

[54] **METHOD OF STAMPING METAL CONVEX ARTICLES FROM SHEETS**

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[22] **Filed:** Dec. 31, 1969

[21] **Appl. No.:** 889,624

[52] **U.S. Cl.**72/57, 72/350, 113/120 H, 29/421

[51] **Int. Cl.**B21d 24/12, B21d 26/02

[58] **Field of Search**.....72/57, 54, 60, 63, 347, 348, 72/350; 113/120 H; 29/421

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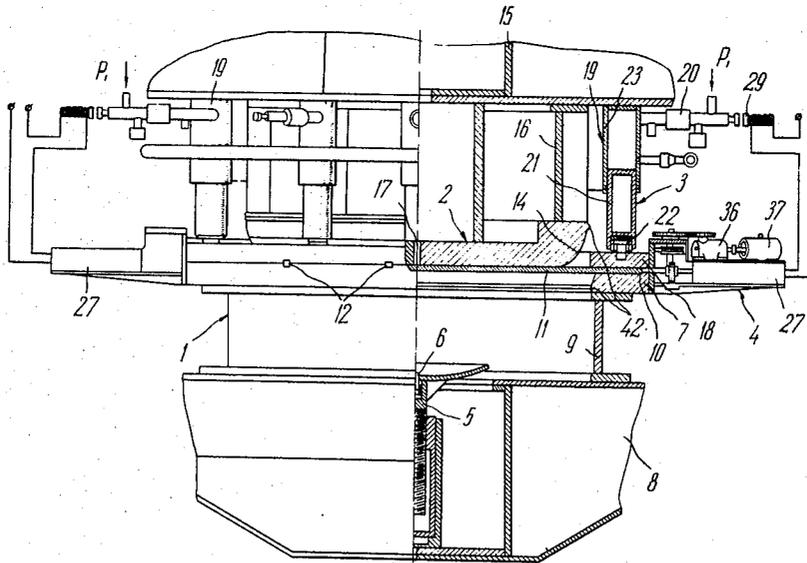
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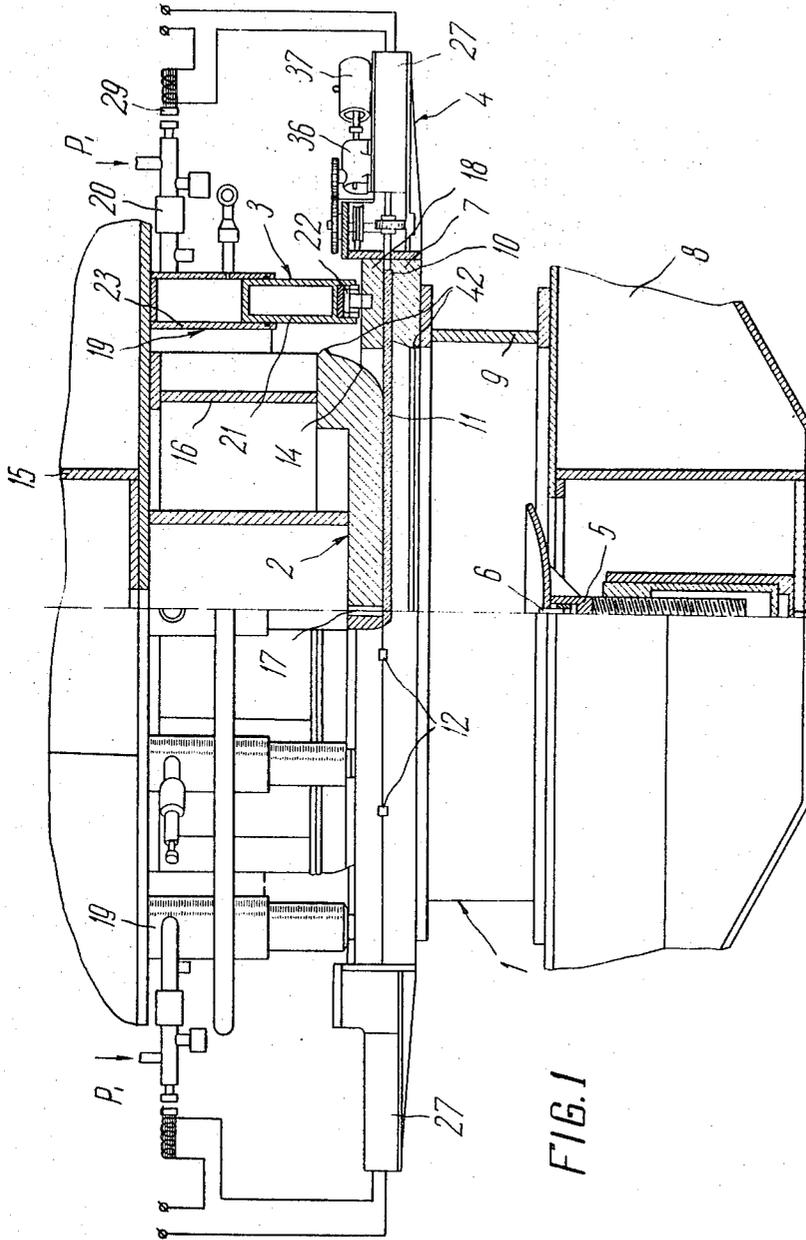
