

June 24, 1947.

H. H. BRUDERLIN

2,422,883

METHOD AND APPARATUS FOR FLANGING SHEET METAL

Filed Jan. 24, 1942

2 Sheets-Sheet 1

Fig. 1.

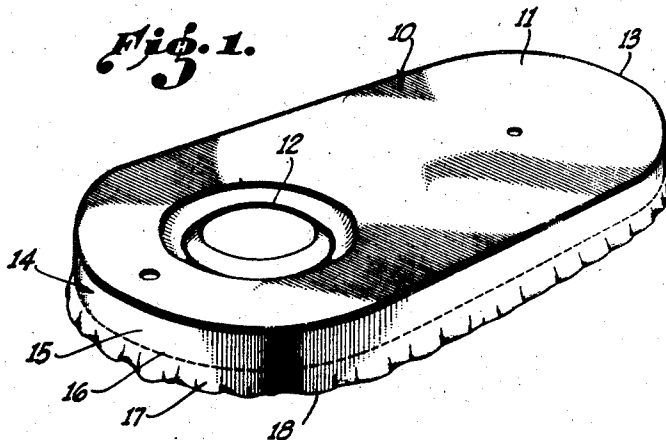


Fig. 2.

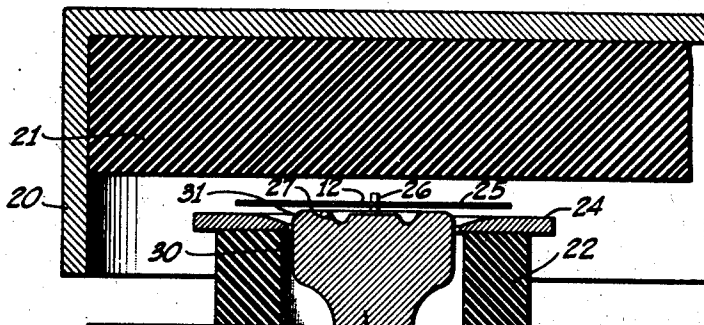


Fig. 3.

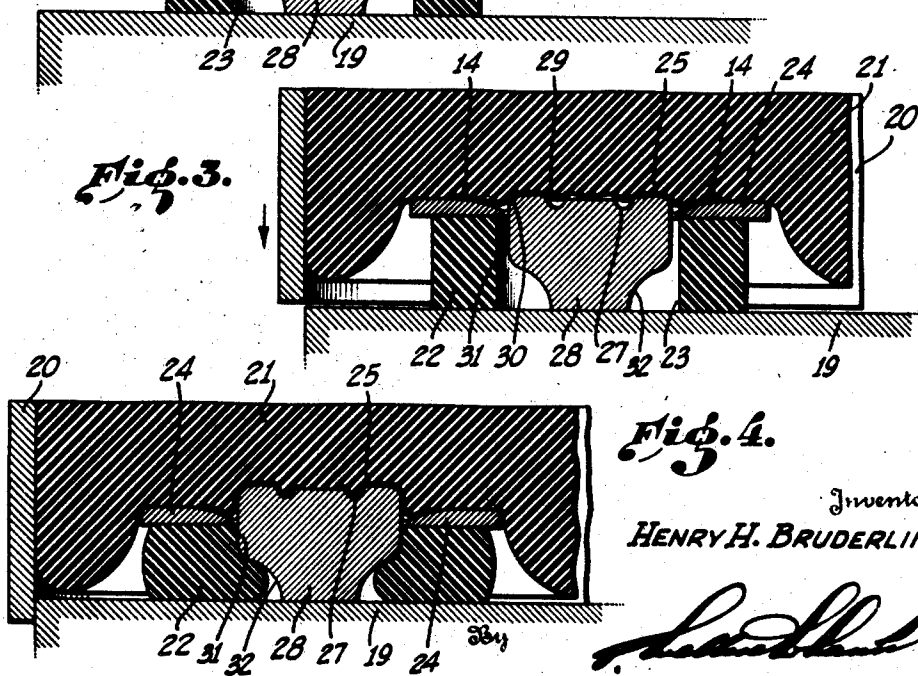


Fig. 4.

