

June 8, 1943.

C. J. FREY ET AL

2,321,075

MEANS FOR FORMING SHEET METAL

Filed June 10, 1941

2 Sheets-Sheet 1

FIG. 1.

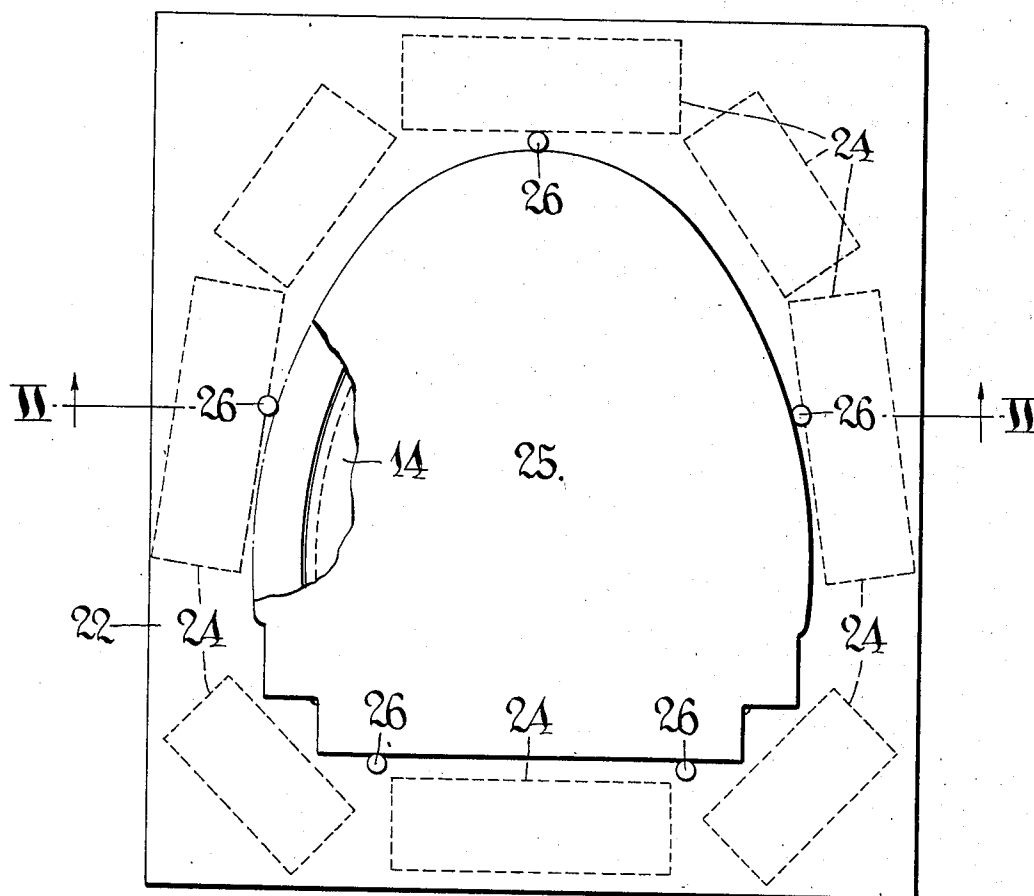
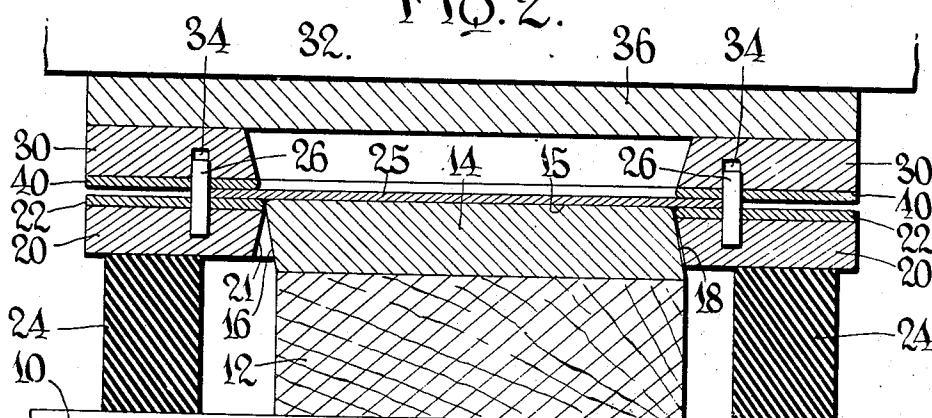


FIG. 2.



