

Feb. 27, 1945.

R. SEIFRIED

2,370,329

BENDING AND BEVELING MACHINE

Filed April 7, 1942

2 Sheets-Sheet 1

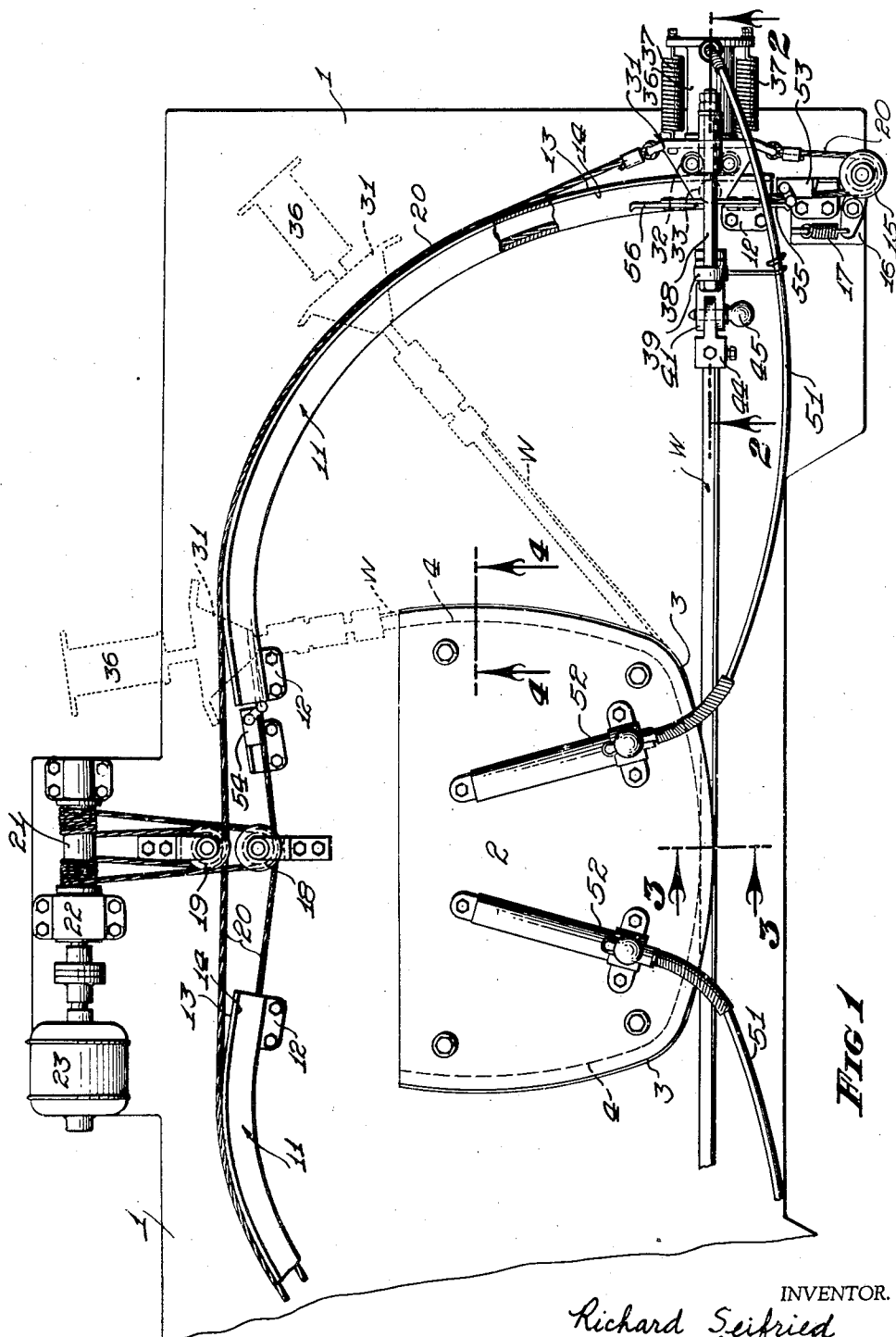


FIG 1

INVENTOR.

