of the longer edge of the uneven free edge of the cup or clip-offs opposite the long edge. In other instances, even when the longer edge of the uneven cup is not clipped off, the wall thickness thereof will be greater than the wall thickness of the remainder of the cup and this situation will be exaggerated as the cup moves through subsequent ironing dies.

As was indicated above, to partially alleviate this problem, it has been proposed to utilize a separate pilot die assembly adjacent each of the ironing assemblies on the downstream side thereof, as viewed in the direction of travel of the punch with respect to the ironing die. However, it has been determined that such arrangement is only partially successful in overcoming the inherent problems, particularly when producing containers from cups that have an uneven upper free edge. It has also been proposed to utilize a pilot die member that is secured into an enlarged recess adjacent the trailing side of the ironing die holder for supporting, if needed, the partially ironed cup as it leaves the ironing die. However, this again has only been partially successful and past experience has shown that the moment the short end of an uneven cup passes through the ironing land of the ironing die, a steady state ironing condition is lost which many times can result in damage to the die and/or the punch and can also result in tear-offs and "clip-offs" which may become trapped in the die assemblies and cause jams in the succeeding operation.

As is almost universal, the ironing die described in the aforementioned DE—A—1 527 908 is shaped with a lead-in conical surface, a narrow land and an exit conical surface. Ironing takes place between the lead-in conical surface and the punch. Ironing theoretically comes to an end at the beginning of the land. The effective gap between the internal diameter of the land and the external diameter of the punch determines the wall thickness of the can. However, due to the elasticity of the materials used for the tools, there still is considerable pressure against the wall in the gap which is causing friction. Normally the axial dimension of the land is preferably maintained as small as possible and is usually on the order of 0.25 to .5 millimetres in length. The conical exit surface immediately relieves the pressure and friction at the end of the die.

The present invention has for its object the overcoming of the disadvantages outlined above resulting from irregularities in the region of the free edge of the cup. This object is achieved in an ironing die according to the invention in which the circular opening has a cylindrical portion between said land and said trailing surface, said cylindrical portion having a diameter (D2) in the range of 1.0003 to 1.0012 times said minimum diameter (D1) to guide said cup after a first portion of the free edge of the cup moves past said land.

Thus, the die has a cylindrical portion that has a slightly greater diameter than the minimum diameter to accurately support and guide the cups while any portion thereof is located within the ironing die. The diameter of the cylindrical portion is selected to be as close as possible to the diameter of the ironing land but must be large enough to eliminate any substantial degree of friction between the peripheral surface of the cup which is being ironed and the inner surface of the cylindrical portion.

Preferably, the ironing land is located closer to the leading surface than the trailing surface and the diameter of the cylindrical portion between the land and the trailing surface is preferably in the range of 1.0003 to 1.0010 times the minimum diameter of the land. In some instances, it may also be desirable for the opening of the die to have a cut out portion to define a recess between the land and the cylindrical portion.

Thus the ironing die is shaped in a unique configuration, having an integral pilot, so as to support the cup-punch during the critical phase of ironing over the uneven edge, thereby resulting in a more uniform thick wall in the transition to the uneven edge as well as of the longer part of the edge itself. By accurately and effectively controlling the thickness of the long edge, tear-offs and "clip-offs" are virtually eliminated.

One example of the inventen will now be described with reference to the accompanying drawings, in which:

Figure 1 shows a cross-section of an ironing die assembly having the ironing die of the present invention incorporated therein;

Figure 2 is an enlarged cross-sectional view of the profile of the opening in the ironing die;

Figure 3 is an enlarged fragmentary sectional view of the joint adjacent the land of the ironing die; and

Figure 4 is a view similar to Figure 2 showing a slightly modified form of the invention.

Figure 1 of the drawings generally discloses an ironing die assembly 10 consisting of an ironing die body 12 inserted in a holder 14 which has an opening 16 extending therethrough and an enlarged recess 18 surrounding the opening adjacent the leading surface 20 of the holder 14 into which the ironing die 12 is received for support thereon.