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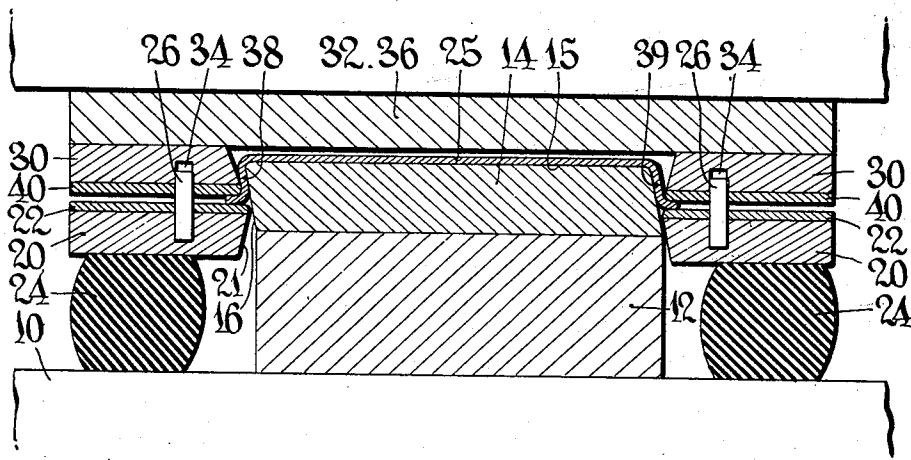
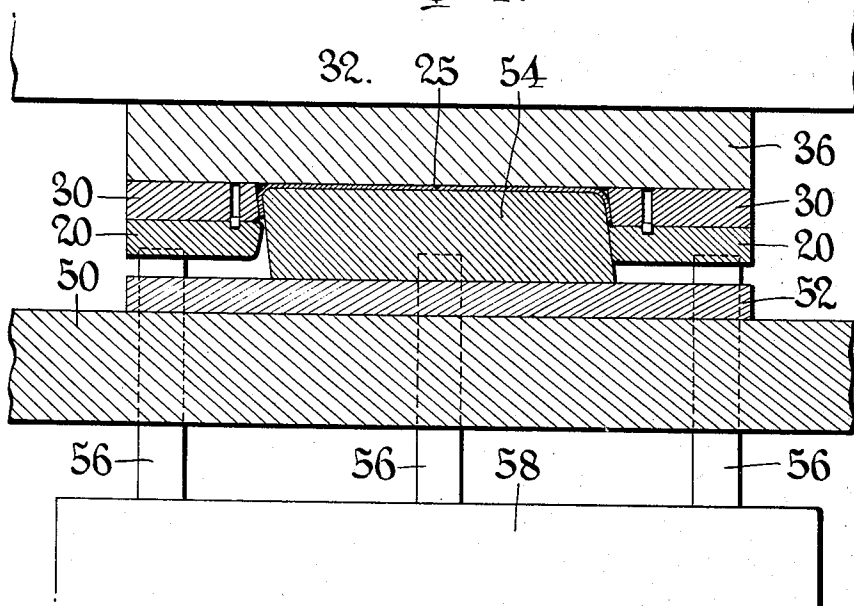


FIG. 3.

FIG. 4.



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UNITED STATES PATENT OFFICE

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MEANS FOR FORMING SHEET METAL

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Application June 10, 1941, Serial No. 397,426

8 Claims. (Cl. 113—46)

This invention relates to means for forming sheet metal and the like, and more particularly to improved die means for forming oblique angle flanges upon sheet metal stock, whereby specially shaped sheet metal products may be economically and expeditiously manufactured. For example, in the airplane manufacturing industry it is often desirable to form sheet metal stock so as to be perimetally flanged at acute and/or varying angularity as, for example, in connection with the forming of wing nose rib elements for wing panels having sweep-back and dihedral; and it is the primary object of the present invention to provide improved sheet metal forming die means which may be employed to advantage for such purpose and to be otherwise of improved utility in connection with the accurate formation of oblique angle flanges on sheet metal stock for other purposes, in an improved manner. Other objects and advantages of the invention will appear in the specification hereinafter.

