Aug. 8, 1933. G. E. IRELAND 1,921,188

SHEET METAL DIE

Filed July 15, 1930 4 Sheets-Sheet 1

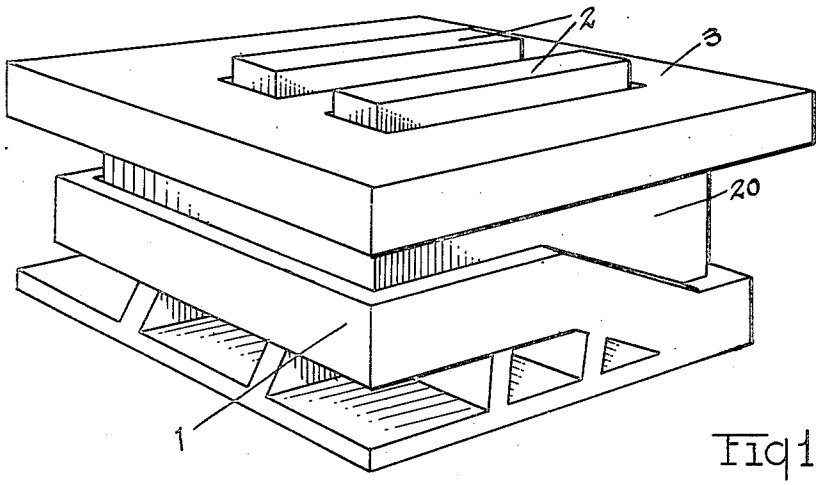


Fig 1

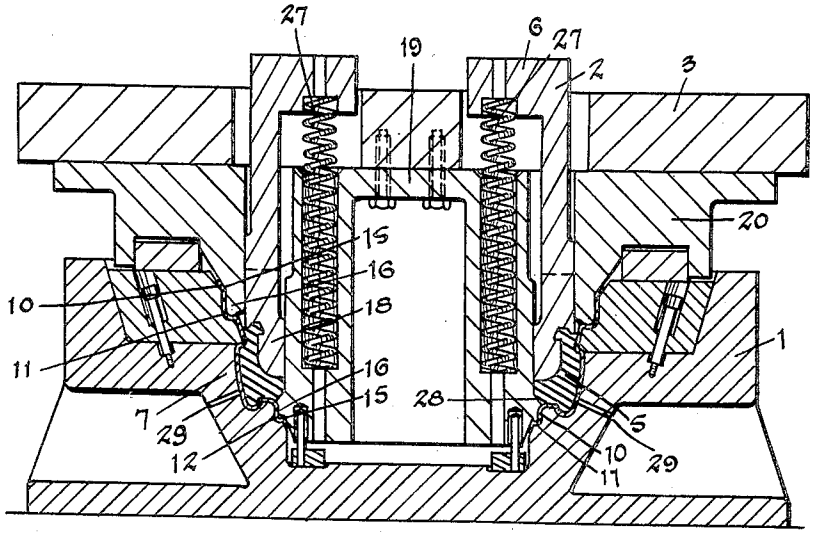


Fig 2

Inventor

George E. Ireland

By Harcourt F. Crampton.