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June 24, 1947.

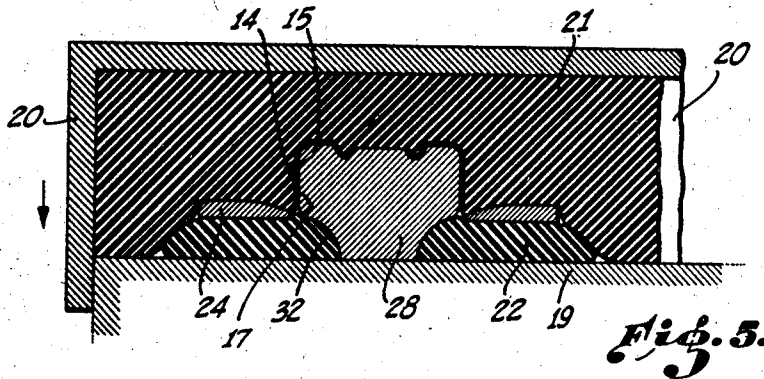
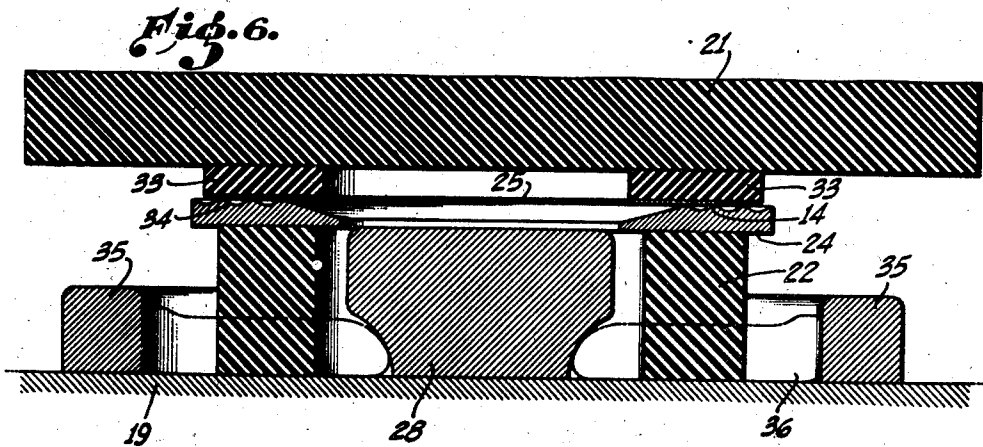
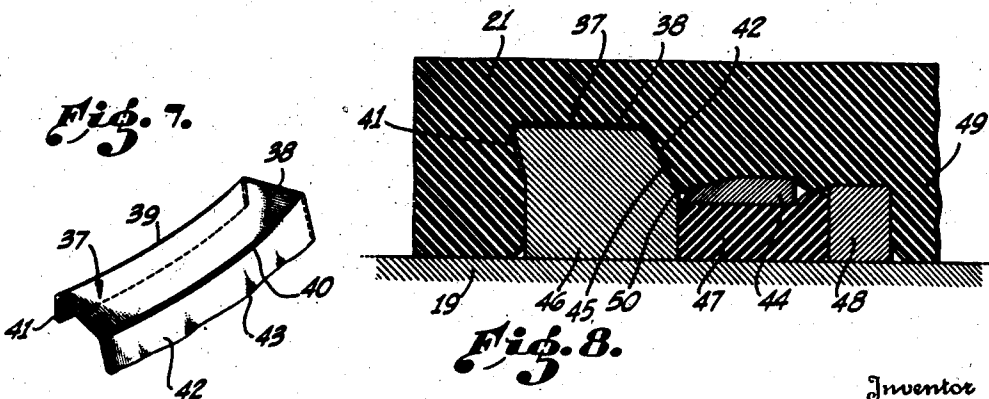
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METHOD AND APPARATUS FOR FLANGING SHEET METAL

Filed Jan. 24. 1942

2 Sheets-Sheet 2



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2,422,883

METHOD AND APPARATUS FOR FLANGING
SHEET METALHenry H. Bruderlin, Hermosa Beach, Calif., as-
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Santa Monica, Calif., a corporation of Delaware

Application January 24, 1942, Serial No. 428,094

9 Claims. (Cl. 113-44)

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My invention relates to an improvement in the art of forming parts from sheet metal wherein a body of rubbery material is applied under pressure to the sheet to form it around a die block, and relates in particular to an improvement in the art whereby a deeper drawing of flanges may be accomplished.