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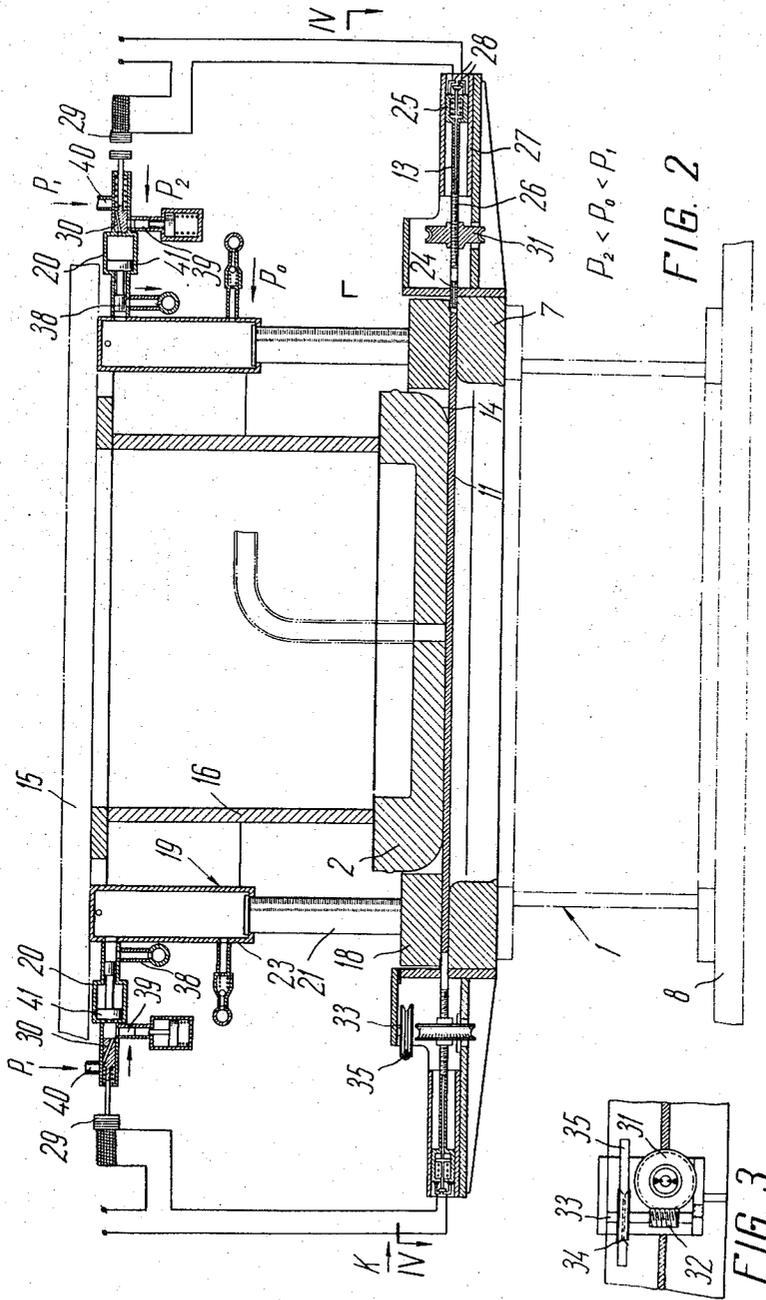
[57] **ABSTRACT**

A method and die set for stamping metal blanks into convex articles including positioning a blank between a punch and a ring-shaped die while clamping the edge of the blank, partially deforming the blank with the punch, and then forcing pressurized fluid between the punch and the partially deformed blank to form a convex article, while concurrently effecting controlled inward movement of the edge of the blank so as to control the thickness and quality thereof.

