

Nov. 6, 1962

W. P. POST

3,062,262

SHEET METAL WORKING APPARATUS

Filed July 9, 1959

7 Sheets-Sheet 1

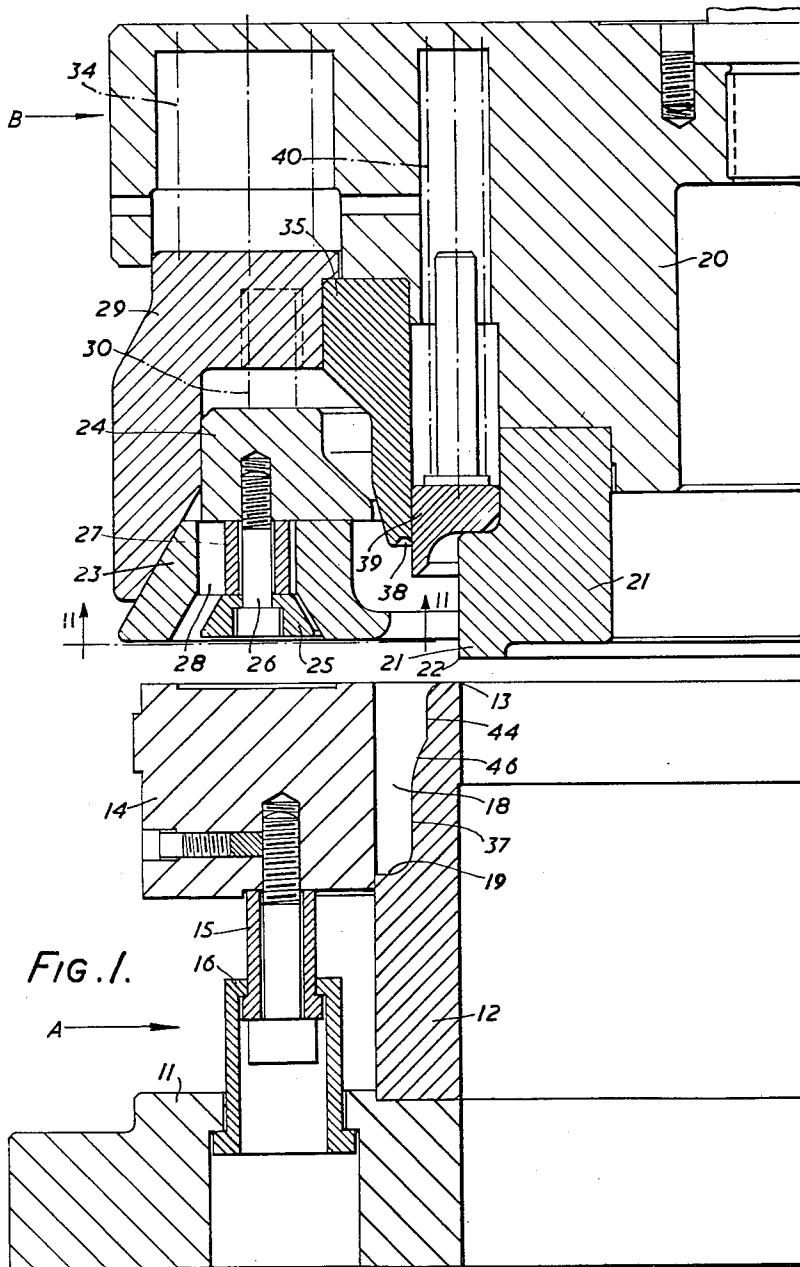


FIG. 1.