The invention is especially suited for the forming of a relatively small number of parts not warranting the making of companion steel punch and die parts, and it is especially valuable in the aircraft industry where many parts are used which are formed from sheet Duralumin. Unless an aircraft has been fully designed and placed in quantity production, the expenditure of many thousands of dollars for companion punch and die parts is not warranted. Each new aircraft designed is as a general rule considered to be an advance over the existing art. In many instances only relatively few of the designs will be built before a new and better design is engineered. If punches and dies had been made for the first design, their abandonment would constitute an appreciable loss. The present invention is an improvement in the art of forming parts from sheet metal in the so-called "rubber press" which makes possible the formation of many different shapes and sizes of parts within the limitations of the process with regard to depth of draw of flanges around curved edges of a part and depth of draw around curved edges where it is desired to have a relatively sharp corner. Where the sheet material is drawn downward over or from a curved edge or corner of a die block, there is a pronounced tendency for the downwardly bent portion to crinkle, which can be avoided only by drawing or stretching the metal as it is moved downward adjacent the curved side wall of the die block, such stretching or drawing of the metal elongating the excessive metal which would otherwise go into the formation of a crinkle.

An object of the invention is to provide a method and apparatus for drawing the portions of the sheet in a flange around a curved edge or corner of the formed part, which method and apparatus are simple and inexpensive, yet produce satisfactory depth of draw.

A further object of the invention is to produce parts formed from sheet metal, having a suitably deep drawing of flanges around curved edges, accomplished without scratching of the surface of the metal. A surface scratch in a part drawn from sheet Duralumin and intended for use in aircraft is often ample ground for rejection of the part, since it is considered that such a scratch

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often furnishes a starting point for rupture under the conditions of vibration and stress produced in the operation of aircraft.

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 perspective view of a simple article formed in the practice of the invention to give an example of the results obtained.

Fig. 2 is a cross-sectional view showing complementary parts for practice of the invention in place in a rubber press.

Fig. 3 is a sectional view similar to Fig. 2 showing the position of the cooperating parts at the start of the forming operation.

Fig. 4 is a sectional view similar to Fig. 2 showing a further step in the forming operation.

Fig. 5 is a sectional view similar to Fig. 2 showing the relative positions of the cooperating parts at the completion of the downward movement of the head of the press.

Fig. 6 is a fragmentary sectional view showing a cooperation of parts employed to give a more pronounced drawing effect.

Fig. 7 is a perspective view of a curved frame channel formed from sheet metal.

Fig. 8 is a fragmentary sectional view showing the manner in which my invention may be employed in the formation of a channel such as shown in Fig. 7.

Fig. 1 shows an article 10 in the condition in which it is taken from the forming press. It comprises a top wall 11 having an opening 12 therein and having an edge 13, portions of which are curved. A flange strip 14 projects downwardly from the edge 13. The upper portion 15 of this flange strip, or the flange proper of the article 10, is straight and uncrinkled above the dotted line 16. The lower portion 17 of the strip 14 has crinkles 18 therein. The downwardly projecting skirt or strip 14 is parted along the dotted line 16, removing the crinkled edge portion 17 and leaving a finished article 10 having a properly formed flange 15 along the curved edge thereof. In the practice of my process, even though the corner formed along the edge 13 is relatively sharp, a suitable deep drawing of the flange 15 may be accomplished. The waste comprising the edge strip 17 is relatively small.