7 Claims, 8 Drawing Figures







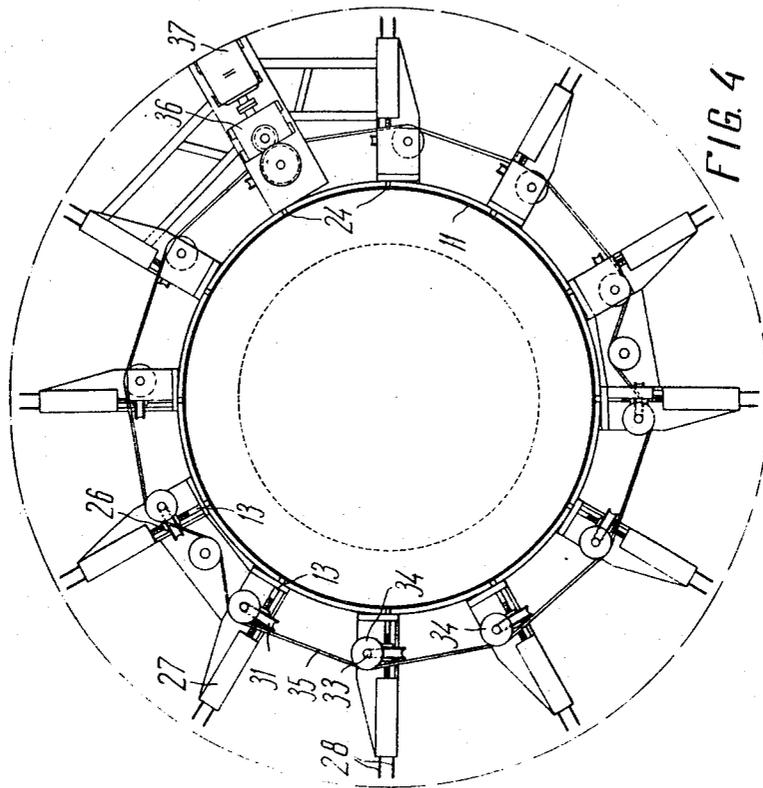
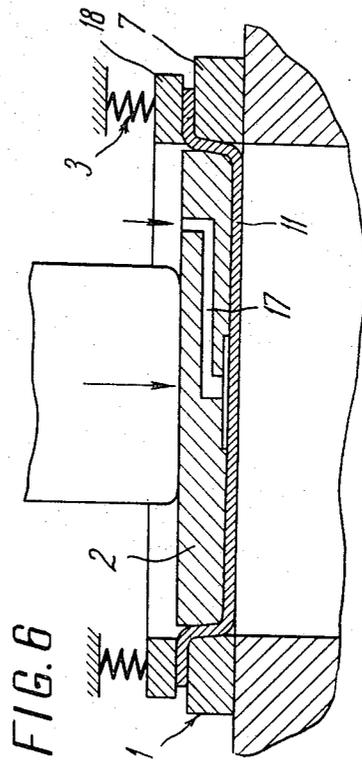
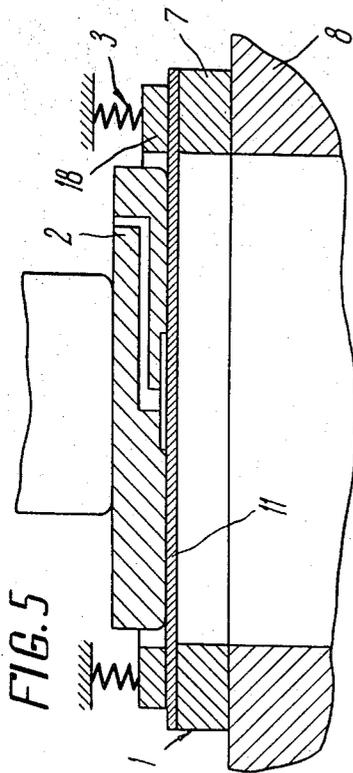