Attorney

Aug. 8, 1933. G. E. IRELAND 1,921,188

SHEET METAL DIE

Filed July 15, 1930 4 Sheets-Sheet 2

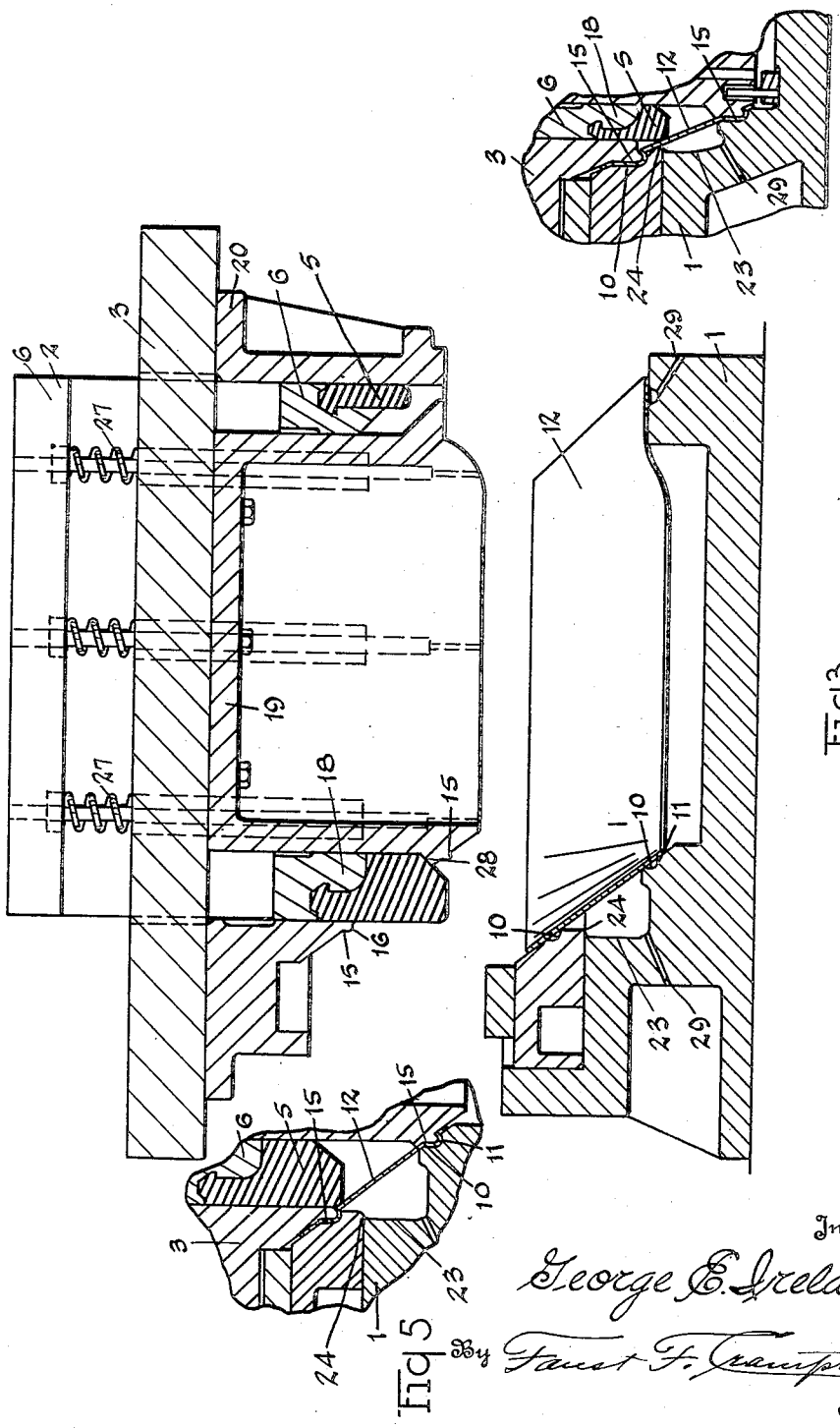


Fig 4

Fig 3

Fig 5

Inventor

George E. Ireland

By Faust F. Crampton

Attorney

Aug. 8, 1933. G. E. IRELAND 1,921,188

SHEET METAL DIE

Filed July 15, 1930 4 Sheets-Sheet 3

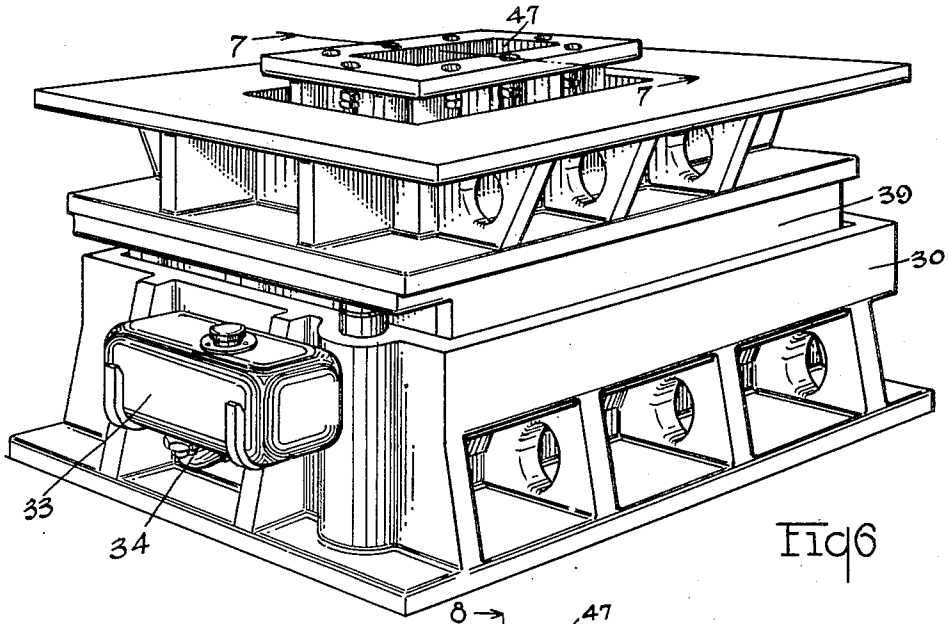


Fig 6

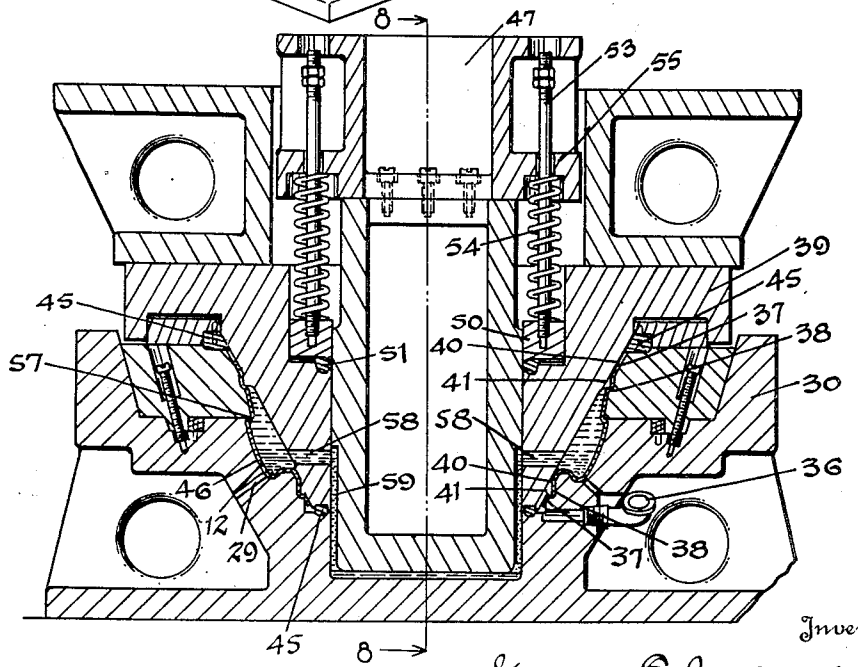


Fig 7

Inventor

George E. Ireland

By Ernest F. Crampton

Attorney

Aug. 8, 1933. G. E. IRELAND 1,921,188

SHEET METAL DIE

Filed July 15, 1930 4 Sheets-Sheet 4

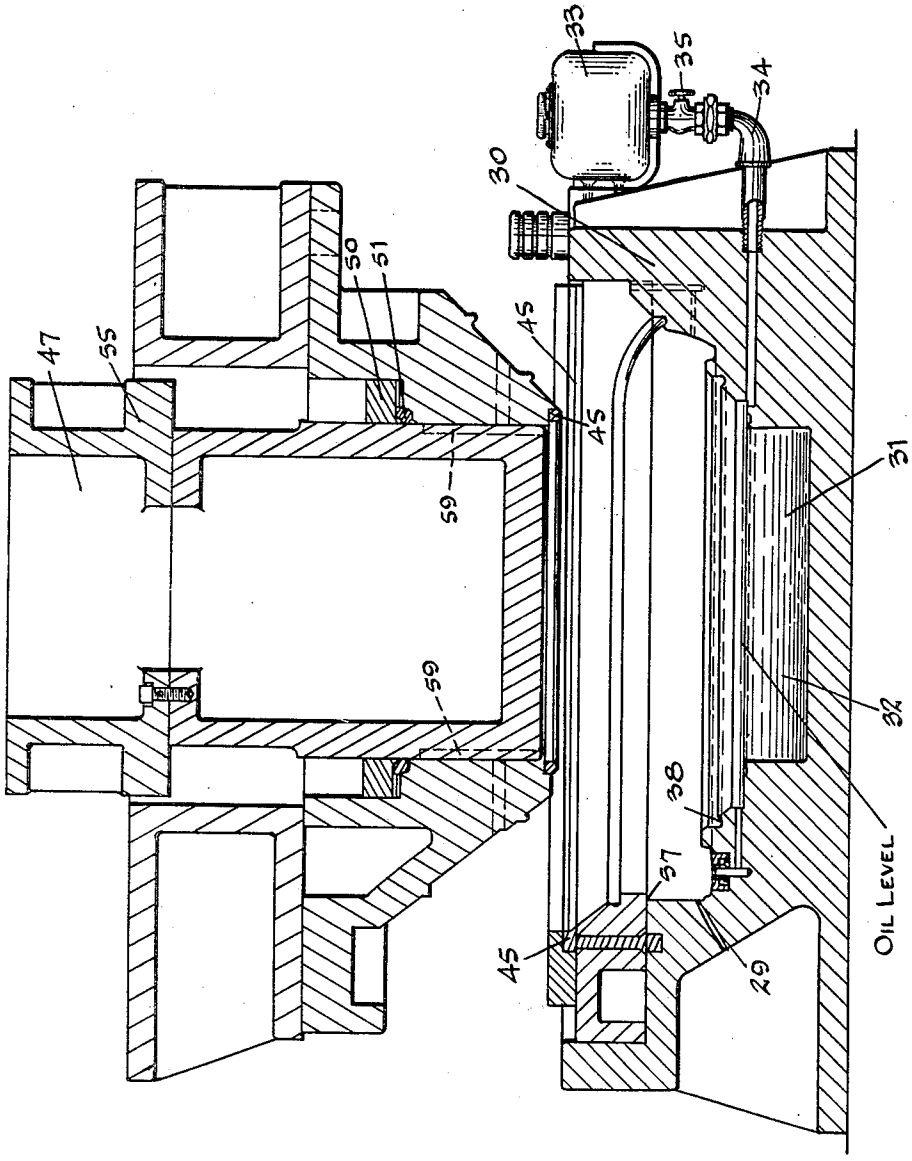


Fig 8

Inventor

George E. Ireland

By Faust F. Crampton

Attorney

Patented Aug. 8, 1933

1,921,188

UNITED STATES PATENT OFFICE

1,921,188

SHEET METAL DIE

George E. Ireland, Toledo, Ohio, assignor to The City Machine & Tool Company, Toledo, Ohio, a Corporation of Ohio

Application July 15, 1930. Serial No. 468,006

15 Claims. (Cl. 113—44)

My invention has for its object to provide a die for shaping sheet metal and comprising two die, or shaping, members, one of which is rigid in form, and operates to give configuration to the sheet metal, and the other of which is formed of a material that is flexible, but whose effective contour is limited by the rigid die member. The flexible die member may be formed of a flexible or mobile material that may be located between, or entrapped between, the fixed die member and