Richard Seifried

BY

Carlos G. Stratton

ATTORNEY

Feb. 27, 1945.

R. SEIFRIED

2,370,329

BENDING AND BEVELING MACHINE

Filed April 7, 1942

2 Sheets-Sheet 2

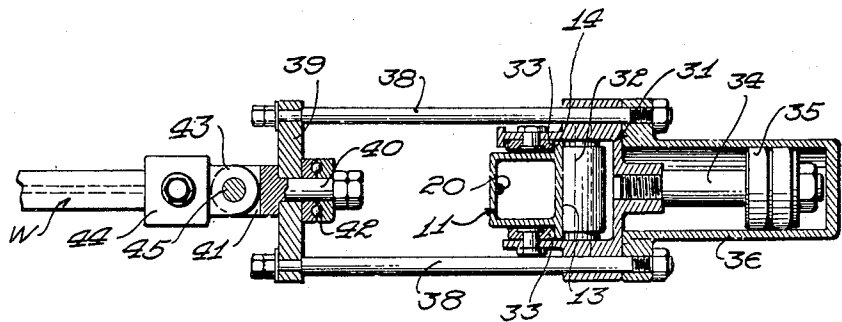


**FIG. 2**

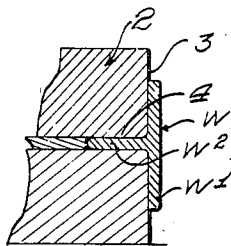


**FIG. 3**

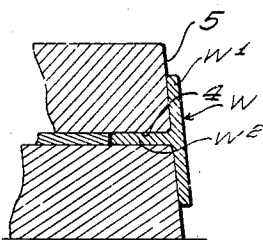


**FIG. 4**

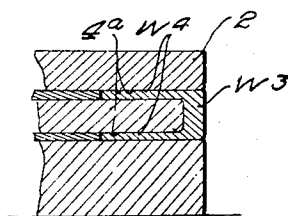


**FIG. 5**

INVENTOR.  
Richard Seifried  
BY Carlos G. Stratton  
ATTORNEY

## UNITED STATES PATENT OFFICE

2,370,329

## BENDING AND BEVELING MACHINE

Richard Seifried, Inglewood, Calif., assignor to  
North American Aviation, Inc., Inglewood,  
Calif., a corporation of Delaware

Application April 7, 1942, Serial No. 437,947

8 Claims. (Cl. 153—32)

My invention relates to bending and beveling machines; more particularly to machines designed to bend and bevel or shape strip material having a structural cross section. Conventionally, such strip material having a T-shaped, L-shaped, U-shaped, Z-shaped, or I-shaped cross section or any of the numerous modifications thereof are bent or shaped around a form either by hand operated tools or by machines which attempt to duplicate the hand operation. Essentially this consists in pounding or hammering or upsetting the material comprising the work piece, and is particularly severe if the radial width of the work piece bears any great ratio to the radius of curvature on which the work piece is bent. Such severe forming tends to develop serious internal stresses which are often localized and therefore the cause of later failure, and is particularly detrimental to aluminum and copper or their alloys which are susceptible to work hardening. Furthermore, it is very difficult if not impossible by such conventional forming methods to make duplicate members to close dimensional tolerances.

Accordingly, among the objects of my invention are:

To provide a bending and beveling machine which is particularly designed to bend or shape (to close dimensional tolerances) strip material having a structural cross section even though the ratio between the width of the work piece and the desired radius of curvature be high.

To provide a bending and beveling machine which is particularly adapted to handle such material as aluminum or copper and their alloys without introducing localized strains and with a minimum of work hardening so as to minimize if not eliminate the need for subsequent normalizing or annealing of the work piece.