FIG. 4



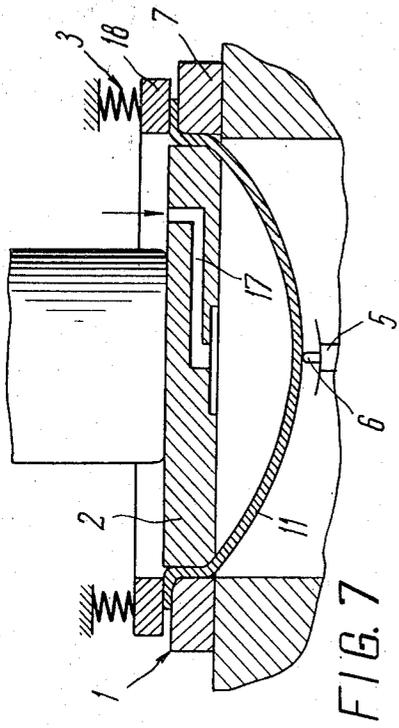


FIG. 7

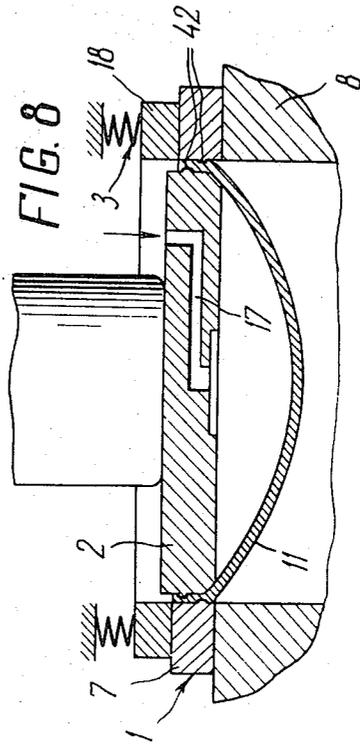


FIG. 8

METHOD OF STAMPING METAL CONVEX ARTICLES FROM SHEETS

The present invention relates mainly to the field of mechanical engineering, that is, to methods of stamping metal convex articles from sheets, preferably bottoms for sealed reservoirs, used under pressure or vacuum, and to dies for their embodiment when stamping large-size articles in cold state.

Known in the prior art are methods and dies for stamping metal convex articles from sheets, wherein a sheet is placed on the die, its edges are held by a hold down means after which it is acted upon by the punch.

In the conventionally known dies a sheet blank is stamped in a die by a punch until a convex shape article is produced. For this operation the blank in most cases is to be preheated.

The known method requires the manufacture of an expensive die set (die and punch), corresponding to the shapes of the article to be produced. In this case the article is stamped by stamping the blank by the punch in the die until the whole surface of the blank contact the die. In this case it is necessary to make a durable die and a massive punch, which considerably increases metal consumption.

When stamping articles by the known methods considerable efforts should be developed on the punch to ensure shaping of the article by the whole inner surface of the die. When the die and punch interact, considerable thinning of the blank takes place in the portion between the convex and cylindrical parts thereof, that is, in that place of the bottom, which is subjected to maximum strains in the course of servicing.

Besides, if the punch reproduces the shape of the articles being manufactured, corrugations are formed (especially when stamping large-size articles of small thickness) due to the action of considerable efforts on the blank, when the punch acts upon the middle portion of the blank, resulting in the (tangential stresses in the fixed part of the blank and radial ones in the rest of it.)

The formation of the corrugations of considerable size results in the reduction of the article strength and causes rejects.

In some cases, when stamping thin-walled articles, a thicker sheet blank is used to reduce durability of formation of corrugations, this, however, results in increased metal consumption and weight of the ready article.

The stamping of large-size articles, having a large diameter and small thickness with the help of the known die sets is impossible at all.

A serious disadvantage of the known methods of stamping resides in that the blank is rigidly fixed on the die with the help of various holders, for example, a holding ring with clamp bolts. In this case the effort of holding the blank is constant and non-adjustable, which results in uneven movement of the blank and tearing of the edges, held by the hold-down means, and, consequently, uneven height of the cylindrical portion. This requires an additional operation of levelling the edges of the article, and in some cases it causes rejects.

Besides, when a punch and die are used for stamping, these punch and die should be replaced by others in case the shape of the article (its convex part) should be changed.

It should also be noted, that the working surfaces of the punch and die wear out quickly due to heavy loads and the action of friction forces. The wear of the working surfaces of the punch and die results in undesirable change of the article shape and, consequently, causes rejects.