INVENTOR

WILLEM PIETER POST

BY

Wm. Hubbard, Vait & Osann

ATTORNEYS

Nov. 6, 1962

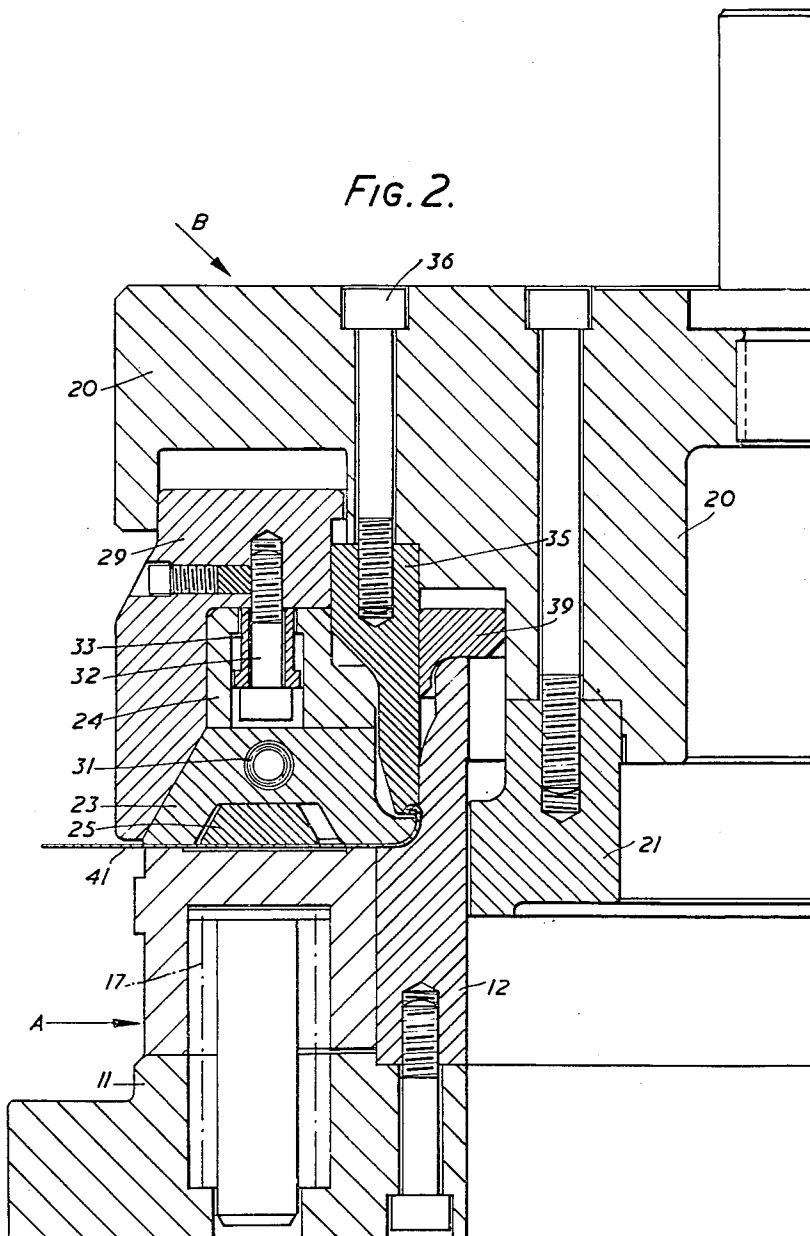
W. P. POST

3,062,262

SHEET METAL WORKING APPARATUS

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7 Sheets-Sheet 2



INVENTOR
WILLEM PIETER POST

BY
Wee, Hubbard, Vort & Osamu
ATTORNEYS

Nov. 6, 1962

W. P. POST

3,062,262

SHEET METAL WORKING APPARATUS

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7 Sheets-Sheet 3

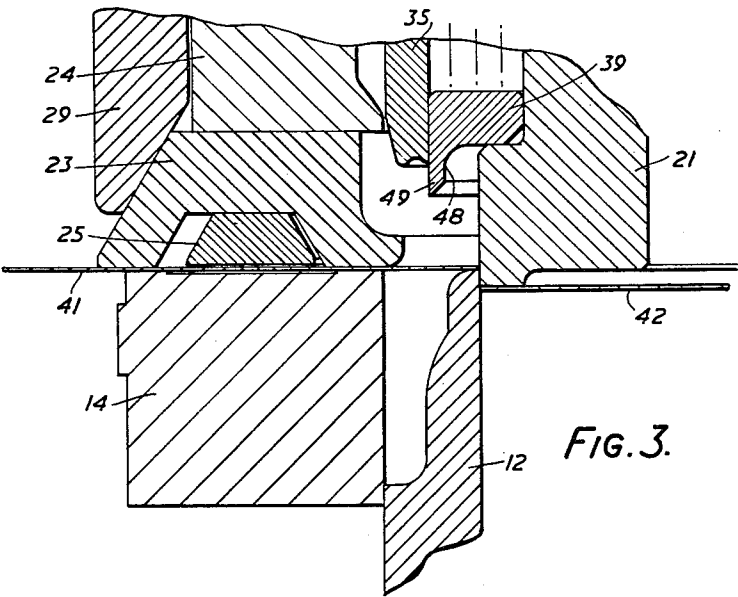


FIG. 3.

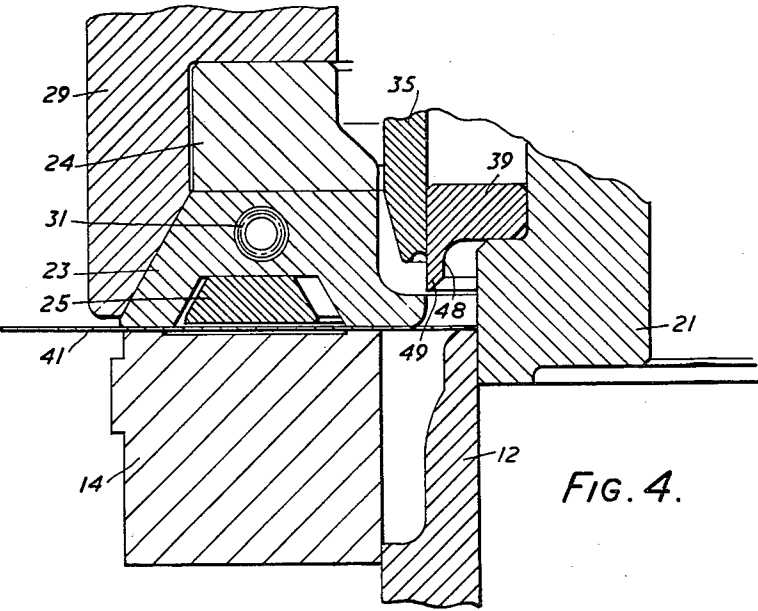


FIG. 4.