the actuating parts of the flexible die member. Thus, the flexible die member may be formed of any pliable or mobile material that will transmit pressure in all directions and is, preferably, without material compressibility within the limits of the ordinary pressures required to shape the sheet metal. Thus the flexible die may be formed of rubber, or a liquid, such as oil, which will transmit the pressure exerted thereon to all parts of the sheet metal located intermediate the flexible die and the fixed die member, and cause the sheet metal to conform to the configuration of the fixed die member.

By using die members of the character referred to, configurations may be formed in sheet metal that cannot easily be formed in the ordinary die having two solid die members, except by performing succeeding shaping operations to complete the formation of the sheet metal. Thus, by the use of a flexible die member, the sheet metal may be expanded laterally and beneath ledges or ridges or overhanging parts of the fixed die member due to the transmission of the pressure exerted on the flexible die member in all directions to cause conformation of the sheet metal. The fixed die member may be formed of segments to enable the removal of the article when formed where the fixed die member is formed to have under-cut portions. By the use of constructions containing my invention, all abrasion and tool markings and scratches are entirely eliminated and shapes of unusual forms may be made.

The invention may be contained in dies of different forms and used to produce various shapes, and, to illustrate a practical application of the invention, I have selected two forms of dies that embody the invention as examples of the various structures and details thereof, that contain the invention, and shall describe the selected structure hereinafter, it being understood that variations may be made without departing from the spirit of the invention. The particular structure selected for purposes of illustration is shown in the accompanying drawings.

Fig. 1 is a perspective view of one form of die containing my invention. Fig. 2 is a view of a transverse section of the die illustrated in Fig. 1. Fig. 3 is a longitudinal section of the die, the members being shown separated from each other. Fig. 4 illustrates a view of a section of the parts of the die members illustrated in Fig. 2, in advance of the shaping of the sheet metal located between the die members. Fig. 5 is a view similar to that of Fig. 4, but wherein are shown the parts of the die members illustrated in Fig. 3 in advance of shaping the sheet metal located between the said parts of the die members. Fig. 6 is a perspective view of another form of die. Fig. 7 illustrates a transverse sectional view of the die illustrated in Fig. 6. Fig. 8 is a longitudinal section taken on the plane of the line 8—8 indicated in Fig. 7.