In the drawings:

Fig. 1 is a diagrammatic plan of a forming die mechanism of the invention;

Fig. 2 is a section taken substantially along line II—II of Fig. 1, showing the die mechanism in position preparatory to a forming operation;

Fig. 3 is a view corresponding to Fig. 2 but showing the mechanism at an intermediate stage of a forming operation; and

Fig. 4 is a view corresponding to Fig. 3 of another form of the die mechanism of the invention.

Figs. 1 to 3 illustrate the die mechanism of the invention as comprising a usual form of press bed 10 mounting the male form 12 which may be provided of wood or any other suitable material. The male form 12 is topped by a facing 14 which may also be provided of wood or any other suitable material and is shaped at its upper face 15 and side faces 16—18 so as to substantially complement the desired contour of the finished product. Thus, the side face portions 16—18 of the facing 15 are shaped to substantially complement the corresponding inner faces of the flanges to be formed perimetally of the stock piece to be operated upon; and as illustrated herein the opposite side face portions 16—18 of the facing 14 are so shaped as to accommodate formation of corresponding flanges at acute and obtuse angles, respectively.

A forming guide and pressure pad 20 is arranged to embrace the die facing 14; being cut away to complement the plan view form of the facing 14. The pressure pad 20 may be formed

generally of wood or "masonite" or any other suitable material, and is preferably faced by means of a steel plate as at 22 for wear-receiving purposes. The pressure pad 20 is arranged to be vertically supported by means of a plurality of rubber posts 24 in such manner that the upper surface portion of the pressure pad liner 22 is substantially level with the upper surface of the male die facing 14. Thus, preliminary to a sheet forming process, the sheet metal stock piece, as indicated at 25 may be rested flatwise upon the table-like surface presented by cooperating adjacent surface portions of the facing 14 and the pressure pad plate 22. Preferably, a plurality of nesting and locating pins 26 will be disposed perimetally of the stock sheet and in vertically extending relation from the pressure pad 20 so as to be adapted to position successively applied stock pieces in proper operative position upon the male form preliminary to each forming operation thereon.

The female die 30 is arranged to be mounted to extend below the usual form of press ram block 32 so as to register with the male form facing 14; and the pins 26 are arranged to extend upwardly into vertically sliding engagement with the female die 30 upon lowering of the ram. For this purpose the die 30 is perforated as at 34 (Fig. 2) so as to engage the pins 26 throughout the forming operation of the mechanism so that the pressure pad 20 and the female die 30 are maintained against relative movement laterally of the direction of the ram movement during the sheet forming process; the pins 26 being rigidly fixed at their lower ends into the pressure pad 20. Preferably, the die 30 is backed up by a bottoming plate 36 which is smooth-faced at its lower surface for pressing against the body portion of the stock piece at the end of the forming process, whereby wrinkling and/or bowing of the main body portion of the stock piece is prevented, and the stock sheet is given a final straightening or flattening coincident with termination of the flange forming process. However, it will be understood that the upper surface of the male form and the lower surface of the bottoming plate may be otherwise shaped to simultaneously form the stock sheet into any other desired shape thereat. The female die 30 is oppositely sloped in upwardly diverging relation at its inner face portions as indicated at 38 and 39 so as to retreat from leading edge portions thereof and to thus avoid frictional interferences with the stock sheet during the forming operation. Also, the female die 30 is preferably faced with a steel wearing

plate 40 corresponding to the liner 22 of the pressure pad 20. The pressure pad 20 is preferably sloped at its inner face portions 21 adjacent the male form so as to diverge inwardly from its leading upper edge and to avoid interferences with the sloping wall portion 18 of the male form.