To provide a bending and beveling machine which is not only capable of bending strip material but may simultaneously twist the material about its own axis or modify the cross section of the material by changing the angular relation between parts of the material; for example, the angular relation of the leg or stem of strip material of T-shaped cross section may be modified with respect to the cross portion thereof.

To provide a bending and beveling machine which materially shortens the time formerly required to shape strip material of structural cross section.

To provide a bending and beveling machine which utilizes simple forming members capable of being constructed from wood or similar readily

available and easily prepared material, and further to provide a machine in which such forming members may be quickly installed or interchanged so that its use is justified even though only a limited number of work pieces of any given contour are required; thereby providing a machine of this character which is particularly suited for the shaping of the frame members of airplane wings and fuselages or boat hulls.

To provide a novel method of bending or contouring strip material of structural section wherein the work piece is maintained under tension and the amount of tension is varied in relation to the rate of curvature or the radius on which the work piece is being bent.

Fig. 1 is a fragmentary plan view of my machine indicating by solid lines its initial position in which a work piece has been fastened in place and is about to be bent, and indicated by dotted lines intermediate and final steps in the bending process.

Fig. 2 is an enlarged fragmentary sectional view through 2—2 of Fig. 1, showing particularly the traveler unit and the means used thereby for gripping and applying tension to the extremity of the work piece.

Figs. 3 and 4 are typical enlarged fragmentary sectional views of the forming block taken through 3—3 and 4—4 respectively of Fig. 1, showing the arrangement of the forming block for handling work pieces of T-shaped cross section.

Fig. 5 is a sectional view similar to Fig. 3 illustrating the arrangement of the forming block for handling work pieces of U-shaped cross section.

My forming and bending machine herein illustrated is designed to bend initially straight extrusions of structural cross section into a generally U-shaped or bow-shaped configuration. Strictly speaking "extrusion" refers to material, usually of aluminum or copper or other soft metals and their alloys or plastics which has been formed by an extrusion process but the term is customarily used, and is herein used, to designate elongated strip material having a structural cross section; such as, T, I, L, U, or Z-section, or any one of the numerous and sometimes complicated modifications thereof whether formed by an extrusion process or otherwise.

A work table 1 is provided to carry my forming and bending machine. Suitably secured to the table 1 in a central position is a forming block or mandrel 2. The forming mandrel is flat and its front and side edges form a working face 3 which, in this case is bow-shaped with the central

portion forward and the extremities directed backward. The transverse shape of the working face is, of course, dependent upon the shape of the work piece W to be formed. If, for example, the work piece is T-shaped in cross section, the working face 3 receives the cross portion W1 of the work piece, and a channel 4 is provided in the work face to receive the leg W2 of the work piece as shown in Figs. 3 and 4. If the work piece be channel shaped or U-shaped, as indicated by W3 in Fig. 5, two channels 4a are provided to receive the two legs W4 of the work piece.

The forming mandrel not only bends the work piece with regard to its length, but also may modify the cross section of the work piece; that is, the work face of the forming mandrel may be perpendicular to the channel as shown in Fig. 3, or beveled, as indicated by 5, in Fig. 4, or may vary progressively from one to the other.

Spaced symmetrically, laterally or outwardly from the two sides of the forming block 2, is a pair of guide members 11. The forward extremities of the guide members are positioned in a common plane tangent to the forward or mid-point of the working face and are spaced therefrom sufficiently to accommodate the entire length of the work piece to be formed as well as a clamp and traveler unit to be described hereinafter. The guide members curve rearwardly and toward each other to points spaced rearward of and substantially tangent to the extremities of the working face. The guide members are so curved that the distance from the mid-point of the working face to any point of tangency of a radius line to the corresponding guide member plus the length of such radius line is substantially constant; that is, the distance from the mid-point of the forming mandrel (the point at which section 3-3 is taken), to the guide member 11 at the solid line position or any of the dotted line positions of the work piece W is substantially constant.