In the particular form of construction shown in Figs. 1 to 5, the die is formed of three parts comprising a fixed, or solid, die member part 1 and a movable part 2, having a flexible die and a clamping member 3, for clamping edge portions of the sheet metal that is to be shaped by the die members of the parts 1 and 2 in advance of the shaping operation. When the clamping part 3 clamps the edge portions of the sheet metal against the corresponding clamping surfaces of the fixed part 1 of the die, substantially the entire central portion of the sheet metal is sealed to prevent the escape of the flexible material which forms the movable die member of the die, over the surface of the edge portions of the sheet metal. The flexible material of the movable part of the die member is also sealed or confined to prevent its expansion other than in the direction of the surfaces that form the fixed die of the part 3 and, hence, when pressure is exerted on the flexible material, such pressure will be transmitted to the surface of the central portion of the sheet metal forcing it against the surface of the fixed die of the part 3 and causing it to conform to the shape of the fixed die.

In the particular form of construction shown in Figs. 1 to 5, the flexible die member 5 is formed of rubber which is secured to the plunger 6. The movable die member 5 has a cross sectional area sufficiently large to provide for the compression of the rubber and yet to fill the space between the lower end of the plunger 6 and the fixed die 7 when subjected to the maximum required pressure with a liberal allowance

for a very large number of operations. The rubber die member may be formed of any shape. Preferably, it is so formed as to roughly conform to the shape of the fixed die 7, it having, however, a volume sufficiently great to allow for its compressibility in continuous use of the die, when subjected to the pressures required to shape the sheet metal. Linearly, it corresponds to the shape of the fixed die 7. The die shown in the drawings is for the formation of radiator shells and provides a means for shaping the radiator shells to produce a returned edge portion or a re-entrant part, as hereinafter described, which ordinarily cannot be produced without the use of more than two solid die members.

To facilitate the removal of the formed article from the re-entrant or undercut contoured area of the die, the die or matrix is formed with removable sections 4. These movable sections are seated within offset portions of the main die member 1 for shifting movement in a diagonal or inclined direction in which they are guided by the inclined surfaces 4*a* and by guiding and limiting studs or pins 4*b* as shown in Figs. 2 and 7. However, as is shown in Figs. 3 and 8, it is not necessary that such movable sections be made to withdraw diagonally, but as there shown may be withdrawn vertically. By retraction of such movable sections 4, the formed article is released for removal from the matrix or die.

The fixed die member part 1 and also the movable sections 4 are provided with clamping surfaces 10, preferably formed with channels 11 into which a part of the edge portion of the sheet metal blank 12 is forced by the movable clamping part 3, in order to securely hold the edge portions of the sheet metal blank during the shaping operation.

The clamping part 3 of the die is provided with the clamping surfaces 15 that correspond to the clamping surfaces 10 of the fixed part 1 of the die. It also is provided with the ridges 16 that conform to the channels 11 of the fixed part 1 of the die. The blank 12 is located in position on the fixed part 1 of the die, and the clamping member 3 is lowered so that the clamping surfaces 15 engage the edge portions of the blank 12 and so that the ridges 16 will force parts of the edge portions of the blank into the recesses 11 to firmly engage the edge portions of the blank in advance of the stretching and expansion of the central body of the blank 12 by the operation of the movable die part 2.

The movable die part 2 is moved downward to cause the production of the desired configuration of the central portion of the sheet metal blank 12. The part 6, particularly at its lower end 16, fits the central block, or shell, 19, that is connected to, or forms a part of, the clamping member 3 of the die, and an outer ring 20 that also forms a part of the clamping member 3 of the die. Preferably, the part 18 of the movable die part extends between points near the clamped edge portions of the blank 12 in order to transmit its pressure to all parts of the blank to be shaped. Consequently, when the plunger 6 descends, the rubber block 5 will be gradually compressed. The rubber is first forced inward, with respect to the central part of the die, in the particular construction shown, as a corner or a part of its surface engages the shaped metal blank. It is then moved along the surface of the sheet metal blank gradually distending it. The inclined position of the sheet metal blank tends to first compress the rubber and force it against the inner block or shell of the clamping part 3 of the die. As the plunger 6 continues its movement downward, the rubber is crowded into a small area until the pressure exerted over its entire surface per square inch is the same as that which is transmitted to it by the plunger 6 to which the rubber die is connected. The sheet metal blank will thus be forced laterally to conform to such under-cut surfaces 23 located beneath any ledges, such as the ledges 24, in the particular form of construction shown. The pressure exerted on the flexible die member 5 operates to cause it to expand the sheet metal of the blank until its outer surface is sustained by the surface of the fixed die 7.