INVENTOR
WILLEM PIETER POST

BY
Wolfe, Hubbard, Voik & Osamu
ATTORNEYS

Nov. 6, 1962

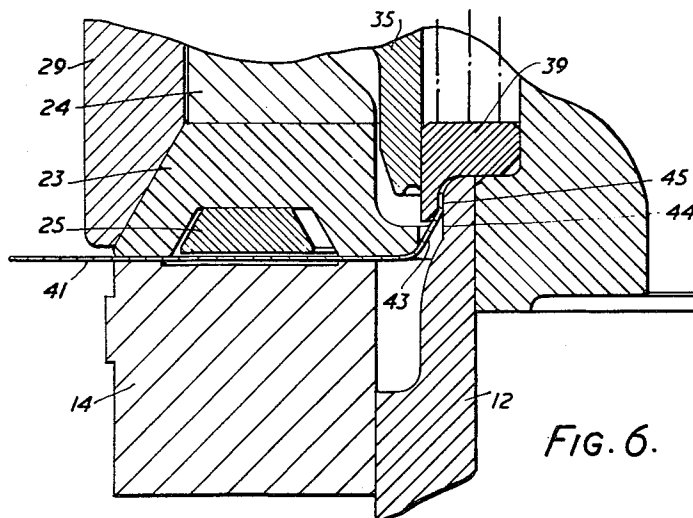
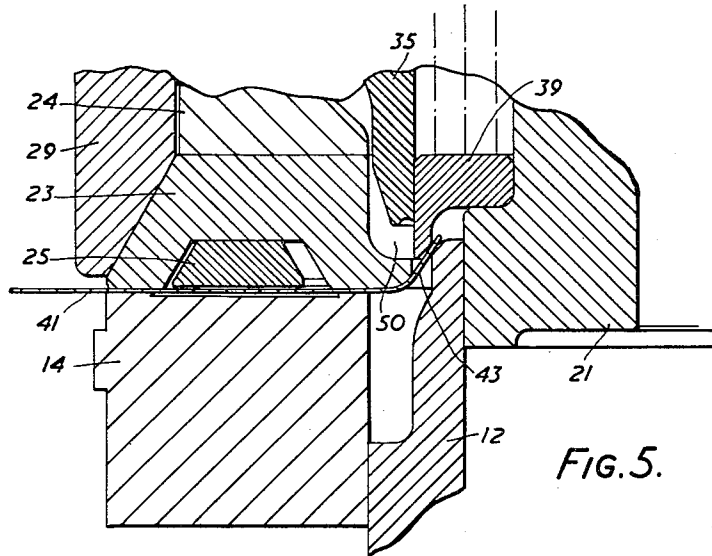
W. P. POST

3,062,262

SHEET METAL WORKING APPARATUS

Filed July 9, 1959

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INVENTOR
WILLEM PIETER POST
BY
Wolfe, Hubbard, Voth & Osann

ATTORNEYS

Nov. 6, 1962

W. P. POST

3,062,262

SHEET METAL WORKING APPARATUS

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7 Sheets-Sheet 5

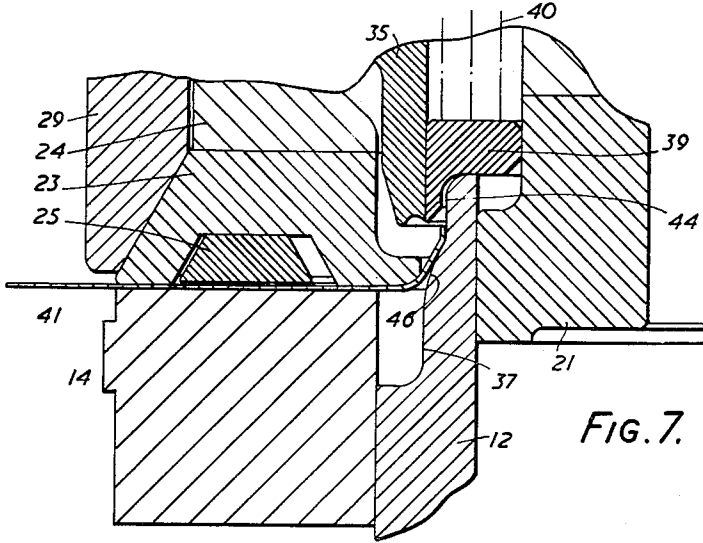


FIG. 7.