An object of the present invention is to develop a method of stamping metal convex articles from sheets, for example, reservoir bottoms, and to develop a simple and reliable die set for the embodiment of this method.

Another object is to provide a possibility of stamping large-size articles having a large diameter, small thickness and level edges (both with a flange and without it), said stamping being effected without bearing portion of the die.

Still another object of the invention is the elimination of corrugation formation in the course of stamping the article.

It is also an object of the present invention to obtain articles with a cylindrical shoulder without thinning it in the dangerous section.

Yet another object of the invention is the reduction of the stamping effort.

A still further object of the invention is the production of articles of even strength throughout the surface thereof.

It is also an object of the invention to prolong the die set life.

An object of the invention is to reduce the cost of producing the punch and die.

It is also an object of the present invention to eliminate the use of auxiliary equipment for heating the blank and flaging the article.

In accordance with the abovesaid and other objects the invention resides in that in the method of stamping metal convex articles from sheets preferably, reservoir bottoms, a sheet blank is placed on a die and its edges are clamped, and then the blank is preliminarily acted upon by the punch until a cylindrical convex part is formed therein, after which the article is finally formed by the pressure of liquid delivered into the clearance between the punch and blank, until a convex shape of the article is formed, the edges of the blank simultaneously moving to the center that is reached by selection of suitable effort of clamping the blank by hold-down means.

It is expedient, that the fluid pressure in the clearance between the punch and blank be from 40 up to 300 atm.

In the die set for the embodiment of the method of stamping metal convex articles from sheets, preferably, reservoir bottoms, its punch, whose bottom working surface is made flat in the middle, has a channel to force fluid into the clearance between the punch and blank in the course of shaping an article, while the die is made as a ring, fixed on the lower cross-piece, a free space being provided below said ring, a hold-down means being installed above the die with the possibility to adjust the effort of its holding the blank.

It is expedient to locate a stripper for the article under the ring-shaped die in the middle part of the lower cross-piece, an adjustable limiter of the article convexity, being mounted in said stripper, said limiter disengaging the system of fluid, forcing into the clearance between the punch and blank.

It is also expedient to make the hold-down means in the shape of a flat ring, articulated to the actuating cylinders, fastened to the punch, with a follow-up device, controlling the movement of the blank edges to the center in the course of preliminary action of the punch upon the blank and during final shaping of the article by forcing fluid and by the effort exerted by the rods of said actuating cylinders pressing said flat ring.

It is expedient to use a system of feelers and pick-ups as a follow-up device, said feelers and pick ups being spaced around the periphery under the flat ring of the hold-down means and connected to the drive, and actuating a slide of the valve, controlling the fluid pressure in a respective actuating cylinders of the hold-down means at the moment of their contact with the blank, this being made with the help of an electromagnet, the pressure in said cylinders being pre-set.

It is desirable that the feeler drive should comprise a system of blocks, which is imparted oscillating rotary movement by the electric motor via a reduction gear, said blocks being connected by an endless belt, the feeler drive should also comprise worm pairs, the worms thereof being installed on the shafts of said blocks, and the worm wheels being screwed onto the thread of the feelers.

Other objects and advantages of the present invention will be given hereinbelow by way of examples with reference to the accompanying drawings, wherein:

FIG. 1 shows a side view of a die set for stamping metal convex articles from sheets, preferably, reservoir bottoms, according to the invention (partial section with the front unit of the follow-up device removed);

FIG. 2 is a sectional side view of a hold-down means with a follow-up device;

FIG. 3 is a view along the arrow "K" of FIG. 2;

FIG. 4 is a section, taken along the link IV—IV of FIG. 2;

FIG. 5 is a schematic view of the initial position of the punch prior to the preliminary stamping of the blank, placed on the die and held thereon by a hold-down means;

FIG. 6 is a schematic view of the punch position after the preliminary stamping of the blank is completed and before pressurized fluid begins to be fed onto the convex surface of said blank;

FIG. 7 shows the same, after the final shaping of the article with the help of fluid;

FIG. 8 shows the production of an article without a flange (seen is a cylindrical portion of the blank, held by means of ring shaped projections on the punch and die).

When describing the embodiment of the invention given herein concrete terminology is used for the sake of clarity. However it should be borne in mind, that the invention is not restricted by these narrow terms, and that each of these terms embraces all the equivalent elements, operating in a similar way and used for the solution of the same problems.