Preferably, the die is located in a machine for raising and lowering the clamping part 3 of the die. Springs 27 are located intermediate the plunger 6 and the clamping part 3 to raise the plunger 6 in advance of raising the clamping part. The clamping part 3 of the die may be provided with guiding surfaces, such as the surface 28 for directing edge portions of the rubber block, or rim, to the position of the blank to be shaped. The surface 28 is preferably inclined to the direction of movement of the movable die member.

In order to prevent the entrapment of the air that will be located in the space between the surface of the fixed die 7, and the sheet metal blank 12, particularly after it has been clamped against the fixed part 1 of the die by the clamping part 3 of the die, suitable ducts 29 are formed in the fixed part 1 of the die to permit removal of the air from the space between the sheet metal blank 12 and the surface of the die 7 as the sheet metal blank is forced to conform to the surfaces of the fixed die 1.

In the form of construction shown in Figs. 6 to 8, the flexible die member is formed of oil that is located intermediate the plunger of the die and the fixed die member, it being enclosed by the sheet metal blank, the clamping part of the die member and the plunger part. The plunger part is operated to move and transmit pressure to the oil which in turn forces the sheet metal blank against the surface of the fixed die, substantially as is done where rubber or similar flexible material is used, as in the form of the die shown in Figs. 1 to 5.

The fixed die member part 30 of the die, shown in Figs. 6 to 8, is formed to have a well 31 that is filled with oil 32. The level of the oil may be regulated by any suitable means. Preferably, a reservoir 33 is provided that communicates with the well 31 through a pipe 34. The supply of oil to the well may be controlled by a suitable valve 35. In order to insure that the level of the oil will be substantially constant, a suitable passageway through the wall of the well that terminates in the elbow 36 may be provided. The elbow is located substantially at the level at which it is desired to maintain the oil in the well. Slight adjusted variations of this leved may be obtained by turning the elbow 36 so as to incline more or less the outlet through the elbow.

The amount of oil maintained in the well 31 is sufficient in quantity that the part displaced by the plunger will be sufficient to flow to the portion of the blank that is to be shaped,

and will transmit the pressure to cause the blank to conform to the fixed die member, that is, to fill the space between the fixed die and the blank and the communicating spaces and passageway. Some of the oil may be also displaced by the clamping member wherein certain shapes, such as that shown in Fig. 7, are to be formed by the die and wherein a lower edge portion of the sheet metal is to be secured in position. The oil then moves through a part of the clamping member and the pressure of the plunger, in its further movement, is transmitted to the oil to force the sheet metal against the rigid or solid die.

The fixed die part 30 may be provided with the clamping surfaces 37 having the channels 38 and the clamping member 39 may be provided with the clamping surfaces 40 that are provided with the ridges 41 that engage the edge portions of the blank 12, and secure the said portions by forcing parts thereof into the channels 38. This also operates to seal the space between the fixed die 30 and the clamping member 39, and prevent the escape of any oil.

If desired, sealing rings may be located between the clamping member 39 and fixed die part 30, such as the sealing rings 45, that may be made in the form of gaskets and located in suitable recesses formed in the fixed die part 30, or in the clamping part 39, or both. The sealing rings 45 are formed of rubber or other suitable sealing material and are, preferably, connected to the clamping part 39 of the die. When, therefore, the clamping part 39 descends to clamp the edge portions of the blank 12, the sealing rings 45 will insure the sealing of the oil within the interior of the fixed die part 30.

In the form of construction shown, the oil well 31 may be located centrally with respect to the fixed die 46, and the plunger 47 may be located so as to pass through the clamping member 39 and into the well 31. This location may be varied. It depends on the shape of the article to be formed. The lower end of the plunger 47 is of a size to cause the displacement of the required amount of oil to force the blank 12 against the surface of the fixed die 46. The plunger 47 fits an opening formed in the clamping part 39 so as to seal it against the escape of the oil between the plunger and the clamping part 39. A suitable packing ring 50 may be located within the clamping part 39 of the die and around the plunger 47, a suitable packing material 51 being located intermediate the packing ring 50 and the clamping part 39 of the die to aid in preventing the escape of any oil by the plunger. If desired, the tightness of the seal may be increased after the plunger penetrates the well, that is, when the pressure transmitted by the oil reaches a certain point, it is found advantageous to increase the sealing pressure. This is particularly true in view of the fact that the pressure per square inch on the oil rises to a very high amount and releasement of the sealing pressure on the sealing material 51, upon withdrawal movement of the plunger, permits greater freedom of movement. This occurs when the pressure is below the said high point. Thus the sealing ring 50 may be connected to the rods 53 that move within the upper end of the plunger 47, but are spring pressed by the springs 54 that surround the rods 53 and are located intermediate a ledge 55 of the plunger and the sealing ring 50. As the plunger descends the pressure of the sealing ring 50 will be increased quite in proportion to the pressure that is exerted on the oil.