Each guide member is in the form of a tube of square cross section open at its ends and supported thereat by brackets 12 so that its underside clears the table 1. The guide members are preferably centered in a plane passing through the transverse center of the working face 3 of the forming mandrel; for example, the channel 4 of a forming block for a work piece of T-section.

The outer side of each guide member forms an outer track 13, and extends above and below the upper and lower surfaces to form inner tracks 14. At the forward end of each guide member is an idler pulley 15, preferably mounted on a separate bracket 16 and provided with a tension spring 17. Also, between the rear or adjacent ends of the two guide members are double pulleys 18 and 19. By "double" pulleys is meant a pair of pulleys, one above the other. Thus there is a pair of such superposed, "double" pulleys at 18 and another pair of superposed pulleys at 19. The pulleys in each pair rotate independently of each other. A cable system 20 extends from the outer track side of each guide member, around the corresponding idler pulley 15 then through the interior of each guide member around the double pulley 18 then around a driving drum 21 located rearwardly of the guide members back around the double pulley 19 and the outer track 13 of each guide member to the point of beginning. The drum 21 is driven through a reduction unit 22 by a motor 23.

Each guide member carries a traveler member

31 which is in the form of a U-shaped frame the cross portion of which overhangs the outer track side of the guide member and the legs of which extend across the top and bottom of the guide member. The cross portion of the traveler member is connected to the corresponding extremities of the cable 20. Rollers 32 and 33 ride on the track 13 and inner track 14 respectively to hold the traveler member in place.

Each traveler member is provided with an outwardly directed piston stem 34 which receives a piston 35. Each piston 35 fits within a cylinder 36 closed at its outer end and which is connected with the traveler member 31 by return springs 37. Secured to the top and bottom sides of the cylinder 36 are tie rods 38 which extend across the top and bottom of the traveler member 31 and the guide member 11 toward the forming mandrel and are joined at their extended or inner ends by a yoke 39. Each yoke 39 journals about the horizontal axis of a stem 40 of a clevis member 41. A thrust bearing 42 is provided between the outer end of the stem 40 and the yoke.

Each clevis is provided with a bifurcated inner end which receives a lug 43 of a clamp member 44 and is secured thereto by a clevis pin 45. A clamp member 44 is secured to each extremity of the work piece W so that the work piece connects the two traveler members and their associated elements.

A hydraulic line 51 extends from each cylinder to a suitable source of hydraulic pressure for the purpose of forcing the cylinders outwardly and thereby apply tension to the work piece. The source may be a reservoir of fluid under pressure under the control of the operator. For the sake of illustration, this is shown as a hand pump 52 for each line 51 and positioned in easy reach of the operator on top of the forming block 2. The lines 51 are flexible to permit movement of the traveler members 31.

The traveler members are adapted in the course of forming the work piece to move from the forward to the rear extremities of the guide members. Movement thereon is terminated by limit switches 53 and 54 located at the forward and rear extremities respectively of one of the guide members. The limit switches are engaged by cam arms 55 and 56 extending from the corresponding traveler member 31 to disconnect the motor 23, the motor being started by other conventional switches not shown.

Operation of my bending and beveling machine and the forming method employed thereby, is as follows:

The ends of the work piece W are secured in the clamp members 44. The traveler members are positioned at the forward extremities of the guide members. The clamp members are secured in their clevis members by the clevis pins 45. Tension is then applied to the work piece W and the motor 23 started to move the two traveler members 31 simultaneously along their respective guide members.

Sufficient tension is applied to stretch the work piece, the amount of stretch being governed by the radius of curvature; that is, as the radius of curvature is decreased the amount of tension is increased. Also, if the form member is acting upon the work piece to modify its cross section as by changing the angular relation of the cross portion W1 and the leg W2, the tension is increased. Proper control of the tension, causes the work piece to conform closely to the forming

mandrel and maintain its conformity when the tension is released.