The die set according to the invention comprises a die 1 (FIG. 1), a punch 2, a hold-down means 3 with a follow-up device 4 and pusher 5 with an adjustable limiter 6 of the article convexity.

The die 1 is made in the shape of a ring 7, fastened to the lower cross-piece 8 of the press with the help of a tubular element 9. The upper surface of the ring 7 is provided with a recess 10 for fixing the blank 11 during stamping and radial grooves 12 for installing the feelers 13 (FIG. 2) of the follow-up device 4.

The punch 2 (FIG. 1) has a working part 14, fastened to the upper cross-head 15 by means of tubular uprights 16. The punch 2 has a channel 17 with an outlet in the middle of the flat bottom part of its working surface used for forcing the fluid into the clearance between the punch and blank 11.

A special device, ensuring a considerable effect, is the hold-down means 3, used in the die set and made with the follow-up unit 4 according to the invention. The hold-down means 3 (FIG. 1) comprises a follow-up unit 4, flat ring 18, 12 actuating cylinders 19 with a valve 20 controlling the fluid pressure. The rods 21 of the actuating cylinders 19 are connected to the flat ring 18 along the periphery by means of hinges 22, while their bodies 23 are rigidly fastened to the punch 2 in the example under consideration, or can be fastened to the upper cross-head 15 of the press. This version is not considered in this description.

Used in said hold-down means 3 are twelve actuating cylinders 19 equally spaced around the periphery. There can be less than 12 cylinders 19, but their number must ensure a necessary effort of holding the blank 11 against the die 1.

The follow up device 4 comprises 12 feelers 13 (FIG. 2), pick-ups 24 being fitted inside said feelers and forced towards the blank 11 by springs 25.

The middle part of the outer surface of the feelers is provided with screw threads 26. One end of the feelers is fitted into the grooves 12 (FIG. 1) of the ring 7, while its other end is fitted into the cylinders 27 (FIG. 2) with the possibility of reciprocating movement therein.

The end part of the cylinders 27 is provided with electric contacts 28, connected to the pick-ups 24 and to electromagnets 29, acting upon the slides 30 of the valves 20. Worm wheels 31 are screwed on the thread 26 of the feelers 13 and interact with the worms 32 (FIG. 3, K), blocks 34 being fitted onto the axles 33 of said worms and connected by a belt 35 to the reduction gear 36 (FIG. 4), which is in turn connected to the electric motor 37.

The pusher 5 (FIG. 1) is mounted in the lower cross-head 8 below the ring 7 in the middle part of said cross head. In the center of the pusher 5 the adjustable limiter 6 of the article convexity is installed, disengaging a hydraulic system (not shown in the drawings) forcing the fluid for the final shaping of the article.

The method of stamping metal convex articles from sheets, according to the invention, is embodied as follows.

The sheet blank 11 (FIG. 5) is placed in the recess 10 in the upper plate of the ring 7 of the die 1 after which the upper

cross-head 15 (FIG. 1) with the punch 2 is lowered until it comes in contact with the blank 11 and its edges are held by the changing effort of the flat ring 18 of the hold-down means 3. The held blank 11 is preliminarily acted upon by the punch 2 until the cylindrical convex part of the blank 11 (FIG. 6) is formed. Simultaneously uniform movement of the edges of the blank 11 towards the center takes place, which eliminates the possibility of thinning and corrugation forming.

The held edges of the blank 11 are moved by means of actuating cylinders 19 (FIG. 2) of a the hold-down means 3. In this case the effort in the actuating cylinders 19 should be one fourth of the effort, created by the punch 2 for the preliminary stamping of the blank 11 (FIG. 6) prior to the formation of a cylindrical convex portion therein. This effort is sufficient to eliminate the thinning at the place, where the curvilinear portion of the article passes into the cylindrical one, and to eliminate the formation of corrugations in the part of the blank 11, which is not in contact with the punch 2.

The corrugations are not formed also because the lower part of the working surface of the punch 2 is made flat, thus, the initial action affects almost the whole surface of the blank 11 being treated, that is, in this case, the tangential and radial stresses in the free part of the blank 11 are balanced, said part of the blank being not in contact with the punch 2.

When the blank 11 is being stamped, the movement of its edges is controlled by means of the follow up device 4 (FIG. 2). The movement of the edges of the blank 11 is followed up as follows.

