Oct. 18, 1938. H. E. GUERIN 2,133,445

METHOD FOR CUTTING AND FORMING SHEET MATERIAL

Filed Dec. 7, 1935 2 Sheets-Sheet 1

Fig. 1.

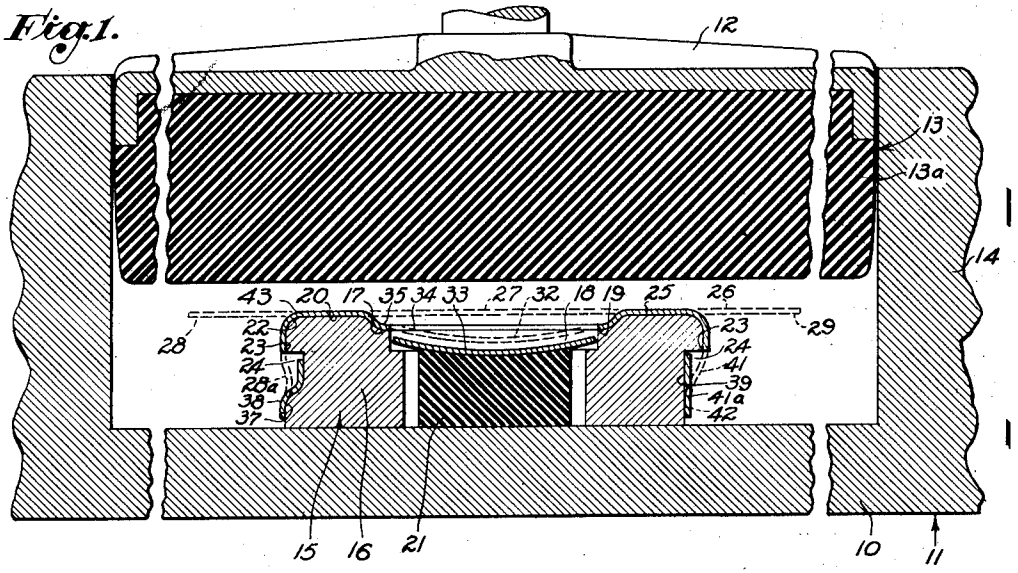


Fig. 3.

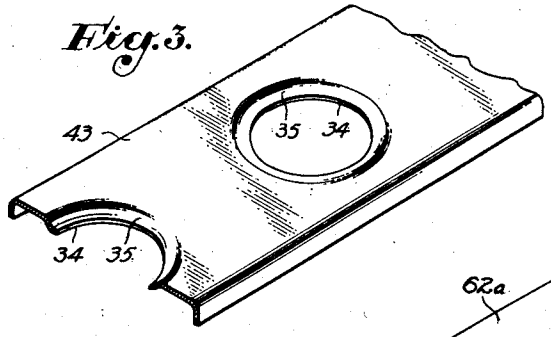


Fig. 6.

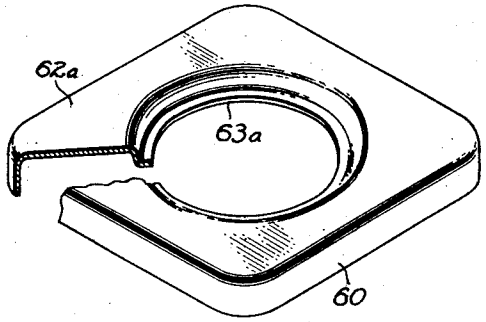
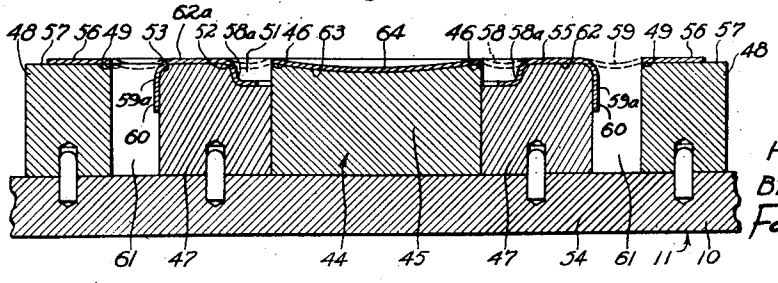


Fig. 4.