When the traveler members have reached the rear extremities of the guide members, the pressure is released so that the clevis pins can be withdrawn. The clamps are then loosened from the work piece and the work piece removed from the forming member. In the meantime the traveler members are returned to their initial or forward positions, by driving the drum, by means of the motor 23 and reduction gear 22, in a direction opposite to that which moved the traveler members to the rear extremities of the guide members. The journal afforded by the clevis and the axis of rotation afforded by the stem 40 and thrust bearing 42 permit the work piece to twist about its longitudinal axis into conformity with the working face of the forming block.

It is, of course, important that the correct amount of tension be applied to the work piece. This varies with the cross sectional pattern of the work piece. The forming produced by the present machine is capable of being made uniform, piece by piece, in the hands of a skilled operator through an entire run, so that successive pieces are substantially identical with each other. One valuable result attained by the present invention is the provision of means whereby the identical "spring back" is, due to the foregoing tension control, obtained in all pieces, so that all finished pieces are identical. Too little tension results in failure of the work piece to conform to the forming block.

Internal stresses or the effects of work hardening cannot be entirely avoided, particularly when bending such material as aluminum or copper or their alloys. However, if these detrimental effects are held below an optimum value, the work piece may be annealed or normalized after forming. Such additional treatment tends to cause the work piece to warp, the amount of warping being in proportion to the internal stresses which have been introduced. By proper operation of my machine such detrimental effects are held to a minimum, and if the bending is not severe, are, to all practical effects, eliminated.

If warping does occur, my companion machine, shown in application Serial No. 439,665, filed April 20, 1942, entitled Truing machine, is employed. In this connection it should be observed that in said companion application, split or multiple forming blocks or mandrels are disclosed and that such multiple forming blocks may be substituted for the single forming block or mandrel 2 herein disclosed, and are desirable to aid in forming certain shapes, or in handling work pieces of certain structural cross section.

It will be observed that the forming mandrel is easily manufactured. Hardwood, or a combination of hardwood and metal is entirely satisfactory. My machine is particularly adapted to form the frame members or edge pieces used in fuselages, wings, control surfaces and other parts of an airplane. Consequently, a large number of pieces are required varying only slightly from each other, so that the simplicity of the forming mandrel and its ease of manufacture is of utmost practical importance. It is a matter of only a few minutes to change forming mandrels. The same guide members may be utilized for several sizes of forming mandrels without changing the position of the guide members on the work table. Additional sizes of forming mandrels may be accommodated by moving the guide members closer or farther apart. Thus a few guide mem-

bers suffice for a large number of forming mandrels.

Also, it should be noted that while the forming block or mandrel is shown as symmetrical in form, this is not mandatory, but instead one half may be shaped differently than the other; that is, the curvature on one side may be greater or less than that on the other.

While I have illustrated and described what I now regard as the preferred embodiment of my invention, the construction is, of course, subject to modifications without departing from the spirit and scope of my invention. I, therefore, do not wish to restrict myself to the particular form of construction illustrated and described, but desire to avail myself of all modifications that may fall within the scope of the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A forming and beveling machine for strip material having a structural cross section wherein at least a portion of said strip material extends edgewise to the intended plane of curvature, and another portion is flatwise thereto and normally at right angles to said edgewise portion, comprising: a forming mandrel defining a lengthwise curved working face for the flatwise portion of said strip material and a channel therein for said edgewise portion; at least portions of said working face being transversely at an angle other than a right angle relative to said channel, whereby when said strip material is forced into conformity with said working face and channel the cross section of said work piece is modified; swivel means engageable with the extremities of said strip material to apply tension thereto but permit relative turning of the strip material; and other means for drawing the extremities of said strip material around said forming mandrel tangentially to said working face and in the plane of said channel while maintaining tension on said strip material to urge said strip material into conformity with said channel and working face.