Thus, it will be understood that preparatory to a flange forming operation upon a stock sheet and while the ram of the press is raised, the stock sheet may be laid flatwise upon the pressure pad and the male form, and between the locating pins 26, and thus it will be properly positioned for operation thereon by the forming die mechanisms. Upon lowering of the press ram the female die 30 will initially clamp against the marginal edge portions of the work sheet 25, as illustrated by Fig. 2; the pins 26 being thereby slidably interconnected with the pressure pad and the female die so as to prevent lateral relative movement therebetween. Upon further downward movement of the ram the female die 30 will transmit the downward pressure of the ram through the marginal edge portions of the stock sheet to the pressure pad 20 whereupon the latter will force the rubber posts 24 to compress and to allow the die 30 to draw the marginal edge portions of the stock sheet downwardly about the side face portions of the male form facing 14, as illustrated by Fig. 3.

It will be noted that as the leading edge of the die 30 moves downwardly below the level of the top surface of the facing 14 the deformable nature of the posts 24 allows the pressure pad and female die unit to move obliquely downwardly and laterally in such manner that the leading edge portion of the die 30 cams against the side face 18 of the facing 14. Thus, the die 30 forms acute and obtuse flange portions 38 and 39 at opposite corresponding sides of the sheet stock (Fig. 3). Upon reversal of the ram motion the die 30 will be lifted out of engagement with the stock piece and the pressure pad 20 will follow the movement of the die 30 to return to the level of the male form facing 14, due to the forces of resiliency within the posts 12; and it will be understood that the pressure pad and female die unit will move obliquely in reverse direction during the elevating process so as to return to its original position of vertical alignment and registry with the top surface portion of the male form, preparatory to a succeeding forming operation. During this return or elevating movement of the press the pressure pad 20 operates as a stripper to remove the finished article from the male form.

Preferably, the die 30 will be rigidly fixed to the bottoming plate 36, and the bottoming plate 36 will be hung from the ram 32 by means of any suitable form of connection device allowing lateral movements of the plate 36 relative to the ram during the flange forming process, as explained hereinabove. Thus, it will be understood that the invention provides a simple and expeditious process for forming acute angle flanges on sheet stock, either in conjunction with other forming processes or independently thereof. Also, it will be understood that the invention is particularly adapted to form flanged sheet metal structures of special shapes and in which the flange angle varies. For example, Figs. 1-3 illustrate the formation of a nose rib element for an airfoil structure, such as an airplane wing or the like, wherein the flange at the right and left hand side portions of the rib element is disposed at obtuse and acute angles, respectively, and is either oblique or right angled at the extreme nose

or upper end portion thereof as viewed in Fig. 1. It will be understood that for such purposes the rubber bolsters 24 will permit the pressure pad and female die unit to move relative to the male form in any direction or composition of directions laterally of the direction of press ram movement.

Thus, employment of the method and means of the invention provides a finished flanged product of varying angularity as the result of a single pressing operation, whereby the need of multiple handling and bending processes is eliminated and the finished article is invariably of true form; it being understood that the die mechanism parts will be so proportioned and arranged that upon completion of the flange pressing operation, of which Fig. 3 illustrates an intermediate stage, the lower surface of the bottoming plate 36 will bear against the main body portion of the sheet stock 25 and press the latter into exact conformity with the upper surface of the male form facing member 14.

Fig. 4 illustrates another form of die mechanism of the invention wherein the female die 30 and the bottoming plate 36 are rigidly fixed to the press ram 32, and the male form is arranged to be laterally displaced relative to its base support during pressing movements of the ram; whereby the male and female die members are enabled to relatively move obliquely for the acute angle flange forming method of the invention. In Fig. 4 the press bed is illustrated at 50, and a bolster plate 52 is mounted thereon to support the male form 54. The male form 54 generally resembles and corresponds to the male form facing member 14 of Figs. 1 to 3, and is similarly shaped at its side faces to complement the desired inner surface form of the article to be finished by the mechanism. The bolster plate 52 and the male form 54 are preferably formed of steel or other suitable metal or the like, and their contiguous upper and lower face portions are smoothly polished so that the male form 54 will be free to slide laterally in any direction relative to the bolster plate 52 under the camming action of the female die 30 against the obliquely disposed side walls of the male form 54 upon operation of the ram.