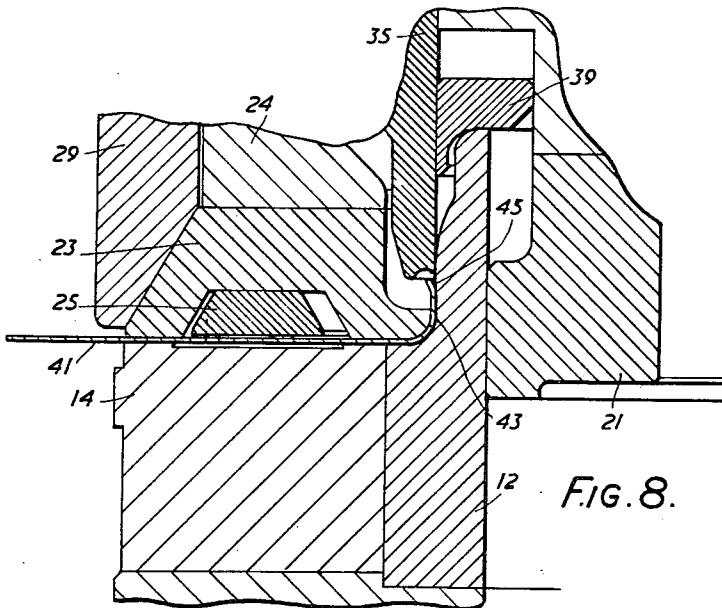


FIG. 8.

INVENTOR
WILLEM PIETER POST

BY

Welf, Hubbard, Voit & Osamu

ATTORNEYS

Nov. 6, 1962

W. P. POST

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SHEET METAL WORKING APPARATUS

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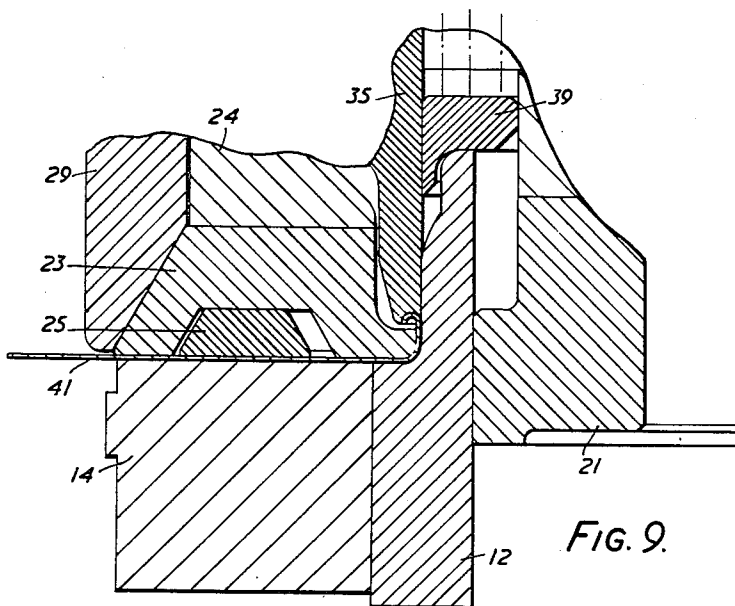


FIG. 9.

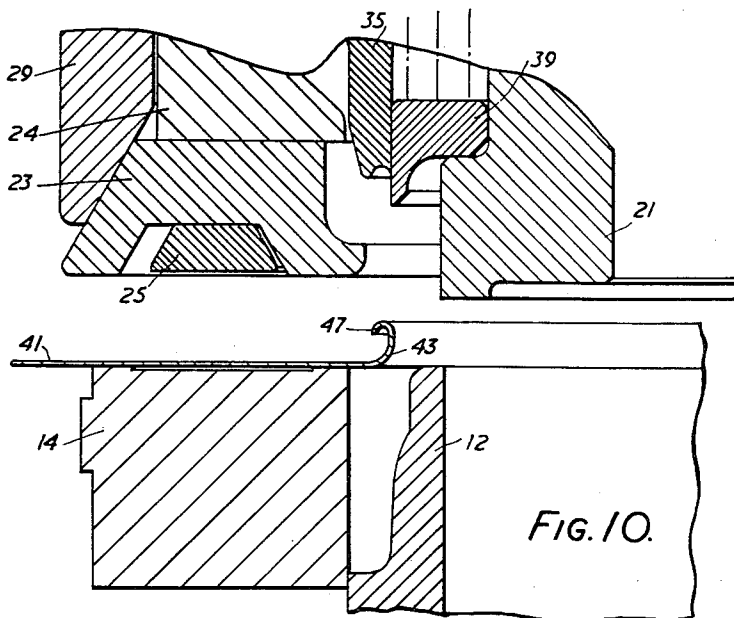


FIG. 10.

