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MEANS FOR FORMING SHEET METAL

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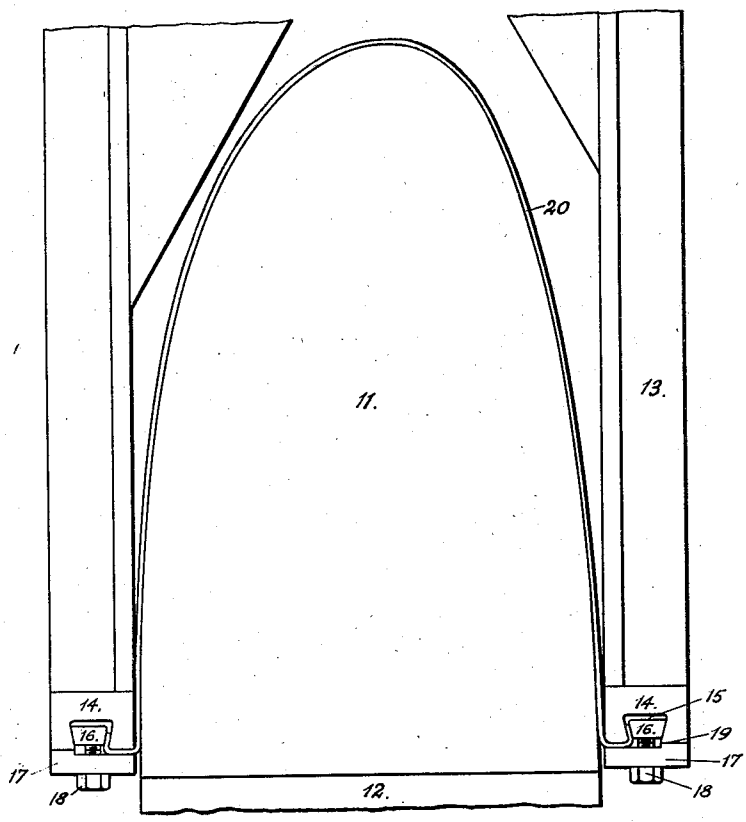


Fig. 1

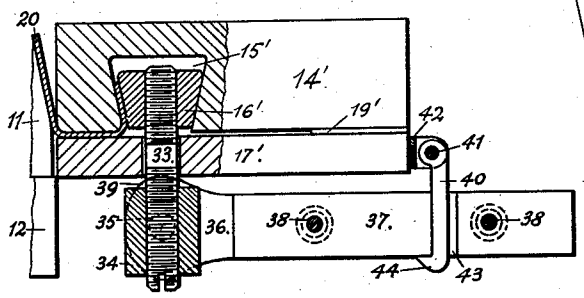


Fig. 2

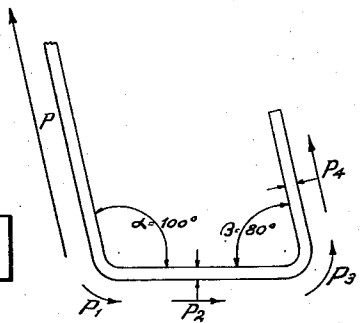


Fig. 3

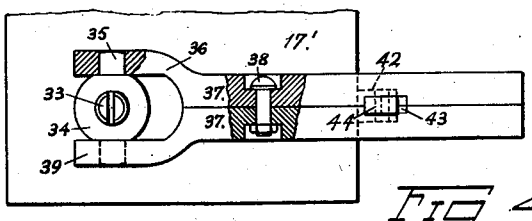


Fig 4

INVENTOR:
H. M. JAGER;

BY:

Robert C. Rasche,
ATTORNEY.

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MEANS FOR FORMING SHEET METAL

Howard M. Jager, Oceanside, N. Y., assignor to Republic Aviation Corporation, a corporation of Delaware

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8 Claims. (Cl. 153—48)

This invention relates to forming flat sheets of metal into various shapes by the employment of machines involving a drawing or stretching action and has more particular reference to a machine involving provisions for anchoring or holding the work sheet during said drawing or stretching operation.

The general object of the invention is to provide a practical machine for draw-forming sheet metal into aircraft components of curved shape such as metallic wing leading-edge sections and the like.

A particular object is to provide a sheet metal forming machine, involving a stretching operation, in which the work-holding means will apply a holding-pressure which will be entirely independent of the stretching strain or load, so that there will be no possibility of the sheet being torn by the machine.

A more specific object is to provide a sheet metal forming machine, involving a drawing action, wherein the holding pressure, or grip, of the holding means on the work sheet can be accurately set to the desired amount before the machine is operated and yet can be readily adjusted for any desired load lying between the elastic limit and the tensile strength of the work sheet; but which will nonetheless apply a differential pressure on the held parts of the sheet and whereby the stretching or drawing load applied will be progressively absorbed and met by progressively increasing sheet-retaining forces.

A further particular object is to provide a machine involving work-holding means of a type which will spread the holding grip over a much larger area of the work sheet than the subsistent work holding means; and in which all the acting surface of the work holding means, though of this improved nature, will be incapable of forming weakening punctures or indentations or other deformations in the held part of the work sheet, and will be perfectly smooth and obviate the employment of any kind of gripping teeth or projections.