INVENTOR
HENRY E. GUERIN
BY
Fred W. Lamm
ATTORNEY.

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METHOD FOR CUTTING AND FORMING SHEET MATERIAL

Filed Dec. 7, 1935 2 Sheets-Sheet 2

Fig. 2.

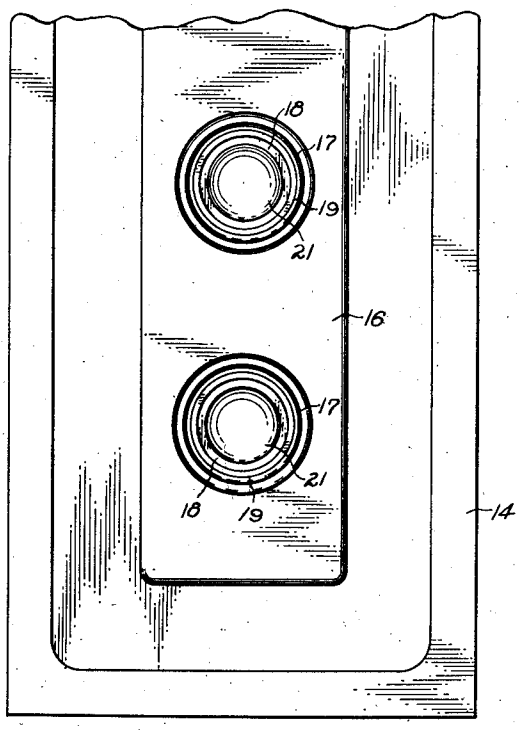


Fig. 5.

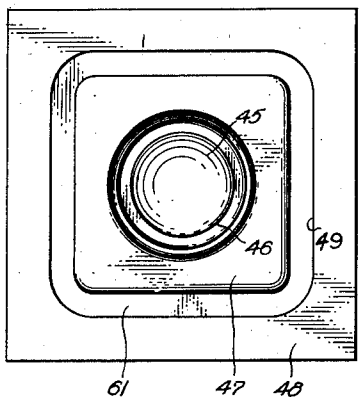


Fig. 7.

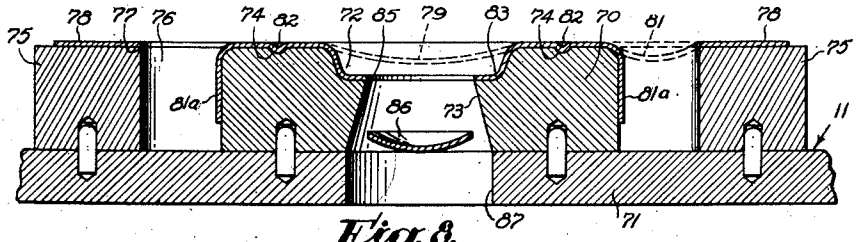
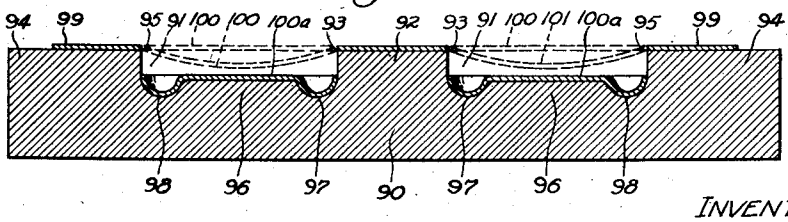


Fig. 8.



INVENTOR
HENRY E. GUERIN
BY
Fred W Lamir
ATTORNEY.