In Fig. 2 I show the table 19 of a forming press and a press head 20 carrying a press pad 21 which is formed of a yieldable material having the general characteristics of rubber so that it will be

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conformable under pressure to the contour of parts placed on the table 19. A die block 28 having an upper portion corresponding to the shape of the part 10 is supported on the table 19. A rubber body 22 of elongated ring form and having an opening 23 therein is placed around the die block in the position shown, and upon the upper face of this rubber body 23 an edge restraining member 24 is placed, this edge restraining member comprising a plate of sufficiently rigid material, such as steel, having an opening therein corresponding to the peripheral shape of the die block 28, so that the member 24 may be placed in a position surrounding the upper portion of the die block 28, as shown in Fig. 2. The sheet 25 to be formed is placed upon the upper face of the die block, with the edge portions thereof projecting over adjacent portions of the member 24. The sheet 25 may be held by guide pins 26 in such position that the opening 12 in the plate 25 will be properly aligned with the depression 27 in the upper face of the die block 28.

As the head of the press 20 is moved downward, the press pad 21 will first engage the upper faces of the sheet 25 and the exposed portion of the edge restraining member 24, and the sheet will be forced downward against the upper face of the die block 28 and the upper face of the restraining member 24, and, as shown in Fig. 3, downward movement of the edge restraining member 24 will be initiated and the forming of the plate will be started, the rubber body 22 yielding downward under pressure applied to the edge restraining member by the press pad 21.

Being formed of a sufficiently strong and rigid material, the member 24 can move only in a downward direction under pressure applied by the press pad 21. The press pad 21 forces the edge portion 14 of the sheet 25 against the member 24, producing a frictional engagement of the edge portion 14 with the member 24, which will increasingly restrain the edge portion 14 from movement toward the die block 28 as the forming operation progresses. Accordingly, there will be a stretching and drawing of the portion of the plate 25 which is being formed downwardly around the corner 30 and the side face 31 of the die block 28, as the continued downward movement of the press pad 21, as shown in Figs. 3 and 4, compresses the rubber body 22, moves the member 24 downward, and forms the sheet 25 down around the peripheral portion of the die block 28. This action will be continued until the cooperating parts reach the positions in which they are shown in Fig. 5, with the edge restraining member 24 disengaged from the edge portion 14 of the sheet 25. An important feature of the invention is the use of the downwardly and inwardly inclined face on the floating ring 24 resulting in the formation of an acute angle bend in the marginal portion 14 of the blank, as this marginal portion is pushed downwardly into the acute angle space between the side wall 31 of the die block 28 and downwardly and inwardly inclined face of the ring 24. Thus, there is formed in the marginal portion 14 an annular channel of acute angle cross-section which provides a greatly increased resistance to the circumferential compression produced in the marginal portion 14 by the drawing operation. A characteristic of such circumferential compression is that it varies from zero where the blank is in contact with the die block to maximum at the outer periphery of the blank. By forming

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an acute angle bend in the marginal portion of the blank adjacent the die block, the compression in this area of the marginal portion of the blank is sufficiently resisted to inhibit the formation of wrinkles.

This inhibition of wrinkling is assisted by the clamping of the marginal portion of the blank between the rubber and the floating ring 24. It is also assisted by the continuous pressure of the rubber against the marginal portion of the blank, pushing the marginal portion into the acute angle space between the side face of the die block and the inclined face. This downward pressure acts to concentrate the components of the circumferential compression above referred to in the direction of increasing the depth of the annular channel and the sharpness of the bend. The excess metal produced by the drawing action, instead of forming wrinkles, is drawn into the bend in the deepening of the channel, and formation of wrinkles is restricted to the outer peripheral region of the blank, as indicated in Figure 1.

The clamping of the marginal portion of the blank between the rubber and the ring 24 assists in the inhibition of the wrinkles in the bend area.

In the general practice of the invention it is desirable to undercut the lower portions of the die block 28 so as to provide spaces, or a continuous peripheral space 32 into which the rubber of the body 22 may flow. The sheet 25 in Fig. 5 is now a formed part such as shown at 10 in Fig. 1. The edge portion 14 thereof will lie against the side face of the die block 28, the upper portion 15 of the edge portion 14 will be substantially flat and straight, and the crinkles 18 will be confined to the lower portion 17. The die block 28 may be formed without great expense from metal, compressed fibrous products, or other materials of sufficient hardness, and the restraining ring 24 may be readily cut from sheet steel. These parts are capable of producing a large number of formed articles at a cost which is very low as compared to the hand forming of such articles, and when the use of any such formed part is abandoned because of changes in design, the loss occasioned by discarding or reworking the die block 28, the edge restraining member 24, and the rubber body 22, will not be great.