In order to convey the oil to the space between the clamping part 39 and the blank 12, the clamping part is provided with suitable ducts or passageways 58. Also, the plunger is provided with suitable passageways that lead from the bottom of the well to allow the oil to pass from the bottom of the well to the ducts 58. This passageway may be formed by recesses or spaces formed between the surface of the well and the surface of the plunger, such as the passageway 59. Preferably, the lower end of the plunger is channeled to permit the oil to pass to the ducts 58.

In the operation of the die, the blank 12 is located in position in the fixed die part 30. The clamping member 39 is lowered to seal the edges of the blank 12 and to secure the edges against movement. The plunger 47 is forced into the well 32 which displaces the oil in the well and forces it against the surface of the blank 12, the blank 46 being thereby distended to conform to the surface of the die 46. It may be forced beneath the ledges, such as the inwardly extending corners or parts 57 of the fixed die, or re-entrant or returned portions may be formed in the blank by the single operation of the press and without tool marking or otherwise injuring or abrading the surface of the blank. Upon raising of the plunger and the clamping member the formed sheet material may be withdrawn and replaced by a blank.

I claim:

1. In a sheet metal forming apparatus, a curvilinear matrix having a contoured surface agreeing with the shape of the article to be produced, blank engaging areas thereof diagonally offset relative to each other in different planes, spaced blank holders co-operating with said blank engaging areas, a mobile body confined between said blank holders, and a pressure applying means for subjecting the mobile body to displacement pressure against the blank, thereby distorting the blank into conformity with the contiguous face of the matrix intermediate the blank engaging areas.

2. In a sheet metal forming apparatus, a matrix to receive a blank and including two curvilinear blank holding areas disposed in substantially symmetric diagonally offset relation in different planes and an intermediate contoured area agreeing with the shape of the article to be produced, coacting blank holder means for simultaneously engaging the blank on spaced lines coincident with said blank holding areas, and a mobile body adapted to be trapped under forming pressure against a blank extending intermediate the blank holding areas and engaged by the blank holders for forcing the intermediate portion thereof into conformity with the contoured area of the matrix.

3. In a sheet metal forming apparatus a matrix to receive a blank, said matrix having a curvilinear flaring formation, including blank holding portions at its top and bottom margins, and an intermediate contoured area conforming to the shape of the article to be produced, parallel spaced blank holders symmetrically disposed in diagonally offset relation coacting with the blank holding portions of the matrix to hold the opposite margins of a blank therebetween, a plunger interposed between the spaced blank holders, and a mobile body adapted to be trapped

between the blank holders against the portion of the blank overlying the contoured area of the matrix and subjected to displacement pressure by the plunger.

4. In a sheet metal forming apparatus, a matrix to receive a blank to be formed, said matrix having a curvilinear flaring formation, including blank holding portions at its top and bottom margins, and an intermediate contoured area conforming to the shape of the article to be produced, parallel spaced blank holders disposed in diagonally offset relation coacting with the blank holding portions of the matrix to hold the opposite margins of a blank therebetween, a pressure applying plunger, and a mobile body adapted to be trapped between the blank holders and against the portion of the blank overlying the contoured area of the matrix, and subjected to displacement pressure of the plunger for forcing such portion of the blank into agreement with the contoured portion of the matrix.

5. In a sheet metal forming apparatus, a matrix to receive a blank to be formed, said matrix having a curvilinear flaring formation, including blank holding areas at its top and bottom margins, and an intermediate undercut re-entrant contoured area conforming to the shape of the article to be produced, and retractable portions enabling the release of an article conforming to such undercut re-entrant contoured area, a mobile body adapted to be confined between the blank holders against the portion of the blank overlying the reentrant contoured area, and means for applying displacement pressure thereto for forcing the blank into conformity with such reentrant contoured area.

6. In a sheet metal forming apparatus, a sectional matrix to receive a blank to be formed and including relatively movable sections, an undercut reentrant contoured area conforming to the article to be produced formed jointly by such sections, blank holding areas formed upon the respective sections, spaced blank holding portions coacting with said areas, a mobile body adapted to be confined between the blank holding portions against a blank held thereby, and means for applying displacement pressure to the mobile body to force the blank into conformity with the contoured area of the matrix.