Usually to reduce the sidewall thickness of a cup, two or three of such assemblies 10 are spaced along a path P for a punch and the sidewall of a cup supported on the punch is reduced in stages to the ultimate thickness for the finished container.

According to the present invention, the profile of the opening in the ironing die is constructed in a fashion so as to constrain the container throughout its movement through the ironing die to prevent tear-offs and "clip-offs" and also result in more uniform wall thickness for the finished drawn and ironed container. As most clearly shown in Figure 2, the profile of the opening 28 (Figure 1) within the body 12 consists of a narrow land 30 of minimum axial length to reduce the frictional forces that must be overcome during an ironing operation. Land 30 is spaced from leading surface 32 and trailing surface 34 of the ironing die and the area or surface 36 of the opening between land 30 and leading surface 32 tapers outwardly slightly to produce an increasing diameter between the land and the leading surface and in fact is the working surface that forces a reduction of the incoming wall thickness down to the thickness prescribed by the gap (i.e., difference between land and punch radius).

According to the present invention, the area between the trailing surface 34 and land 30 is cylindrical in shape or has a cylindrical wall portion 38 which has a diameter that it slightly larger than the diameter of land 30, which is the minimum diameter of the opening within ironing die body 12. The land 30 and cylindrical portion 38 are formed on integral body 12 and an inclined portion 42 located therebetween.

The diameter of cylindrical portion 38 is only slightly larger than the diameter of land 30 and should be just large enough to eliminate any substantial amount of friction between the peripheral surface of the partially formed cup and the inner surface of cylindrical portion 38 while still positively controlling and supporting the cup throughout its movement through the ironing die. The particular relative dimensions of the diameters D1 and D2 are to some measure a function of the elasticity of the tooling utilized, particularly the composite elasticity of the materials for ironing die assembly 10 and the elasticity of the material for the punch (not shown) as well as the material from which the cup is formed. While these parameters have not been fully developed, it is believed that the diameter D2 should be in the range of 1.0003 to 1.0012 times the minimum diameter D1 of the opening within ironing die 12 and is preferably in the range of 1.0003 to 1.0010 times the minimum diameter D1.

While not limiting the invention to exact dimensions, an example of a specific profile configuration for an ironing die which has been operated successfully when drawing and ironing aluminium cups will now be given. An ironing die having a thickness of approximately 9.52 mm between the leading surface 32 and the trailing surface 34 had a land of approximately 0.25 mm located intermediate the leading and trailing surfaces and the land had a diameter of 66.67 mm. The trailing edge of the land 30 was located closer to the leading surface than the trailing surface and the area between the land and the leading surface had an outward taper on the order of 8 degrees per side. The diameter of the cylindrical portion 38 was selected to be 0.025 mm greater than the diameter of the land and had an axial length of approximately 5.08 mm.

Utilizing three of these ironing assembles with progressively reducing diameter lands arranged at axially spaced locations with respect to a movable punch, more uniform wall thickness was consistently achieved for the cups that were converted into finished containers and virtually no tear-offs or "clip-offs" were developed during the ironing of a cup into a finished container.

In another test using commercial tooling and the above dimensions, the cylindrical portion 38 was made 0.046 mm larger than the diameter of the land 30. Again, more uniform wall thickness was achieved for the finished containers and less tool wear was encountered.

In both examples the need for a pilot die in the toolpack was eliminated. This resulted in an overall reduction in cost for the toolpack.

Of course, the respective dimensions could readily be varied. For example, if cups having an uneven edge which would result in a difference of more than approximately 5.08 mm between the shortest and the highest point on the uneven edge where encountered, the length of cylindrical portion 38 could be increased to insure that the container or partially ironed cup would be supported within cylindrical portions at all times when there is any part of the upper free edge of the partially ironed cup within the ironing land 30.

Actual tests have shown that utilizing an ironing die having an inner surface profile of the configuration described above results in less tool wear so that the life of the punch and die was increased substantially. At the same time, consistently more uniform wall thickness for each container was achieved.

A slightly modified form of the invention is illustrated in Figure 4 and since all elements of the die are identical to the embodiment illustrated in Figure 2, the same reference numerals have been retained. In the embodiment illustrated in Figure 4, opening 28 has a cut out portion 50 to produce a recess 52 between land 30 and cylindrical portion 38.