The pressure pad 20 of the die mechanism of Fig. 4 corresponds to the pressure pad illustrated in Figs. 1 to 3, but an alternative form of mounting for the pressure pad is illustrated in Fig. 4 as comprising a plurality of posts 56 extending from a cushioned lower ram 58. The posts 56 abut at their ends against the pressure pad 20, and thus are adapted to transmit the downward pressures of the female die 30 against the pressure pad 20, to the lower ram. Thus, the pressures operating against the lower ram may be regulated by the operator of the mechanism so as to provide a pressure differential of accurately adjusted magnitude for acting upon the sheet stock during the flange forming operation. It will be noted that, as in the case of Figs. 1 to 3, the female die and the pressure pad will be locked together against relative lateral movements by means of nesting pins, and that thus the female die and pressure pad assembly will move vertically as a unit during pressing and retreating operations of the ram 32; and that the male form 54 will automatically shift laterally upon the bolster plate 52 in response to the camming action between the female die and the male form to provide the oblique relative movement therebetween for the flange forming operation of the invention.

Thus, it will be understood that the invention contemplates provision for relative movements between the male and female die elements in directions laterally of the direction of ram movement, and in response to camming interaction between the male die and a sheet stock marginal edge clamping unit including the female die and opposing pressure pad, in such manner that as the ram lowers the edges of the stock sheet are drawn from between the female die and the pressure pad and accurately pressed into conformity with the side wall portions of the male die; whereby a single pressing operation is enabled to produce an accurately formed sheet metal article having flanges or other pressed parts disposed at various angles to the plane of the original stock sheet, in an improved manner. It will be understood, of course, that the elastically deformable posts 24 of Figs. 1 to 3 may be in the form of coil springs, or the like, or any other suitable form in lieu of being formed of rubber or the like as explained hereinabove. It will also be understood that in lieu of the specific relative arrangement of the parts illustrated and described hereinabove, any other suitable arrangement thereof may be provided within the concept of the invention, whereby the features and advantages thereof may be obtained; and that although only a limited number of forms of the invention have been shown and described in detail it will be apparent to those skilled in the art that the invention is not so limited but that various changes may be made therein without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. A press for the formation of acute angle flanged sheet metal articles comprising, in combination, a press bed, a male form resting upon said press bed and adapted to support the major body portion of a stock sheet thereon and having opposite parallel side wall portions sloped obliquely to the press axis to complement the desired flanged form of said stock sheet, a pressure pad arranged adjacent said male form contiguous to said side wall portions thereof, a press ram arranged above said press bed, a female die mounted upon said ram in registry with said male form and adapted to cooperate with said pressure pad to clamp therebetween portions of said stock sheet extending laterally of said male form upon lowering of said ram, means adapted to fix said female die and said pressure pad against relative lateral movement upon lowering of said female die below the upper level of said male form, and support means extending between said pressure pad and said press bed normally supporting said pressure pad at an elevated position of registry with said male form and being elastically deformable in transverse directions and adapted to be deformed under pressure forces applied by said ram to permit said pressure pad and female die unit to move as a unit to a position below the level of said male form and laterally of the direction of ram movement in response to the camming action of sloping wall portions of said male form.

2. A sheet stock press comprising, in combination, relatively movable press bed and ram members carrying male and female die members for pressing a sheet stock piece therebetween, said die members having cooperating sloping wall and leading edge portions arranged to move in laterally camming registry upon pressing opera-

tion of said ram, said male die member having a forward sheet stock contacting surface portion and opposite side wall portions sloping parallel therefrom obliquely to the direction of ram motion whereby one of said side wall portions is disposed acutely relative to said forward surface portion, said female die member having an inner side wall surface portion disposed in registry with said male die acutely disposed side wall portion and sloped relative to the direction of ram movement to be parallel to said acutely disposed male die side wall portion, said die members being mounted upon said bed and ram members so as to permit relative movement of said die members in directions laterally of the direction of ram movement under the camming action of said leading edge and sloping side wall portions during stock pressing operations.