Under some conditions in the use of the invention, greater stretching and drawing effect is required than can be obtained from the arrangement of parts shown in Figs. 2 to 5 inclusive. As shown in Fig. 6, additional gripping effect between the edge restraining member and the sheet may be obtained by use of a number of different expedients together or separately. Greater pressure of the edge portion 14 of the sheet 25 may be obtained by increasing the height of the rubber supporting body 22, thereby raising the edge restraining member 24 so that the sheet 25 will be supported in raised relation to the upper face of the die block 28. A rubber insert 33 may be placed upon the edge portion 14 of the sheet 25 so as to be engaged by the press pad 21 before the lower face of the press pad 21 engages the sheet 25. Accordingly, as the press pad 21 is moved downwardly, pressure will be transmitted through the insert 33 to apply pressure to the edge portion 14, move the restraining member 24 downward, and produce a substantial gripping effect between the edge portion 14 of the sheet 25 and the upper face of the restraining

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member by the time the intermediate portion of the sheet 25 reaches the top face of the forming block 28. In addition to the foregoing, the upper face of the edge restraining member 24 may be provided with sinuous undulations 34 to increase the frictional retarding effect and also to assist in maintaining the edge portion in a substantially flat condition while in engagement with the upper face of the edge restraining member 24. It will be perceived that the frictional restraining effect on the edge portion of the sheet 25 is increased during the forming of the sheet upon the die block 28, as the result of the pre-compression of the rubber supporting member 22 prior to the engagement of the sheet 25 with the upper face of the die block 28, and the greater force applied to the opposite faces of the edge portion 14 by the rubber insert 33 and the edge restraining member 24 during the performance of the actual forming operation.

The volume of rubber in the supporting body 22 has been increased in Fig. 6. So that suitable lateral deformation of the rubber body 22 may take place without interference as a result of engagement with a portion of the press pad 21, I provide a dam 35 comprising a wall of rigid material such as metal in spaced relation to the rubber body 22. This dam 35 may extend entirely around the rubber body 22.

The rubber forming press is used for forming of thin walled channels, used as portions of frames. Such a channel has been indicated at 37 in Fig. 7. It comprises a flat web 38 with curved edges 39 and 40, from which flanges 41 and 42 extend downward. The outer flange 42 will be often found to have a slight wave therein, as indicated at 43, in view of excess metal therein. To remove this wave is bothersome, in that it involves hammering of the flange 42 against a curved forming block.

In Fig. 8 I show a practice of my invention wherein the channel 37 may be initially formed without wave in its outer flange 42, by the simple expedient of using an edge restraining bar 44 along the face 45 of the forming block 46, on which the channel 37 is formed. This edge restraining member 44 need extend only along the face 45, and may be supported in this position on a rubber body 47. In Fig. 8 the edge restraining member 44 is shown in a depressed position resulting from downward application of pressure by the press pad 21, and the rubber body 47 is shown laterally deformed in the space provided by a dam 48 consisting of a bar in suitably spaced relation to the rightward face 45 of the forming block 46. This dam 48 prevents the portion 49 of the press pad 21 from exerting its pressure against the laterally extending portion of the rubber body 47 so as to resist lateral deformations thereof. It will be understood that after the formation of the channel 37, the waste edge 50, Fig. 8, will be severed from the flange 42.

The extent and degree of crinkle in the flange portions are found to vary under different conditions of use of the invention. For example, by use of a specially constructed press, one wherein a pressure of 1500 pounds per square inch or more can be applied to the press pad, and with the flange height not too great, for example three-quarters of an inch or less, it is possible to draw the flange clear down without wrinkles, and therefore the blank may be cut to actual size. The inclination of the inner portion of the face of the ring 24 gives an inward component of the pressure of the rubber against the mar-

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ginal portion of the blank which increases the tendency of the rubber to push the marginal portion of the blank into the form of a deepening channel.