Patented Oct. 18, 1938 2,133,445

UNITED STATES PATENT OFFICE

2,133,445

METHOD FOR CUTTING AND FORMING SHEET MATERIAL

Henry E. Guerin, Los Angeles, Calif., assignor to Douglas Aircraft Company, Inc., Santa Monica, Calif., a corporation of Delaware

Application December 7, 1935, Serial No. 53,346

11 Claims. (Cl. 113—51)

My invention relates to a method for producing cut and formed articles from sheet material in a single operation, and the present invention constitutes a continuation in part of my copending application, Serial No. 39,696, filed September 9, 1935, for Method and apparatus for cutting sheet metal, which issued into Letters Patent No. 2,055,077 on September 22, 1936. In my previous application above noted I disclose the manner of cutting blanks from sheet metal by the use of a simple cutting die in a press having a body of yieldable plastic material, such as a rubber or composition having rubbery qualities, and the subsequent forming of these blanks to desired cross-sectional shape.

My invention also includes a method wherein sheet metal may be not only cut but also formed during the same operation so that when the invention is practiced a sheet of metal may be placed in the apparatus of my invention, the apparatus operated, and an article of the desired size, shape, and configuration produced by such operation. In the performance of my invention, therefore, I may cut the sheet metal to a desired size and it may be formed or otherwise worked upon in other apparatus; I may in the practice of my invention cut the sheet metal to the desired configuration and then form it during the same operation or sequence of steps and thus produce the finished article; or in the performance of my method I may first form the sheet of metal to the desired shape and thereafter cut it to the desired size and configuration, thus producing the article of the desired shape; and also in the performance of my invention the forming and cutting steps may be simultaneously performed in order to produce articles of the desired size, shape, and configuration.

It is an object of my present invention to accomplish the cutting of the blank and the forming of the same to desired cross-sectional shape in a single operation in which a single die accomplishes both the cutting and the forming of the sheet material.

It is a further object of the invention to provide a method for producing formed articles from sheet material wherein pressure is applied to the sheet to move the same, wherein the movement of different parts of the sheet is limited or controlled in such a manner that the sheet will be deformed from its original cross-sectional shape to a desired cross-sectional shape, and wherein one part of the sheet is held against movement along a line of division so that the movement of the adjacent part of said sheet under said pressure will cause the sheet to be severed along the line of division.

It is a further object of the invention to provide a simple die member having a forming portion provided with a shape or contour which is to be imparted to the sheet, and having a cutting edge so formed that the sheet will be cut along prescribed lines as the result of pressure of the sheet against the die by the yieldable plastic material. In the preferred practice of the invention this yieldable plastic material consists of a body of rubber which, when it is placed under pressure, will form itself around the die member in such a manner that a sheet of material, such for example as duralumin, placed between the body of rubber and the die member will be forced against the die member under great pressure so that the sheet will assume the form of the die member and will be cut by the cutting edges of the die member.

In the practice of the invention the sequence of the steps of forming and cutting may vary considerably. For example, the initial movement of the sheet by the rubber material under compression may shape a part of the sheet and then subsequent to this shaping of the sheet may produce the cutting action, or the initial movement of the sheet with relation to the die member may result in the cutting of the same and then the formation of the sheet to a desired cross section by the pressing of the sheet against the surface of the forming portion of the die member; or, on the other hand, the cutting and shaping operations may be alternated; that is, the first movement of the sheet relative to the die by the rubber material will cut one portion of the sheet, the second movement will shape a portion of the sheet, and the third movement will accomplish another cutting operation.

It is another object of my invention to provide a method by which sheet metal is formed and cut in which the sheet of metal is gripped and secured against a die member by means of a body of flowable material in order that those portions of the sheet which are to constitute the finished article will be protected from tensile and bending strains to which the surplus portion of the sheet is subjected during the subsequent cutting operation.

It is a still further object of my invention to provide a method in which the sheet of metal is first gripped by a body of flowable material and is thereafter cut, and as a final operation is formed to the desired shape.

It is another object of my invention to provide a process in which the body of flowable material is employed to first completely form the sheet into the desired shape and to thereafter separate the surplusage of the sheet in order that the sheet will first be formed to the desired configuration and thereafter cut to the desired size.

Further objects and advantages of the invention will be brought out in the following part of the specification.

Referring to the drawings, which are for illustrative purposes only,

Fig. 1 is a fragmentary sectional view showing a portion of a press with a die therein for practicing the invention in one of its embodiments.

Fig. 2 is a fragmentary plan view, to reduced scale, of the die used in Fig. 1.