## Claims

1. An ironing die mounted in a holder (14), for use with a punch to reduce the wall-thickness of the sidewall of a metal cup, comprising a body (12) having a circular opening (28) therein extending from a leading surface (32) to a trailing surface (34) which are substantially parallel to each other, said opening having a land (30) spaced from said surfaces (32; 34) and defining a minimum diameter, characterised in that the circular opening (28) has a cylindrical portion (38) between said land (30)

and said trailing surface (34), said cylindrical portion having a diameter (D2) in the range of 1.0003 to 1.0012 times said minimum diameter (D1) to guide said cup after a first portion of the free edge of the cup moves past said land.

2. An ironing die according to Claim 1 characterised in that the spacing between said land (30) and said trailing surface (34) is greater than the spacing between said land (30) and said leading surface (32).

3. An ironing die according to Claim 1 or Claim 2 characterised in that the wall of said opening has a cut out portion (50) to define a recess (52) between said land (30) and said cylindrical portion (38).

4. An ironing die according to any of Claims 1 to 3 characterised in that the diameter of said cylindrical portion (38) is in the range of 1.0003 to 1.0010 times said minimum diameter.

## Revendications

1. Outil d'étirage sur mandrin monté dans un porte-outil (14) à utiliser avec un poinçon pour diminuer l'épaisseur de la paroi latérale d'une chope métallique, comprenant un corps (12) présentant une ouverture circulaire (28) qui s'étend à partir d'une surface antérieure (32) jusqu'à une surface postérieure (34) qui sont en substance parallèles l'une à l'autre, cette ouverture présentant une plage (30) espacée des dites surfaces (32, 34) et définissant un diamètre minimum, caractérisé en ce que l'ouverture circulaire (28) présente une partie cylindrique (38) entre la plage (30) et la surface postérieure (34), cette partie cylindrique ayant un diamètre (D2) de l'ordre de 1,0003 à 1,0012 fois le dit diamètre minimum (D1) pour guider la chope après le passage d'une première partie du bord libre de cette chope en regard de la dite plage.

2. Outil d'étirage sur mandrin suivant la revendication 1, caractérisé en ce que l'espace prévu entre la plage (30) et la surface postérieure (34) est supérieur à l'espace prévu entre la plage (30) et la surface antérieure (32).

3. Outil d'étirage sur mandrin suivant la revendication 1 ou 2, caractérisé en ce que la paroi de l'ouverture présente une gorge (50) pour définir un évidement (52) entre la plage (30) et la partie cylindrique (38).

4. Outil d'étirage sur mandrin suivant l'une quelconque des revendications 1 à 3, caractérisé en ce que le diamètre de la partie cylindrique (38) est de l'ordre de 1,0003 à 1,0010 fois le dit diamètre minimum.

## Patentansprüche

1. Matrize, die in einem Halter (14) angeordnet ist und in Verbindung mit einem Stempel die Wanddicke der Seitenwand eines Metallbehälters verringert, umfassend einen Körper (12) mit einer kreisförmigen Öffnung (28), die sich von einer Anlauffläche (32) zu einer Ablauffläche (34) erstreckt, die im wesentlichen parallel zueinander sind, wobei die genannte Öffnung einen Steg (30) aufweist, der im Abstand von den genannten Flächen (32; 34) angeordnet ist und einen Mindestdurchmesser bestimmt, dadurch gekennzeichnet, daß die kreisförmige Öffnung (28) einen zylindrischen Teil (38) zwischen dem genannten Steg (30) und der genannten Ablauffläche (34) aufweist, wobei der genannte zylindrische Teil einen Durchmesser (D2) im Bereich des 1,0003-fachen bis 1,0012-fachen des genannten Mindestdurchmessers (D1) hat, um den genannten Behälter zu führen, sobald sich ein erster Teil der freien Randes des Behälters über den genannten Steg hinausbewegt.

2. Matrize nach Anspruch 1, dadurch gekennzeichnet, daß der Abstand zwischen dem genannten Steg (30) und der Ablauffläche (34) größer ist als der Abstand zwischen dem genannten Steg (30) und der genannten Anlauffläche (32).