I claim as my invention:

1. In a device for forming a flanged article from a sheet, the combination of: a die block having a front face to receive the sheet and a side face over which the edge portion of the sheet is to be formed; a body of conformable material having the general characteristics of rubber; means for moving said body toward the front face of said die block into contact with that part of said sheet which overhangs the margin of said die block so that it will apply both inward and rearward pressure to said sheet to form the same on said die block with a combined compressive and drawing action; an edge restraining member comprising a plate disposed with one edge adjacent said side face of said die block, and a front face against which the edge portion of said sheet is forced by said body of conformable material, producing engagement of said edge portion to resist movement of said edge portion toward said side face of said die block as the forming operation progresses; a supporting body of a material having the general characteristics of rubber adjacent said side face of said die block and yieldably supporting said edge restraining member so that it will recede across said side face of said die block as the pressure in said body of conformable material increases and gradually increases the compression of said supporting body; and a dam disposed adjacent said supporting body on the side thereof opposite said die block to define a space to receive an edge portion of said supporting body.

2. In a device for forming a flanged article from a sheet, the combination of: a die block having a front face to receive the sheet and a side face over which the edge portion of the sheet is to be formed; a body of conformable material having the general characteristics of rubber; means for moving said body toward the front face of said die block into contact with that part of said sheet which overhangs the margin of said die block so that it will apply both inward and rearward pressure to said sheet to form the same on said die block with a combined compressive and drawing action; an edge restraining member comprising a plate disposed with one edge adjacent said side face of said die block, and a front face against which the edge portion of said sheet is forced by said body of conformable material, producing engagement of said edge portion to resist movement of said edge portion toward said side face of said die block as the forming operation progresses; a supporting body of a material having the general characteristics of rubber adjacent said side face of said die block and yieldably supporting said edge restraining member so that it will recede across said side face of said die block as the pressure in said body of conformable material increases and gradually increases the compression of said supporting body; and a dam disposed adjacent said supporting body on the side thereof opposite said die block to define a space to receive an edge portion of said supporting body, there being a recess formed in the lower part of said die block to receive another edge portion of said supporting body as it expands laterally due to compression by said edge restraining member.

3. In a device for forming a flange on a sheet

of metal over a die, the combination of: a base; a die block supported by said base having a front face to receive the sheet and a side face over which the edge portion is to be formed; a body of rubber-like material of high coefficient of friction opposite and overlying said front face and having a portion extending beyond the meeting edge of said faces; a resiliently compressible support on the base laterally adjacent the die block and opposite the extending portion of the body; a facing of rigid material, inclined inwardly and rearwardly on the front face of the support; and means for moving the body in a direction toward the front faces of the block and facing to press a sheet of material against said front faces to form the sheet on said die block, the said sheet during the forming operation being held laterally immovably centered on the die block and being slidably movable between said facing and the extending portion of the body while pressurally engaged therewith the pressural engagement being such as to produce a progressively increasing drawing action and having an inward component of pressure adapted to produce a mild compressive action in the bend formed in said sheet.

4. In a device for forming a flanged article from a sheet, the combination of: a die block having a front face to receive the sheet and a side face over which the edge portion of the sheet is to be formed; a body of conformable material having the general characteristics of rubber; means for moving said body toward the front face of said die block so that it will apply pressure to said sheet to form the same on said die block; and an edge restraining means consisting of a movable ring surrounding said die block, and having a non-conformable rigid front face, inclined inwardly and rearwardly against which said body of conformable material forces an edge portion of said sheet for the purpose of resisting inward movement of said edge portion toward said die block and thereby produces a progressively increasing stretching and drawing action in the same, and a ring of rubber surrounding said die block and supporting said edge restraining means so that its pressure against said edge portion of said sheet will increase as said edge portion and said edge restraining means are moved rearwardly across the side face of said die block as the pressure applied by said body of conformable material increases.