INVENTOR
WILLEM PIETER POST

BY
Wespe, Hubbard, Vait & Oram

ATTORNEYS

Nov. 6, 1962

W. P. POST

3,062,262

SHEET METAL WORKING APPARATUS

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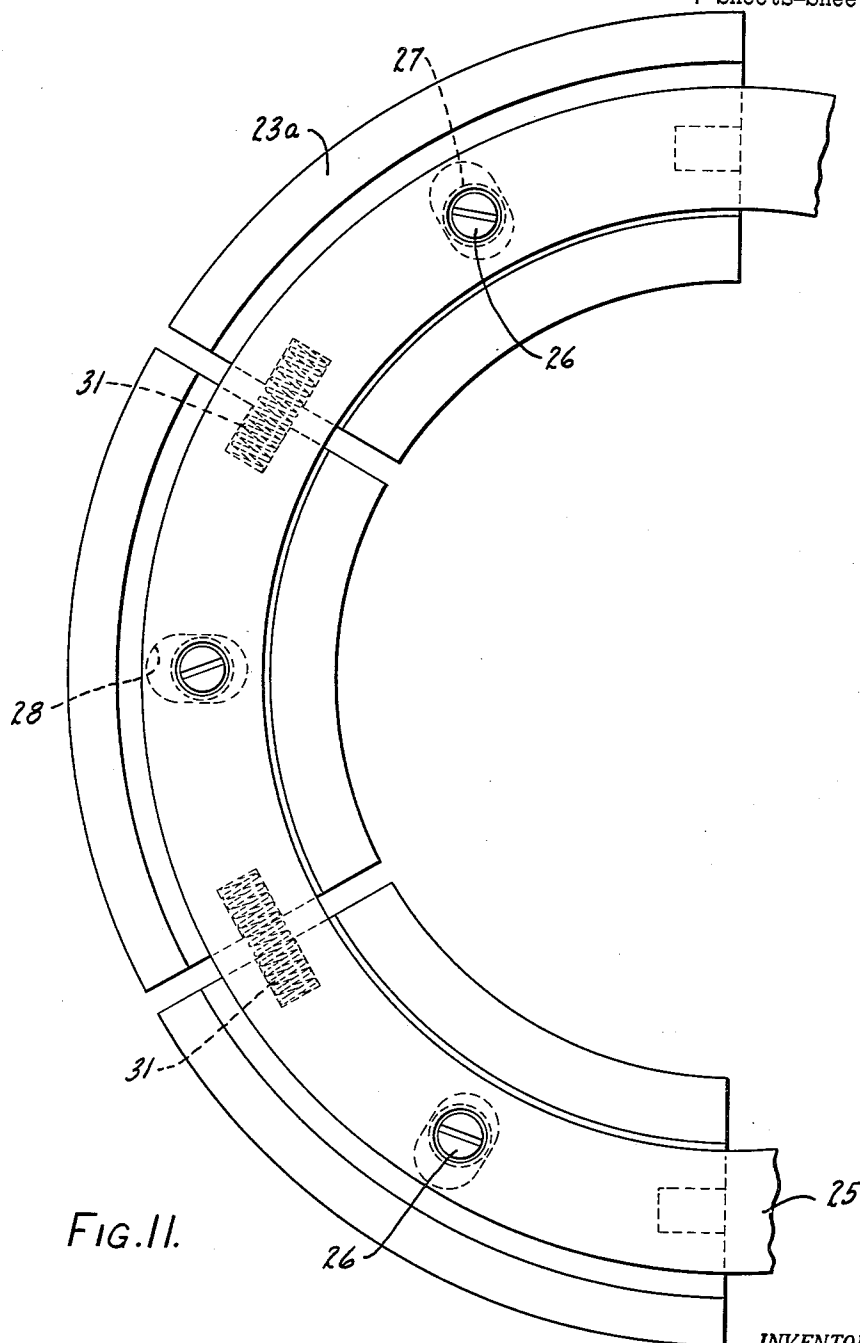


FIG. II.

INVENTOR.

WILLEM PIETER POST

BY

Wolfe, Hubbard, Voit + Osann
ATTORNEYS

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3,062,262

SHEET METAL WORKING APPARATUS

Willem P. Post, Amstelveen, Netherlands, assignor to Metal Containers Limited, London, England, a limited-liability company of England

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4 Claims. (Cl. 153—2)

The invention relates to improvements in sheet metal working apparatus and more particularly to apparatus for forming in sheet material a substantially circular opening surrounded by a projecting flange having a curled bead along its free edge.