3. Matrize nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Wand der genannten Öffnung einen ausgeschnittenen Teil (50) aufweist, der eine Ausnehmung (52) zwischen dem genannten Steg (30) und dem genannten zylindrischen Teil (38) bestimmt.

4. Matrize nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß der Durchmesser des genannten zylindrischen Teils (38) im Bereich des 1,0003-fachen bis 1,0010-fachen des genannten Mindestdurchmessers liegt.

Fig.1.

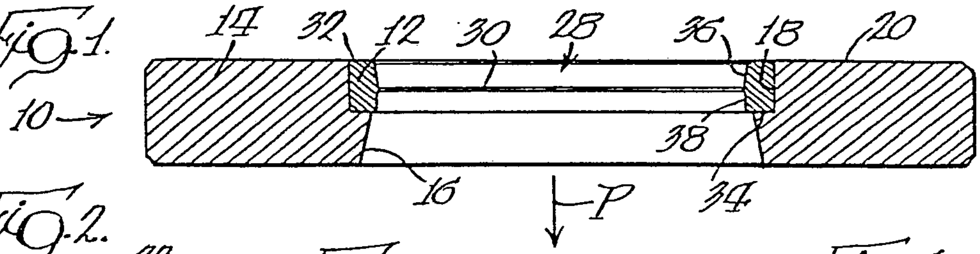


Fig.2.

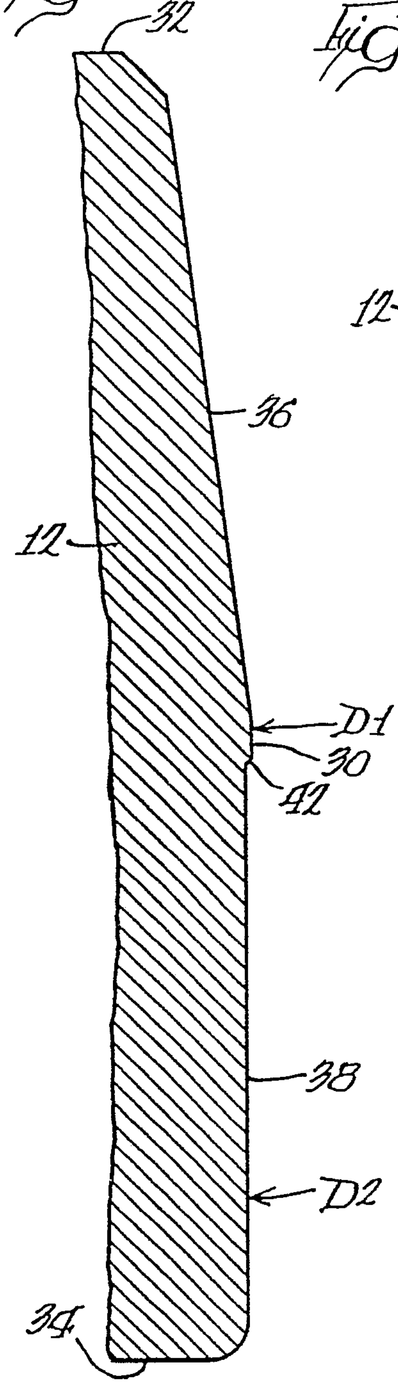


Fig.3.

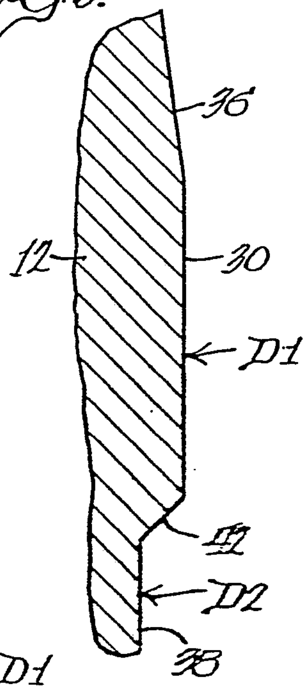


Fig.4.