In the initial position the feelers 13 with the pick-ups 24 are installed around the periphery with a certain clearance to the blank 11, held by the hold down means 3. A certain pressure is pre-set in the actuating cylinders 19, said pressure being equal to about one fourth of the main stamping effort. This pressure is maintained constant owing to the fluid release into the atmosphere through the adjusting valves 20. The fluid pressure P_1 in the valves 20 is smaller than the pressure P_0 created in the actuating cylinders 19, and ensures not full opening of holes 38.

At the beginning of the downward movement of the punch 2 the electric motor 37 (FIG. 4) is switched on, which, via the reduction gear 36, belt 35, blocks 34 and the worm pair 31, 32 actuates the feelers 13, the latter starting their synchronous movement following the edge of the blank 11.

When the edge of the blank 11 in some place happens to move slower than required, the pick-up 24 (FIG. 2) of the respective feeler 13 is sunk thus closing the electric contacts 28, the electromagnet 29 moving the slide 30 of the control valve 20 into the extreme rear position, communicating the space 39 of the valve 20 with space 40. The pressure P_2 in the space 39 being lower than the pressure P_1 , piston 41 is moved to the left (the valve 20 being to the left in the drawing), fully opening the hole 38 in the actuating cylinder 19. The pressure in the actuating cylinder 19 drops, the flat ring 18 is raised, resulting in the reduction of the effort of holding the blank 11 in this place. The edge of the blank 11 is released and begins to move faster. After the edge of the blank 11 is levelled the electric contacts 28 are opened, the corresponding valve 20 is closed (the slide 30 occupies the initial position) and the pressure in the respective actuating cylinder 19 is raised up to the pressure in the rest of the cylinders, the effort of holding down the edge of the blank 11 in this place being thus increased.

When the edge of the blank 11 happens to move slower in another place, the valve 20 of the respective actuating cylinder 19 operates.

Separate units of the follow-up device periodically operate in this way.

Another embodiment of the follow-up device is possible, in which selsyns can be used instead of the blocks 34 with the belt 35, an electric motor 37 with the reduction gear 36 said selsyns being connected by a closed chain or some other connection, ensuring concentric movement of the feelers 13 synchronously with the movement of the edge of the blank 11 (these embodiments are not shown in the drawings).

On completion of the preliminary stamping of the cylindrical convex part, fluid is forced for the final shaping of the article into the blanks along the channel 17 of the punch 2, into the clearance between the punch and the convex part of the blank (FIG. 7). The article is shaped until the convex shape is obtained, said shape being controlled by the adjustable limiter 6. During the final shaping of the article the edges of the blank are also moved, said movement being controlled by the abovedescribed method. The ready article is pressed out by the pusher 5.

The fluid pressure for the final shaping is selected depending on the physical properties of the material and the dimensions of the blank 11. For example, when producing steel bottoms having the diameter of 1,800 mm and wall thickness of 10 mm the convex part of the bottom is shaped by the fluid pressure of about 70 atm.

The article can be finally shaped, with physical properties of the material and size of the blank being duly taken into account, by means of volumetric proportioning of the fluid.

In this case a definite volume of the fluid is fed onto the convex surface of the blank 11 from the side of the punch 2, said volume being capable to ensure the formation of the convex part of the article of pre-set dimensions.

The best version of the final shaping is the use of the adjustable limiter 6 of the article convexity, which ensures in a pre-set position the release of the pressure of the fluid, delivered for shaping the article.

In all the cases the pressure of the fluid, delivered into the channel 17 of the punch 2, is within the range of 40 to 300 atm depending on the thickness, diameter, convexity of the article being shaped, as well as on the physical properties of the blank material.

The articles can be produced both with a flange and without it (FIG. 8). When the article is made without the flange, it is expedient, that the working part 14 (FIG. 1) of the punch 2 should have ring-shaped projections 42. In this case during preliminary stamping of the cylindrical part of the article the entire clamped edge of the blank 11 is moved into the cylindrical part of the article being shaped and is clamped by the ring-shaped projections 42.

Besides, the projections 42 serve as sealings, preventing the leakage of the fluid between the blank 11 and punch 2.

In all the abovedescribed cases the blank 11 is held down and its edge is followed up by the hold-down means 3 with the follow-up device 4.

The advantages of the method of producing metal convex articles from sheets and of the die set for its embodiment according to the invention, are as follows.

The production of costly metal-consuming profiled die sets is not required.