Apparatus has been proposed for forming relatively small openings of the above character in sheet material, usually sheet metal. Such apparatus ordinarily comprises means for successively cutting an opening, forming a projecting flange around the opening and curling the free edge of the flange. The means for performing such operations ordinarily includes two main units reciprocable relative to one another along the axis of the opening. One of the main units has a central sleeve with its extremity formed to serve as one cutting edge for punching a disc out of the sheet. A supporting ring conventionally surrounds the sleeve and is supported for axial sliding movement relative to the sleeve against the bias of a spring. The other main unit comprises a central stamp for cooperation with the sleeve in punching a disc out of the sheet. A press ring surrounds the stamp and is axially slidable relative thereto against the bias of a spring. A curling ring having an annular groove is positioned between the stamp and the press ring for forming the bead on the flange.

Limitations inherent in such known apparatus have restricted it to the forming of relatively small openings in sheet metal. Attempts to adapt that apparatus for forming relatively large openings in thin sheet metal have met with little success. One primary reason is that the curling ring cannot be made to engage the projecting flange uniformly around its entire circumference. Because of those difficulties it has been the general practice to form relatively large openings with their surrounding curled flanges in three separate operations executed by three separate sets of apparatus or die mechanisms. This is obviously a rather slow and laborious process and substantially increases costs.

One object of the present invention is to overcome the above and other drawbacks and provide improved apparatus capable of forming flanged openings of any size in a single operation.

A more specific object is to provide apparatus of the above general character in which accurate formation of the curled bead is insured by providing auxiliary means for preforming the flange prior to the curling operation.

A further object is to provide die mechanism for precurling the end of a sheet metal flange embodying novel means for preventing scale or other foreign material chipped from the work from entering between the other operating parts of the mechanism.

Other objects and advantages of the invention will become apparent from the following detailed description, reference being made to the accompanying drawings showing by way of example only a preferred embodiment of the invention. In the drawings:

FIGURE 1 is a vertical cross-sectional view of the essential part of the improved apparatus in its inoperative or idle position, that is, before the beginning of the operation.

FIG. 2 is a cross-sectional view of the apparatus similar to FIG. 1 but with the various parts shown in the positions which they occupy at the end of an operation.

FIGS. 3, 4, 5, 6, 7 and 8 are similar fragmentary cross-

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sectional views of a part of the apparatus showing the relative positions of the elements during various stages of the operation hereinafter described in detail.

FIG. 9 is a fragmentary cross-sectional view similar to the preceding FIGURES showing the positions of elements at the end of the operation.

FIG. 10 is another fragmentary cross-sectional view similar to the preceding FIGURES, showing the apparatus after the elements have moved back to the position shown in FIG. 1 and the finished workpiece ready for removal from the apparatus.

FIG. 11 is a fragmentary sectional view taken in a plane substantially on the line 11—11 of FIG. 1.

The exemplary apparatus shown in the drawings comprises two main units, including a lower or die unit indicated generally at A and an upper or stamp unit indicated generally at B. The stamp unit B is axially reciprocable relative to the die unit A, although it will be appreciated that the die unit A might be reciprocated or both units might be mounted for simultaneous movement.

The die unit A as shown comprises a base plate 11 with a rigid central sleeve 12 supported thereon. The upper inner edge 13 of the sleeve is formed to serve as one of the cutting edges of a die for punching a disc out of a sheet of material so as to form an opening therein. Encircling the sleeve 12 is a supporting ring 14 mounted for axial sliding relative to the sleeve. Such movements of the supporting ring are guided by means of a plurality of circumferentially spaced telescoping guides 15, 16. The supporting ring is urged outwardly from the base plate 11, in this instance, upwardly, by a plurality of circumferentially spaced springs 17 (FIG. 2) positioned in alternate relationship to the guides. In the upper position of the supporting ring there is an annular space 18 between the ring and the upper end of the sleeve 12. This annular space is bounded at one side by the inner wall of the ring 14 and at the other side by the shaped outer wall of the sleeve. The lower end of the space 18 is defined by a collar 19 formed on the sleeve. While the collar 19 may, if desired, be formed by a separate ring about the sleeve, it is shown here as formed directly on the sleeve.

The shaped wall portion of the sleeve 12 includes a substantially cylindrical portion merging at its lower end in a rounded corner with the collar 19 and at its upper end in a convexly curved surface with another cylindrical surface portion of smaller diameter than the first-mentioned cylindrical portion. The small diameter portion of the sleeve terminates in a rounded external corner at the top of the sleeve. In the lowermost position of the supporting ring 14 in which it rests on the base plate 11, the upper surface of the supporting ring and the surface of the collar 19 are in alignment as shown in FIG. 2.

The stamp unit B comprises a main body 20 to the lower end of which a central and preferably hollow stamp or punch 21 is secured. The outer edge 22 at the lower extremity of the punch is adapted to cooperate with the upper inner edge 13 of the sleeve 12 for punching a disc out of the sheet to be operated on.