5. A method of forming a sheet into a flanged article by use of a die block and a body of flowable material, comprising: placing the sheet in proximity to the front face of the die with an edge portion of the sheet projecting from the edge of the die; moving said body of flowable material towards said die so as to force said sheet toward the die; applying to the rear face of said edge portion of said sheet, with relatively light pressure and at an acute angle relative to the direction of movement of said moving body, a non-yielding restraining force cooperating with said flowable material to lightly clamp said edge portion and stretch and draw same, the angle and magnitude of said restraining force being sufficient to urge the peripheral margin of said edge portion laterally toward proximity with the remainder of said edge portion to thereby further move metal from said remainder of the edge portion into the bend formed in said sheet and confine the formation of crinkles to said peripheral portion; moving said restraining

means rearwardly across the side face of said die as said edge portion is moved into a position along the side face of said die; and gradually increasing the magnitude of said restraining force as the movement of said restraining means progresses toward the rear of said die block.

6. A method of forming a sheet into a flanged article by use of a die block and a body of flowable material, comprising: placing the sheet in proximity to the front face of the die with an edge portion of the sheet projecting from the edge of the die; moving said body of flowable material toward said die so as to force said sheet toward the die; applying to the rear face of said edge portion of said sheet, with relatively light pressure and at an acute angle to the direction of the aforesaid movement, a non-yielding restraining force cooperating with said flowable material to lightly clamp said edge portion and stretch and draw the same, the angle and magnitude of said restraining force being sufficient to urge the peripheral margin of said edge portion laterally toward proximity with the remainder of said edge portion to thereby further move metal from said remainder of the edge portion into the bend formed in said sheet and confine the formation of crinkles to said peripheral portion; moving said restraining means rearwardly across the side face of said die block as said edge portion is moved into a position along said side face of said die, gradually increasing the magnitude of said restraining force as the movement of said restraining means progresses toward the rear of said die; and gradually forcing the said crinkled peripheral portion rearwardly into alignment with the rest of said edge portion to locate the crinkles at the lower portion, only, of the flange.

7. A method of forming a sheet into a flanged article, comprising: placing the sheet in proximity to the front face of a die with an edge portion of the sheet projecting from the edge of the die; moving a body of flowable material toward said die so as to force said sheet against said die with a pressure that is exerted both laterally inwardly toward the die and rearwardly toward the back of the die; applying to the rear face of said edge portion, through a surface which is non-yielding laterally, a force that is directed both forwardly in opposition to the rearwardly directed pressure of said flowable material and inwardly toward the die in assistance of the inwardly directed component of the pressure applied by said flowable material, whereby to urge the material of the marginal portion of the sheet into a channel formation of acute angled cross-section which inhibits the formation of wrinkles in said marginal portion.

8. A device for forming a flanged article from a sheet, comprising the combination of: a die block having a front face to receive the sheet and a side face over which an edge portion of the sheet is to be formed; a body of material having the general characteristics of rubber; means for moving said body toward the front face of said die block so that it will apply pressure to said sheet to form the same on said die block; a movable member surrounding said die block and having a non-yielding front face including a surface inclined acutely toward the side of said die block, against which acutely inclined surface said flowable material is adapted to force the peripheral margin of said edge portion and bend said peripheral portion frontwardly at an acute angle with reference to the rest of said edge portion

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while resisting inward movement of said edge portion towards said die blocks; and resilient means surrounding said die block and supporting said movable member so that its pressure against said edge portion of said sheet will increase as said edge portion and said movable member are moved rearwardly across said side of said die block.

9. In a device for forming a flanged article from a sheet, the combination of: a die block having a front face to receive the sheet and a curved side face over which the edge portion of the sheet is to be formed; a body of conformable material having the general characteristics of rubber; means for moving said body toward the front face of said die block into contact with that part of said sheet which overhangs the margin of said die block so that it will apply both inward and rearward pressure to said sheet to form the same on said die block with a combined compressive and drawing action; an edge restraining means yieldably supported adjacent said side face of said die block, and having a non-conformable rigid front face including a surface inclined acutely toward the side of said die block against which said body of conformable material forces an edge portion of said sheet for the purpose of resisting inward movement of said edge portion toward said die block and thereby produces stretching and drawing action in the same, said edge restraining means having adjacent said die block an

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edge which is curved in complementary relation to the said side face; and resilient means to support said edge restraining means so that the pressure thereof against said edge portion of said sheet will increase gradually as said edge portion and said edge restraining means are moved rearwardly across the side face of said die block as the pressure applied by said body of conformable material increases.

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