Several embodiments of the inventive objects and concepts are described hereinafter and shown in the accompanying drawings, but it is to be understood that the invention is limited in its embodiments only by the scope of the sub-joined claims.

In the drawing

Figure 1 is a fragmentary side elevation of a sheet metal forming machine embodying a preferred form of the invention;

Figure 2 is a partial transverse section showing a modification of the clamping instrumentalities shown in Figure 1;

Fig. 3 is a diagram showing the resistances set up in and by the clamp to the stretching forces; and

Figure 4 is a fragmentary bottom plan view of the clamp of Figure 2, with certain parts in section.

The forming machine shown in Figure 1 is there applied to form a skin of a leading edge section of an airplane wing and includes a stationary form block 11, carried on a platen 12 of a conventional hydraulic press and a saddle-shaped frame 13 to which the metal sheet is clamped and which frame is acted upon by the ram (not shown) of the hydraulic press.

The metal sheet 20 to be formed is bent beforehand to conform roughly with the shape of the block 11 and has its opposite longitudinal edges bent twice in a "break" so as to form two externally projecting U-channelled retaining borders. Thus prepared, the sheet 20 is slid endwise over the block 11, while each of said U-borders is inserted between two longitudinal beams 14 and 17 forming the upper and lower jaws of a clamp.

In the upper jaw 14 is provided a longitudinal dovetailed recess 15 in which works a longitudinal wedge-shaped gang nut 16, cooperating with a series of screws 18 for gripping and anchoring the U-shaped ends of the work sheet 20. One side 19 of the lower jaw 17 is slightly higher than the other to compensate for the thickness of the sheet 20.

When thus clamped in position over the form 11, the work sheet 20 can be stretched by lowering the ram of the press over the frame 13 until the sheet is stretched and deformed and assumes permanently the shape of the form. During this operation there is no risk of tearing the work sheet along the inner bend of the U-borders, even if the pressure exerted by the ram rises beyond the ultimate tensile strength of this sheet, due to the fact that the gripping pressure is independent of the stretching force and is adjusted by tightening the screws 18 to the desired value lying between the elastic limit and the tensile strength of the sheet, and also due to the fact that the gripping pressure is spread over a relatively large area of the sheet, i. e., the wing of the U-border is pressed between the wedge 16 and one slanting side of the recess 15 and the bottom of the U-border is pressed between the two jaws 14, 17, thus providing a "differential" clamping action.

After the sheet **20** is thus formed—here into a leading edge skin section—the ram of the press is raised and the screws **18** are loosened and the section is removed endwise from the gripping jaws **14, 17.**

Figures 2 and 4 show a slightly modified form of the preferred embodiment of the clamp. In this form, the ledge or thicker part, **19,** is replaced by a shim **19'** corresponding to the thickness of the work sheet **20** and the standard screws **18** are replaced by studs **33** provided with left and right-hand threaded portions. On the lower threaded portion of each of said studs is screwed a cylindrical nut **34** carrying two diametrically opposed trunnions **35** on which is swivelled the forked end **36** of a handle in two parts **37** fastened together by means of short bolts **38.** The curved part of the fork **36** forms an eccentric or cam **39** allowing for a quick operation of the clamp after it has been adjusted by turning the studs **33** with a screw-driver.

The handles **37** may be locked in their active position by means of latches **40,** pivoted as at **41** to a bracket **42** mounted on the side of the lower jaw **17'.** Each latch **40** swings in a slot **43,** formed between the two parts of each handle **37,** when said handle meets a ramp **44** formed at the free end of the latch.

Figure 3 shows diagrammatically the relative magnitude of the four reaction forces P1, P2, P3, and P4, which oppose the stretching force P when the clamp is closed and the machine operated. As angle $\alpha=100°$ and angle $\beta=80°$, and as the pressure applied by the wedge **16** or **16'** on the upturned wing of the U-channel is substantially greater than the pressure applied by the jaw **17** or **17'** under the bottom of the U-channel, there are these relations: (1): $P1+P2+P3+P4>P$; and (2): $P1<P2<P3<P4$.

By thus having four distinct clamping forces, and increasing their magnitude, and by spreading these forces over a much larger area than in subsistent clamps, stress concentration at the point where the sheet leaves the clamp is avoided, thereby entirely obviating the tendency of the sheet to tear at this point. This tendency of the sheet to tear is further effectively precluded by having all the active surfaces of the jaws of the clamps perfectly smooth, as distinguished from the clamps of any analogous art of the kind in which said surfaces are roughened or provided with small teeth in order to increase their gripping action.

It is to be understood that each of the opposite longitudinal edges of the work sheet is formed with angled borders, or compound bends—here disclosed as twice bent—merely in order to facilitate clamping of the work sheet and in the ultimate product, these bends need not appear.