The stamp unit B is provided with a press ring 23 encircling the punch 21 and being axially slidable relative to the main body 20 against the bias of a spring to be described hereinafter. The press ring 23 preferably consists of a number of sector shaped elements mounted on a base ring 24 for radial movement and which are held by a cage ring 25 connected to the base ring 24 as by screws 26. The screws 26 are surrounded by guide rings 27 slidably seating in radially extending slots 28 provided in each of the press ring elements. The entire assembly formed by the press ring 23, the base ring 24 and the cage ring 25 is axially slidable in a suspension ring 29 which, in turn, is axially slidable in the main body 20 of

the unit. A plurality of circumferentially spaced compression springs 30 are interposed between the base ring 24 and the suspension ring 29 urging the assembly outwardly with respect to the suspension ring. Tangentially disposed compression springs 31 (FIG. 2) are provided between the separate elements of the press ring. When the assembly formed by the press ring 23, the base ring 24 and the cage ring 25 is axially pressed into the suspension ring 29, the press ring elements are shifted radially inwardly by cooperation of their conical outer surfaces with the complementally shaped inner surface of the suspension ring 29. The springs 31 resist radial displacement of the elements while the springs 30 yieldably urge the assembly of the press ring and associated parts out of the suspension ring 29. When the assembly is allowed to move under the action of the springs 30, the springs 31 urge the press ring elements away from one another and thereby cause them to move radially outwardly. The press ring 23, with its associated parts, is held in assembled relation with the press ring 29 by means of circumferentially spaced screws 32 and guide bushing 33, each provided with a collar. The suspension ring 29 is urged outwardly with respect to the main body 20 by a series of compression springs 34 interposed between the inner end of the ring and the adjacent surface of the body.

Disposed in the annular space between the punch 21 and the various rings above described is a curling ring 35. This latter ring is rigidly secured to the main body 20 by means of screws 36 (FIG. 2), thereby serving to retain the suspension ring 29 in assembled relation with the body. The lower extremity of the curling ring 35 has an inner diameter which conforms as precisely as possible to the outer diameter of the cylindrical portion 37 of the central sleeve 12. The annular lower front face of the curling ring is formed with an annular groove 38 shaped to form a curl on the workpiece, that is, on an upstanding flange when the ring is forced against the upper edge of the flange.

In accordance with one aspect of the invention, a precurling ring 39 is mounted within the curling ring 35 in encircling relation to the punch 21. The precurling ring is supported for axially sliding movement relative to the main body 20 and the parts carried by the body. A series of springs 40 urge the precurling die outwardly relative to the body. The arrangement is such that the precurling ring is adapted to engage the workpiece prior to the curling ring and in cooperation with a portion of the outer surface wall of the sleeve 12 to form an outwardly flaring marginal edge along the upper end of the projecting flange of the workpiece during the formation of the flange.

The operation of the apparatus in forming an opening with an encircling flange and curling the end of the flange in a single operation is briefly as follows. A sheet of material 41 in which the opening is to be formed is inserted between the punch and die units A and B while those elements are in the retracted position shown in FIG. 1. As the stamp unit B moves downwardly the punch 21 initially engages the sheet and cuts a disc 42 therefrom by cooperation of the cutting edges 13 and 22 on the sleeve 12 and punch 21, respectively. This step of the operation is shown in FIG. 3 and it will be observed that the hole left by the removal of the disc is substantially smaller than the finished opening in the sheet, thus leaving a marginal portion 43 for the formation of the flange to surround the opening.

On further downward movement of the stamp unit B the press ring 23, which is in engagement with the sheet, is pressed into the suspension ring 29 against action of the springs 30 and 31. In such movement the press ring elements are moved radially inwardly as shown in FIG. 4. Springs 17 are proportioned to resist movement of the supporting ring 14 during this phase of the operation.

When the press ring 23 and the associated base ring reach the end of this stroke and bottom against the sus-

pension ring 29, continued movement of the stamp unit B causes the supporting ring 14 to be pressed downwardly against the action of the springs 17. In such downward movement the marginal edge portion 43 of the sheet is deformed upwardly to start the formation of the flange as indicated in FIG. 5. More particularly, the marginal portion is gradually stretched into generally conical shape as the body of the sheet is carried down while the marginal portion rides over the rounded end of the sleeve 12.

As the elements approach the position shown in FIG. 5, the precurling ring 39 cooperates with the upper small diameter cylindrical portion 44 of the sleeve 12 to bend a circumferential edge 45 out of the upper end of the flange portion 43. At the end of this stage of the operation the precurling ring 39 abuts the upper face of the sleeve 12 as shown in FIG. 6.

The stamp unit B continues its downward movement, thereby urging the supporting ring 14 further downwardly. The projecting flange portion 43, which up to this time is conically shaped, then engages the convexly curved portion 46 of the outer surface of the sleeve 12. This curved portion 46 merges into the large diameter cylindrical portion of the sleeve, as shown in FIG. 7. As the stamp unit B continues its downward movement the projecting flange is converted from its conical shape into a cylindrical shape by the cooperation of the press ring 23 with the curved portion 46 and the cylindrical portion 37 of the sleeve 12. During such deformation the initially cylindrical edge 45 is flared outwardly, thereby forming the precurl as shown in FIG. 8. At the end of this stage of the operation the supporting ring 14 bottoms on the base plate 11 so that further downward movement of this part of the press ring assembly is precluded. The upper surface of the supporting ring now lies on the same level as the upper surface of the collar 19 on the sleeve 12.