7. In a sheet metal forming apparatus of the character described, a section matrix to receive a blank to be formed, said matrix having an undercut contoured area conforming to the shape of the article to be produced, said matrix including a relatively fixed portion and a movable portion, an inclined guide for the movable portion directing such portion diagonally into and out of operative relation with the fixed portion, blank holders for engaging the blank in substantially parallel offset relation, a mobile body adapted to be confined between the blank holders and against the portion of a blank overlying the undercut contoured area of the matrix, and means for applying displacement pressure thereto.

8. In a sheet metal forming apparatus, a curvilinear matrix to receive a blank to be formed, said matrix having a flaring formation having an undercut or reentrant contoured area conforming to the shape of the article to be produced, a retainer for making a sealing contact with a blank disposed over said area at opposite sides thereof, a mobile body adapted to be confined by the retainer against that portion of the blank overlying the contoured area, and pressure applying means for displacing the mobile body against the yielding resistance of the blank by which the blank is forced into conformity with such area.

9. In a sheet metal forming apparatus for forming a blank, two substantially parallel spaced curvilinear blank holding portions diagonally offset relative to each other in different planes, a body portion upon which the blank holder portions are carried for unison motion into and out of engaging position, a matrix having mating portions engaged thereby to hold a sheet metal blank and having therebetween a contoured area conforming to the shape of the article to be produced, a mobile body adapted to be confined between the blank holders and against that portion of the blank overlying the contoured area of the matrix, and a plunger transmitting pressure to the mobile body for distorting the blank into conformity with the contoured area.

10. In a sheet metal forming apparatus for forming a blank, a pair of interconnected curvilinear blank holders for simultaneously engaging opposite margins of a strip of material in relatively spaced substantially parallel planes, the engaging portions of the blank holders being relatively offset from each other in their respective planes, a matrix having mating blank holding portions and a contoured area therebetween conforming to the shape of the article to be produced, a mobile body adapted to be confined between the blank holders and pressure applying means subjecting the mobile body to displacement pressure by which the blank is deformed into conformity with the contoured area.

11. In a sheet metal forming apparatus for forming a blank, two curvilinear concentric blank holders diagonally offset relative to each other in different substantially parallel planes, a matrix having mating blank holding portions coacting therewith and having a contoured area intermediate the blank holding portions conforming to the shape of the article to be produced, a mobile forming body adapted to be confined between the blank holders and against that portion of the blank overlying the contoured area, and pressure applying means for subjecting the mobile body to forming pressure.

12. In an apparatus for forming radiator shells or the like from a blank of metal, a substantially U shaped flaring matrix having a contoured area conforming to the shape of the article to be formed to receive a flaring U shaped blank in overlying relation with the contoured area, a chambered member for making a sealing contact with the blank at opposite sides of the contoured area, a mobile body adapted to be confined within the chamber of said member and contacting the blank and pressure applying means for transmitting to the mobile body forming pressure sufficient to force the blank into agreement with the contoured area.

13. In an apparatus for forming radiator shells or the like from a blank of metal, a substantially U shaped matrix of flaring formation having a contoured area to receive a flaring U shaped blank in overlying relation with the contoured area, blank holders for engaging the blank at opposite sides of the contoured area, a flexible former interposed between the blank holders and pressure applying means for subjecting the flexible former to sufficient pressure

to force the blank into conformity with said contoured area.

14. In an apparatus for forming radiator shells or the like from a blank of metal, a substantially U-shaped matrix of flaring formation having a contoured area including a reentrant recess to receive a flaring U-shaped blank in overlying relation with the contoured area, blank holders for engaging the blank at opposite sides of the contoured area, one of the blank holders overhanging said recess, a U-shaped flexible former interposed between the blank holders, and pressure applying means for causing the flexible former to move in a direction normal to the direction of said pressure so as to cause the blank to follow the contour of the reentrant area.

15. In an apparatus for forming radiator shells or the like from a blank of metal, a substantially U-shaped matrix of flaring formation having a contoured area including a reentrant recess to receive a flaring U-shaped blank in overlying relation with the contoured area, blank holders for engaging the blank at opposite sides of the contoured area, said blank holders cooperating with the blank to form a substantially U-shaped chamber, and a fluid under pressure adapted to fill said U-shaped chamber to force the blank into conformity with the contoured area.

GEORGE E. IRELAND.