3. A sheet stock press comprising, in combination, relatively movable press bed and ram members comprising supports carrying male and female die members for pressing a sheet stock piece therebetween, said die members having cooperating sloping wall and leading edge portions arranged to move in laterally camming registry upon pressing operation of said ram, one of said die members having opposite side wall portions thereof sloping parallel to each other and obliquely to the direction of ram motion, one of said die members being mounted upon its support by means of rubber post devices so as to permit relative movement of said die members in directions laterally of the direction of ram movement under the camming action of said leading edge and sloping wall portions during stock pressing operations.

4. A sheet stock press comprising, in combination, relatively movable press bed and ram members comprising supports carrying male and female die members for pressing a sheet stock piece therebetween, said die members having cooperating sloping wall and leading edge portions arranged to move in laterally camming registry upon pressing operation of said ram, one of said die members having opposite side wall portions thereof sloping parallel to each other and obliquely to the direction of ram motion, one of said die members being mounted upon its support by means of elastically deformable supporting members so as to permit relative movement of said die members in directions laterally of the direction of ram movement under the camming action of said leading edge and sloping wall portions during stock pressing operations.

5. A sheet stock press comprising, in combination, relatively movable press bed and ram members carrying male and female die members for pressing a sheet stock piece therebetween, said die members having cooperating sloping wall and leading edge portions arranged to move in laterally camming registry upon pressing operation of said ram, said male die member having a forward sheet stock contacting surface portion and opposite side wall portions sloping parallel therefrom obliquely to the direction of ram motion whereby one of said side wall portions is disposed acutely relative to said forward surface portion, said female die member having an inner side wall surface portion disposed in registry with said male die acutely disposed side wall portion and sloped relative to the direction of ram movement to be parallel to said acutely disposed male die side wall portion, said die members being mounted upon said bed and ram members so as to permit relative movement of said

die members in directions laterally of the direction of ram movement under the camming action of said leading edge and sloping wall portions during stock pressing operations, and a pressure pad arranged adjacent said male die member and opposed to said female die member so as to cooperate therewith to clamp marginal edge portions of the sheet stock therebetween during pressing operations and to move therewith as a unit during said camming action.

6. A sheet metal press comprising, in combination, a press bed and a male die mounted thereon, a ram movable relative to said press bed and a female die mounted on said ram in registry with said male die, said male die having opposite side wall portions thereon sloping in parallel relation and obliquely relative to the direction of ram movement relative to said press bed, a pressure pad mounted upon said bed by means of a support device adapted to normally support said pressure pad so as to be disposed in registry with the top surface portion of said male die and adjacent thereto so as to oppose pressing movement of said female die relative to said male die, said support device being deformable in directions parallel to the direction of ram movement and in directions transverse thereto and spline connection means associated with said pressure pad and said female die for fixing them against relative movements in directions laterally of the direction of ram movement.

7. A press for the formation of flanged sheet metal articles comprising, in combination, a press bed, a press ram arranged above said press bed, a male form resting upon said press bed and adapted to support the major body portion of a stock sheet thereon and having opposite side wall portions sloped obliquely to the direction of press ram movement to complement the

desired flanged form of said stock sheet, a pressure pad arranged adjacent said male form contiguous to said sloped side wall portions thereof, a female die mounted upon said ram in registry with said male form and adapted to cooperate with said pressure pad to clamp therebetween portions of said stock sheet extending laterally of said male form upon lowering of said ram, means adapted to fix said female die and said pressure pad against relative lateral movement upon lowering of said female die below the upper level of said male form, and elastically deformable means extending between said pressure pad and said press bed normally supporting said pressure pad at an elevated position of registry with said male form and adapted to be deformed under pressure forces applied by said ram to permit said pressure pad female die unit to move below the level of said male form, said male form being slidably mounted upon said press bed and adapted to move as a body of unchanged dimension relative thereto in directions laterally of the direction of movement of said press ram in response to the camming action of sloping wall portions of said male form against said pressure pad.

8. In combination, a pair of opposed dies adapted to be relatively moved for stock forming purposes and having coacting cam surface portions, and a support device for one of said dies formed so as to be elastically deformable in directions parallel to the direction of die relative movement and transversely thereto and adapted to allow said supported die to move obliquely relative to the other of said dies under the influence of coaction of said cam surface portions during stock forming movements of said dies.

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