The stamp unit B continues its downward movement with the curling ring 35, the springs 34 acting on the suspension ring 29 and associated parts being compressed. In this movement the ring 35 forms the curled bead 47 on the projecting end of the flange 43 as shown in FIGS. 2 and 9. Due to the edge 45 having been flared away from the cylindrical surface portion 37 of the sleeve the inner sharp edge of the curling ring around the annular curling groove 38 in the face of the ring is certain to penetrate into the inside of the flange 43 on the sheet. This arrangement also insures that the curl will be formed in the correct direction, that is, bent outwardly. In this stage of the operation, the press ring 23 cooperating with the cylindrical portion 37 of the sleeve supports the flange 43 and thus performs the third of its functions.

Upon completion of the flange forming operation the stamp unit B is retracted to the position shown in FIGS. 1 and 10. The finished workpiece can then be removed from the press and a new sheet to be operated on can be inserted.

In order to insure the correct sequence of the various stages of the operation above described and the proper displacement of the parts in relation to one another, the various biasing springs are dimensioned or their strengths are adjusted with respect to one another in such a way that the spring system 30, 31 resisting axial displacement of the press ring 23 is the weakest. The spring system 17 biasing the supporting ring 14 against axial displacement is slightly stronger than the preceding spring system. Next in strength is the spring system 40 resisting the axial displacement of the precurling ring 39. Finally, the spring system 34 resisting axial displacement of the press ring 23, together with its base ring 24 and the suspension ring 29 relative to the stamp unit's main body is the strongest.

Although the cylindrical inner surface 48 (FIG. 4) of the precurling ring 39 is the active surface in the formation of the precurl 45 and its presence would ordinarily be sufficient to enable it to perform its intended function, the ring is also formed with a conical extension 49. This

extension serves as a baffle for preventing scales of steel bursting from the sheet, passing into the space 50 (FIG. 5) and marring the finish of the flange. This arrangement is particularly desirable for working hot rolled sheet steel.

The cylindrical portion 44 on top of the convex portion 46 of the outer surface of the sleeve 12 is somewhat longer than would be required for the actual formation of the bent-over edge 45 on the projecting flange portion 43. This extended length is advantageous as it permits the upper rim of the sleeve 12 to be ground to restore the cutting edge 13 so that replacement of the sleeve is required only after repeated grinding.

In the apparatus shown, the punch 21 is intended to engage the sheet to be operated on first. Accordingly, in the inoperative position of the unit A the punch forms the furthest protruding part of the unit. This is advantageous in that it permits adjustment of the stamp unit in relation to the die.

I claim as my invention:

1. An apparatus for forming in sheet material an opening surrounded by a projecting flange having a curled bead along its free edge, said apparatus comprising means for successively cutting the opening, forming the projecting flange and curling the edge thereof, and consisting of a stationary die unit and a movable die unit axially reciprocable relatively to the stationary unit, in which one of said units includes a central sleeve the extremity of which is adapted to serve as a cutting edge for punching a disc out of the sheet, and a supporting ring surrounding said sleeve and being axially slidable against spring action and in relation to the sleeve, the other of said units including a central stamp for punching a disc out of the sheet in cooperation with said sleeve, a press ring surrounding said stamp and cooperating with said sleeve in forming the flange around the opening defined by removal of the disc, said press ring being axially slidable against spring action and in relation to the stamp, said other unit also including a curling ring having an annular curling groove and

being positioned between said stamp and said press ring, characterized by the provision of a precurling ring positioned within said curling ring and being axially slidable against spring action and relatively to the associated main unit and to said curling ring, said precurling ring being operative to engage the edge portion of the formed flange prior to engagement of the flange by the curling ring and, in cooperation with a portion of the outer surface of said sleeve, to form an outwardly flaring marginal edge along the upper edge of the projecting flange during the formation thereof.

2. An apparatus as claimed in claim 1, characterized in that said press ring is constituted by a plurality of radially movable sectors which in their innermost position assist in forming the projecting flange around the opening and supporting said flange during the curling operation.

3. An apparatus as claimed in claim 1, characterized in that the central sleeve of said one die unit has a substantially cylindrical outer surface portion which at the end adjacent the other unit merges into a convexly curved surface portion, the latter joining a substantially cylindrical surface portion having a smaller diameter than that of the first named cylindrical surface portion.

4. An apparatus as claimed in claim 1, characterized by the provision of an extension on the precurling ring operative to engage and preliminarily shape the workpiece for subsequent engagement by the curling ring.

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