Fig. 3 is a fragmentary perspective view showing the part produced by the means shown in Fig. 1.

Fig. 4 is an enlarged cross-sectional view of another die which may be used in the practice of the invention.

Fig. 5 is a plan view of Fig. 4, to reduced scale.

Fig. 6 is a perspective view showing the type of article which may be produced by the die shown in Fig. 4.

Fig. 7 is a cross section of another die wherein the cutting and shaping operations are alternated.

Fig. 8 is a cross-sectional view of another form of die embodying the invention, wherein the entire cutting operation is accomplished before the shaping operation.

In Fig. 1 I show the bed 10 of a press 11 having a head 12 to which a body 13 of yieldable plastic material 13*a* is secured. This body 13 is of a semi-fluid character found in a number of different substances, such, for example, as rubber which yields and likewise flows when a pressure is applied thereto, heavy tars which will likewise flow due to their semi-fluid character, and heavy paste or putty-like materials which have some resistance to deformation but due to their plasticity will deform or flow under pressure. Such materials can best be described as fluid-like or flowable materials. In the preferred practice of the invention, however, the body of yieldable plastic material is a rubber or rubber compound, the characteristics, that is the resilience, of which may be selected in accordance with the type of sheet material to be operated upon.

The table 10 has a side wall 14 extending around the periphery thereof for limiting the lateral expansion of the body 13 when the head 12 of the press 11 is forced toward the base or table 10. On the table 10 I show a forming member or die 15 comprising an elongated body 16 of suitable metal, such as tool steel which may be hardened after its formation. This body 16 has a plurality of relatively shallow depressions 17 in the upper face 20 thereof and a recess or opening 18 in the bottom of each depression 17 and preferably in centralized relation thereto. The upper end of each opening 18 is defined by a sharp annular edge or corner 19 constituting a cutting edge, and within each of the openings 18 an ejecting member 21 in the form of a body of rubber may be placed. Around the periphery of the upper face 20 is a rounded corner 22, and in the exterior side wall of the body 16 a cutting edge or shoulder 23 is formed, with an adjacent depression 24.

A sheet 25 of suitably ductile material is placed upon the die 15 in flat condition, as indicated by dotted lines 26. The head 12 is then lowered under pressure so that the yieldable plastic body 13 will engage the sheet 25 and press the same downwardly, with the result that the dotted line areas 27 over the recesses 17 will be deflected downwardly into the recesses 17, and peripheral portions 28 and 29 will be swung downwardly over the corner 22 which, as previously explained, extends peripherally around the body 16. The portions of the sheet now lying across the openings 18 will be deflected downwardly by the yieldable material, as indicated by dotted lines 32, and when the downward deflection indicated at 32 is sufficient, the pressure of the yieldable material of the body 13 will cause the metal to part along the cutting edge 19 at the upper end of each opening 18 with the result that a severed disc 33 will be forced downwardly into the opening 18 as shown, leaving holes 34 in the sheet 25 concentric with the depressed portions 35 of the sheet 25 which have resulted from the forcing of the sheet into the depressions 17. It will be perceived that the sheet 25 has been first formed or bent into the depressions 17 and that this forming has been followed by the cutting out of circular areas or discs 33. The edge portions 28 and 29 of the sheet 25 are formed downwardly across the sides of the body 16, and then, due to the lateral flowing of the yieldable plastic material, or rubber, under the heavy pressure employed, the outer portions of the edges 28 and 29 are caused to part across the cutting edges 23 resulting from the forcing of the sheet into the depression 24 lying below the cutting edge or shoulder 23.

On the left-hand side of the body 16 of Fig. 1 I show a shoulder 37 below the depression 24 against which the outer portion 38 of the edge 28 is pressed by the yieldable material in a manner to grip the same. Below the cutting edge 23 the edge portion of the sheet 25 indicated at 28*a* is first deflected inwardly as indicated by dotted lines, and then further lateral movement of the yieldable material in rightward direction causes the edge portion to be cut. At the right side of the body 16 I show how the depression 24 may be formed without the use of the shoulder 37, but with the bottom wall 39 of the depression extending perpendicular to the lower face of the body 16. Where the peripheral cutting edge of the die is formed in this manner, the extreme edge portion of the plate 25 indicated by dotted lines 41 is first deflected inwardly into engagement at 42 with the bottom wall 39 of the recess 24, after which the cutting action takes place at the cutting edge 23, and the edge portion 41 is forced by the yieldable material 13*a* into the position in which it is shown by full lines 41*a*.