The effort required for stamping the article is reduced approximately twice owing to the fact that only the cylindrical portion of the article is stamped.

The produced articles are of better quality and uniformly durable owing to the fact that the thinnings are not formed at the place where the curvilinear portion of the article passes into the cylindrical one (in the dangerous cross section) and owing to the fact that the corrugations are not formed in the part of the article 11, which is not contact with the punch 2.

The produced articles have level edges (both with a flange and without it). This is achieved by using a hold down means 3 with a follow-up device 4. Besides, the fact of employing the hold down means 3 allows to level the upper cross-head 15 with the punch 2 in the press by means of actuating cylinders 19.

The production of large-size articles having a large diameter and negligible thickness is possible.

The employment of heating furnaces for heating the article 11 prior to stamping is not required.

The specified method and die set for its embodiment allow to change the shape of the article (its convex part) without replacing the punch 2 and die 1.

Due to the reduction of loads and friction forces the punch 2 and die 1 do not wear out, which is achieved by using the design of the punch 2 and die 1 in accordance with the invention.

According to the invention, the produced articles can be used without heat treatment. This allows to preserve the strength of the article metal, obtained in the course of cold deformation of the article.

Although the present invention is described in connection with a preferable embodiment thereof, it is clear that variations and changes can take place within the spirit and scope of the invention, which is clear for those skilled in the art. These variations and changes are considered to be within the spirit and scope of the invention and the appended claims.

We claim:

1. A method of stamping metal convex articles from sheets, preferably reservoir bottoms, on a stamping press, comprising; placing a sheet blank on a ring-shaped die, clamping the edges of said blank with a hold-down means, deforming said blank by a punch which is attached to an upper cross-head of the press so as to form a convex cylindrical portion therein, and finally shaping the article by delivering a pressurized fluid into the space between said punch and the convex part of said blank, until the final convex configuration of the article obtained, concurrently during the forming and final shaping of the article moving the edges thereof uniformly towards its center, said edge movement being responsive to a predetermined adjustment of the clamping force applied by said hold-down means to said blank, said adjustment obviating the formation of corrugations on the article and the thinning out of its cross-sectional thickness in the critical portions thereof.

2. A method as claimed in claim 1, comprising maintaining the fluid pressure in the space between said punch and said blank within the range of 40 to 300 atm.

3. A die set for carrying out the method of stamping metal convex articles from sheet blanks, preferably reservoir bottoms, on a stamping press, comprising a punch attached to an upper movable cross-head of the press; a die mounted on the bed of the press; hold-down means for clamping the blank edges attached to said upper cross-head of the press; said punch comprising a flat disc having a radial chamfer about its blank-contacting working surface; a channel in said punch for forcing fluid between said punch and said blank; said die comprising a ring fastened to a tubular member at a distance from the plane of a lower cross-head of said press.

4. A die set as claimed in claim 3, comprising an article pusher located below said ring-shaped die in the center portion of said lower cross-head; an adjustable limiter for controlling the shape of the article, said limiter being mounted on said pusher and adapted to discontinue flow of said fluid into the space between said punch and said blank.

5. A die set as claimed in claim 3, wherein said hold-down means comprises a flat ring clampingly engaging said blank; a plurality of power cylinders connected to said upper cross-head; said power cylinders each having piston rods articulated to said flat ring; a follow-up device for adjusting the uniform movement of the edges of said blank towards its center by varying the clamping force exerted by the rods of said power cylinders on said flat ring, said device being operative during the course of the forming of said blank by said punch and during the final shaping of the article by said fluid.

6. A die set as claimed in claim 5, wherein the follow-up device comprises a system of feelers having pick-ups equidistantly spaced about the circumference of said flat ring; said feelers being provided with helical threading on their external surface; a drive for said feelers imparting motion to said feelers to follow up the positioning of the edges of said blank; pick-ups connected to said feeler drive; a valve for adjusting the required fluid pressure in respective ones of said power cylinders; and electromagnets acting upon the slide of a respective fluid-pressure adjusting valve at the instant of contact between a corresponding pick-up and the blank edge.

7. A die set as claimed in claim 6, wherein said drive to feelers comprises a system of pulleys inter-connected by a belt transmission; an electric motor having a reducing gear, said motor being adapted to impart rotation to said system of pulleys; and paired worm wheels and worms, said worms being positioned on the shafts of said pulleys, and the worm wheels being engaged on the helical thread of said feelers.

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