It is to be noted that although the triple-jaw clamp of the present invention, when operated by the tightening means disclosed, applies a differential pressure over different portions of the compound bends of the angled borders of the work sheet, it applies this pressure progressively, and over the entire, total surface of the pre-formed borders, with this pressure increasing most toward the extreme edges of the work sheet. Moreover, the stretching load is taken up, progressively, and in sequence, by four increasing, retaining-forces: a first, rounded bend between the main portion of the work sheet and each of the angled borders; the friction indirectly created between the fixed jaw and one of the movable jaws of the clamp; a second rounded bend forming the angle of each border; and a second frictional reaction created directly between the fixed jaw and the other movable jaws of the clamp.

Having thus disclosed the inventive concepts and several forms of embodiment thereof, what is claimed is:

1. A clamp, comprising: a fixed jaw having a dovetail recess; a jaw mounted free to move vertically in said recess; a second movable jaw opposed to both said fixed jaw and said first movable jaw, a stud rotatably mounted in said second movable jaw and having left and right-hand threaded ends, one of said ends passing through said first movable jaw; an adjustable nut on the other threaded end of said stud; diametrically opposed trunnions secured on said nut; and a cam-lever pivoted on said trunnions to move said movable jaws in opposite directions simultaneously towards said fixed jaw.

2. A clamp, comprising: a fixed jaw having a dovetail recess; a jaw mounted free to move vertically in said recess; a second movable jaw opposed to both said fixed jaw and said first movable jaw, a stud rotatably mounted in said second movable jaw and having left and right-hand threaded ends, one of said ends passing through said first movable jaw; an adjustable nut on the other threaded end of said stud; diametrically opposed trunnions secured on said nut, a cam-lever pivoted on said trunnions to move said movable jaws in opposite directions simultaneously towards said fixed jaw; and latching means for locking said cam-lever in its active position.

3. A clamp comprising: a base member defining a wedge-action recess therein; a member mounted in said recess for movement; a second movable member mounted opposed to both said members; a fastening member having oppositely-acting ends mounted rotatably in said second movable member and having one of the ends engaged with said first movable member; a fulcrum-member mounted on said rotatable member adjacently to said second movable member and having lateral projections; and a cammed-member pivoted on said projections and organized with the aforementioned structure to apply pressure and tension respectively to said second movable member and said first movable member, whereby to move both said movable members simultaneously in opposite directions.

4. A clamp, comprising: a base member defining a wedge-action recess therein; a member mounted in said recess for movement; a second movable member mounted opposed to both said members; a fastening member having oppositely-acting ends mounted rotatably in said second movable member and having one of the ends engaged with said first movable member; a fulcrum-member mounted on said rotatable member adjacently to said second movable member and having lateral projections; and a cammed-member pivoted on said projections and organized with the aforementioned structure in such manner as to adapt same to move both said movable members simultaneously in opposite directions, and means for retaining said cammed member in its functioning position.

5. In a sheet metal forming machine the combination with a form block, of a pair of superposed beams disposed upon each side of said form block and longitudinally coextensive therewith, the upper of said beams being provided with a longitudinal groove in its lower face hav-

ing upwardly divergent sides, a longitudinally extending wedge member freely mounted in said groove and having its longitudinal sides substantially parallel to the upwardly divergent sides of the coacting groove, and means coacting with said wedge and the lower of said beams for moving the wedge member downwardly in its groove and bringing the lower beam upwardly to coact with the lower surface of the upper beam, whereby adjacent portions of a work sheet may be clamped simultaneously between one side of the groove and said wedge member and between opposed faces of said beams.

6. In a sheet forming machine, the combination with a form block, of a pair of superposed beams arranged upon each side of the said form block and longitudinally coextensive therewith, the upper of said beams being provided with a longitudinal groove in its lower face having upwardly diverging sides, each side being at an acute angle to the face of said beam, a longitudinal wedge member freely mounted in said groove having its sides substantially parallel to the sides of the coacting groove, and means coacting with said wedge and the lower of said beams to clamp a portion of a work sheet between said beams upon one side of the longitudinal axis of said beams and to move said wedge downwardly in its groove to clamp an adjacent portion of the same work sheet between adjoining and coacting sides of the wedge and groove.

7. A clamp comprising a fixed jaw having a recess in its clamping face the sides of which diverge at acute angles to the face of the jaw, a first movable jaw mounted for movement in said recess, trapezoidal in cross section, and having sides converging toward the face of the fixed jaw and parallel to the divergent sides of the recess, a second movable jaw opposed and parallel to the outer faces of both the fixed jaw and the first movable jaw, and means coacting with the movable jaws to move them simultaneously in a direction normal to the clamping faces of the fixed jaw and the second movable jaw and at an acute angle to the clamping face of the first movable jaw.

8. A clamp comprising two spaced, fixed members having their adjoining faces divergent, said members combining to form a composite fixed jaw the outer face of which lies at an acute angle to both of said divergent faces, a wedge, trapezoidal in cross section, disposed for movement between the divergent faces of the said members and having its outer face parallel to the outer face of said composite jaw and its side faces respectively always parallel to adjacent divergent faces of the fixed members, a second and movable jaw disposed parallel to the outer faces of said composite jaw and said wedge, and means connecting said wedge to said movable jaw to move them simultaneously in opposite directions.

HOWARD M. JAGER.