The result of the operation previously described produces a formed article 43 shown in Figs. 1 and 3 and a residue or scrap consisting of the discs 33 and the severed peripheral edge of the original sheet 25 indicated by the numerals 38 and 41*a* in Fig. 1. The formed article 43 in the present instance may consist of a lightweight strut or structural member to be used in airplane construction, this member being lightened by the punching of holes 34 and strengthened by the formation of the depressed portions 35.

In Fig. 4 I show a practice of the invention wherein a sheet is cut before the forming operation. In this practice of the invention I employ the press 11 in conjunction with a die 44 consisting of a central circular block 45 having an upwardly and outwardly faced cutting edge 46, a forming block 47 disposed around the central body or cutting block 45, and an outer cutting block 48 disposed around but spaced from the member 47 and having an inwardly and upwardly faced cutting edge or shoulder 49. The inner portion of the forming block 47 is cut away to form a depression or recess 51 around the body 45 and adjacent the cutting edge 46 thereof,

there being a rounded annular corner or shoulder 52 at the upper edge of the wall portion of the member 47 defining the depression or recess 51. Likewise, the forming block 47 has a peripheral rounded corner 53 lying in spaced relation to the cutting edge 49 of the outer cutting block 48. The members 45, 47, and 48 may be separately machined and mounted upon a supporting plate 54.

In the practice of the invention here described, a sheet 55 is placed upon the upper face of the die 44 in such position that the edge portions 56 thereof will lie upon the upper faces 57 of the outer cutting block 48. When the table 10 and the head 12 of the press 11 are moved relatively together or toward each other, the yieldable material 13a will force the sheet 55 downwardly, and, as indicated by dotted lines 58 and 59, will initially depress those portions of the sheet 55 lying over the recess 51 and over the recess 61 between the members 47 and 48. At this time the pressure of the yieldable material 13a will grip the sheet tightly against the upper face 57 of the block 48, the upper face 62 of the forming block 47, and the upper face 63 of the central body 45, thereby preventing lateral movement or displacement of those portions of the sheet engaging such upper faces of the die 44. After the initial downward deflection of the unsupported portions of the sheet 55, indicated by dotted lines 58 and 59, the yieldable material 13a will cause the severing of the sheet along the cutting edges 46 and 49. In other words, the yieldable material 13a in moving downwardly relative to the cutting edges will have a cutting effect. The subsequent downward movement of the yieldable material 13a into the recesses 51 and 61 will bend the portions 58 and 59 downwardly over the rounded corners 52 and 53 into engagement with the wall of the forming member 47, as indicated in full lines 58a and 59a. The operation above described results in the production of a formed article 62a, such as shown in Figs. 4 and 6, having an opening 63a and a flange 60, and scrap consisting of a central disc 64 and the outer edge portion 56 of the original sheet 55.

Also, in the practice of the invention, it is conceived that cutting and forming may be accomplished simultaneously and also in an alternating manner. For example, in Fig. 7 I show a die having a forming body 70 mounted on a plate 71, this body 70 having a depression 72 and a central opening 73 extending downwardly from the bottom of the depression 72. Likewise, the body 70 may have a groove 74 in the upper face thereof around the depression 72. Mounted on the plate 71 is an outer cutting block 75 separated from the body 70 by a recess 76 and having an inwardly faced cutting edge 77. A plate 78 placed upon the upper face of the die shown in Fig. 7 and forced downwardly by means of the body 13 of yieldable material 13a will first have portions thereof deflected downwardly into the recesses 72 and 76 as indicated by dotted lines 79 and 81, and at the same time a portion of the sheet 78 may be deflected into the channel 74 so as to form a bead 82. Further downward movement of the body of yieldable material 13a will cause the sheet to shear at the cutting edge 77 and will cause a further deflection of the central portion of the sheet into the recess 72 until the portions 81a and 83 of the sheet are forced into tight engagement with the corresponding surfaces of the body 70, after which there will be a cutting at the cutting edge 85 formed in the body 70 at the upper end of the opening 73 so that a disc 86 will be severed from the sheet 78 and will drop into the opening 73 which is preferably expanded downwardly to permit the disc 86 to drop freely through the aligned opening 87 of the plate 71 when the die is lifted from the table of the press 11. It will be recognized that in the practice of the invention the actions of cutting and forming are nearly instantaneous so that it is difficult to state in some instances which of the acts is accomplished first.

In Fig. 8 I show a die 90 having an annular channel 91 cut in the upper face thereof so as to leave a central upstanding wall 92 having a peripheral cutting edge 93 and an outer upstanding wall 94 having an inner cutting edge 95. The bottom wall 96 of the depression 91 may be suitably contoured, as by the formation of channels 97 and 98, to a form which is desired to be imparted to that portion of a metal sheet which is forced into the channel 91. In the use of the die of Fig. 8 a plate 99 is first placed upon the upper face of the die 90, and the body 13 of yieldable material 13a is then forced downwardly, deflecting the unsupported portion 100 of the plate 99 into the channel 91 through a position indicated by dotted lines 101 and finally into a position against the bottom wall 96 of the channel 91, as indicated in full lines 100a. When the unsupported portion 100 is in approximately the position indicated by dotted lines 101, a cutting action will take place at the cutting edges 93 and 95, and the ring of sheet metal thus formed will move downwardly into engagement with the bottom wall 96 of the depression 91, after which the yieldable material 13a will deform the metal ring into the channels 97 and 98, thereby producing a formed metal article such as indicated by the full lines 100a.

In the foregoing detailed description of my invention I have described various forms of my invention capable of producing satisfactory results. It should be understood, however, that the forms of my invention illustrated herein have been chosen merely for the purpose of teaching those skilled in the art as to how my invention may be practiced. Various modifications and alterations may be made not only in the apparatus which I have illustrated and described but also in the method which has been disclosed herein. In view of these facts I do not wish my invention to be narrowly construed so that it will be limited to the precise method and apparatus disclosed herein, but wish my invention to be broadly construed so as to include all methods and apparatus which come within the broad principles and scope of my invention, which invention is broadly defined by the claims appended hereto.

I claim as my invention:

1. A method of cutting and shaping sheet metal, including: placing a sheet of metal over a die having a top wall, a side wall, a rounded corner between said top wall and side wall, said side wall comprising an upper sheet-engaging portion, a shoulder extending inwardly from the lower end of said portion, said sheet engaging portion and said shoulder merging in a cutting edge spaced a desired distance below said top wall, and a second sheet-engaging portion extending downwardly from said shoulder; applying pressure to said sheet of metal through a flowable material to cause a portion of said sheet to be bent to conform to the shape of said round-

ed corner, to hold said sheet of metal against said sheet engaging portions on opposite sides of said cutting edge, and to cause said metal to part along said cutting edge.

2. A method of cutting and shaping sheet metal, including: placing a sheet of metal over a die having a top wall, an exterior side wall, a rounded corner joining said top wall with said side wall, said side wall being provided with a cutting edge spaced a desired distance below said top wall and with sheet-engaging portions above and below said cutting edge; applying pressure to said sheet of metal through a flowable material to cause a portion of said sheet to be bent to conform to the shape of said rounded corner, to hold said sheet of metal against said sheet-engaging portions, and to cause said metal to part along said cutting edge.

3. A method of cutting and shaping sheet metal, including: placing a sheet of metal over a die having a top wall, a side wall, a portion of a desired shape joining said top wall with said side wall, said side wall being provided with offset sheet-engaging portions and a cutting edge intermediate said sheet-engaging portions, applying pressure to said sheet of metal through a flowable material to cause a portion of said sheet to be bent to conform in shape to said portion of desired shape, to hold said sheet of metal against said offset sheet-engaging portions, and to cause said metal to part along said cutting edge.

4. A method of cutting and shaping sheet metal, including: placing a sheet of metal over a die having a top wall, exterior side walls, a portion of a desired shape connecting said top wall with each of said side walls, each of said side walls being provided with offset sheet-engaging portions and a cutting edge between said sheet-engaging portions; applying pressure to said sheet of metal through a flowable material to cause said sheet to be bent to conform in shape to said portions of desired shape, to hold said sheet of metal against said offset sheet-engaging portions and to cause said metal to part along said cutting edges.

5. A method of cutting and shaping sheet metal, including: placing a sheet of metal over a die having a top wall, an exterior side wall, a rounded corner connecting said top wall and said side wall, said side wall being provided with a cutting edge, a sheet-engaging portion above said cutting edge, and a sheet-engaging shoulder below and spaced from said cutting edge; and applying pressure to said sheet of metal through a flowable material to cause a portion of said sheet to be bent to conform to the shape of said rounded corner, to hold said sheet of metal against said sheet-engaging portion and sheet-engaging shoulder, and to cause said metal to part along said cutting edge.

6. A method of cutting and shaping sheet metal, including: placing a sheet of metal over a die having a top surface with a shallow depression of a desired shape formed therein, and an opening in the bottom of said depression, the upper edge of said opening being defined by a cutting edge; and applying pressure to said sheet of metal through a flowable material to hold said sheet against said top surface, to cause the metal overlying said depression to conform to the shape of said depression, and to cause said metal to part along said cutting edge.

7. A method of cutting and shaping sheet metal, comprising: placing a sheet of metal over a die having a top surface with a shallow depression of a desired shape formed therein, an opening in the bottom of said depression, the upper edge of said opening being defined by a cutting edge, and an ejecting member in said opening; applying pressure to said sheet of metal through a flowable material to hold said sheet against said top surface, to cause the metal overlying said depression to conform to the shape of said depression and then part along said cutting edge, forcing the severed portion of said sheet into said opening; and then relieving the pressure applied by said flowable material to permit said ejecting member to eject said severed portion.

8. A method of cutting and shaping sheet metal including: placing a sheet of metal over a die having a top wall and an exterior side wall with a rounded corner between said top wall and side wall, said top wall having a shallow depression of a desired shape formed therein and an opening in the bottom of said depression, the upper edge of said opening being defined by a cutting edge, said side wall being provided with sheet-engaging portions and a cutting edge intermediate said sheet-engaging portions; and applying pressure to the sheet of metal through a flowable material to press said sheet against said die to cause the same to conform to the shape of said depression and said rounded corner and to be severed along the cutting edges of said top and side walls.

9. A method of cutting and shaping sheet metal, including: placing a sheet of metal over a die having a central cutting block having a peripheral cutting edge, and a forming block having a depression of a desired shape disposed around said central cutting block; applying pressure to said sheet of metal through a flowable medium to grip said sheet upon opposite sides of the cutting edge of said cutting block, and applying additional pressure to said sheet through said flowable medium to cause said sheet to be severed along said cutting edge and to cause said sheet to conform to the shape of the depression of said forming block.

10. A method of cutting and shaping sheet metal, including: placing a sheet of metal over a die having a top wall provided with a shallow recess having side and bottom walls of a desired shape and a part projecting above the plane of said bottom wall and terminating in a cutting edge; applying pressure to said sheet of metal through a flowable medium to grip said sheet against said top wall and against the top of said projecting part, and applying additional pressure to said sheet through said flowable medium to cause said sheet to be severed along said cutting edge and to cause said sheet to conform to the shape of said shallow recess.

11. A method of cutting and shaping sheet metal, including: placing a sheet of metal over a die member having a recess formed in a top wall thereof, said recess having side walls which terminate in cutting edges and having a bottom wall contoured to impart a desired shape to that portion of a sheet of metal which is severed by said cutting edges and is forced into said recess; and applying pressure to said sheet of metal through a flowable material to grip said sheet against said top wall and to first cause the metal to part along said cutting edge and to thereafter cause the severed portion of the metal to be forced into said recess and to conform to the shape of the bottom of said recess.

HENRY E. GUERIN.