2. A forming machine for strip material of structural cross section, comprising: a forming mandrel having a curved working face defining the contour of which the material is to be formed; a pair of curved track elements; travelers adapted to ride on said track elements; clamp means at the inner sides of said track elements adapted to engage the extremities of said strip material; variable yielding means carried by each traveler at the outer side of its track element, connections, including a swivel, between said variable yielding means and said clamp means for applying tension to said strip material; means for moving said travelers on said track elements, said track being positioned laterally from the working face of said forming mandrel and shaped to guide the extremities of said strip material tangentially around the working face.

3. A forming machine for strip material of structural cross section, comprising: a forming mandrel having a generally bow-shaped working face; traveler members; means carried by said traveler members for applying tension to said strip material; track elements for said traveler members positioned at opposite sides of said forming mandrel and extending from points tangent to a mid point of said working face to points tangent to the extremities of said working face; and cable means connected to move said traveler members on said track elements in rela-

tively opposite directions to, and from an initial position wherein the mid portion of said strip material substantially coincides with the mid point of said working face to a final position wherein said strip material is wrapped around said working face.

4. A forming machine for strip material having a structural cross section wherein at least a portion of the strip extends edgewise in the substantially intended plane of curvature, comprising: a forming mandrel defining a curved working face and having a channel extending along said working face to receive said edgewise extending portion of the strip material; traveler members; track elements for said traveler members positioned at opposite sides of said forming mandrel and extending from points tangent to a mid point of said working face to points tangent to the extremities of said working face; means for moving said traveler members on said track elements in relatively opposite directions to, and from an initial position, wherein the mid portion of said strip material substantially coincides with the mid point of said working face and the edgewise portion of said strip material extends into the mid portion of said channel, to a final position wherein said strip material is wrapped around said working face and said edgewise portion is urged into said channel along its length; and means connected to apply variable tension between the traveler members and the strip material during said forming movements.

5. A forming and beveling machine for strip material having a structural cross section wherein at least a portion of said strip material extends edgewise to the intended plane of curvature, and another portion is flatwise thereto and normally at right angles to said edgewise portion, comprising: a forming mandrel defining a lengthwise curved working face for the flatwise portion of said strip material and a channel therein for said edgewise portion; at least portions of said working face being transversely at an angle other than a right angle relative to said channel whereby when said strip material is forced into conformity with said working face and channel the cross section of said work piece is modified; pressure fluid means for applying tension to said strip material; and means for urging said strip material against said working face and into channel into conformity thereto while maintaining said strip material under tension; traveler members including means engageable with the extremities of said strip material to apply tension thereto; track elements for said traveler members positioned at opposite sides of said forming mandrel and extending from points tangent to a mid point of said working face to points tangent to the extremities of said working

face; and means for moving said traveler members on said track elements in relatively opposite directions, to and from an initial position wherein the mid portion of said strip material

6 engages said forming member at said mid point, to a position wherein said strip material is wrapped around said working face, said strip material being under tension during said movement whereby the edgewise extending portion is urged into said channel and said flatwise extending portion into conformity with said working face.

6. A forming machine for strip material of structural cross-section comprising a forming mandrel having a working face defining the contour to which the material is to be formed; cable-actuated means for moving at least one of the extremities of said strip material around said working face; piston and cylinder means independent of said cable actuated means connected to apply tension to the strip material when pressure fluid is supplied to move the cylinder and piston relative to each other; resilient means connected to resist relative movements of the piston and cylinder, and connections to supply pressure fluid to the cylinder to operate the piston and cylinder means against the action of the resilient means.

7. A forming machine for strip material of structural cross-section comprising a forming mandrel having a lengthwise working groove and a lengthwise working face that is transversely beveled at an angle other than a right angle relative to said groove, defining the contour to which the material is to be transversely deformed during bending thereof; cable-actuated means for moving at least one of the extremities of said strip material around said working face; means independent of said cable actuated means for applying tension to the strip material, and swivel means connecting the strip material and the strip moving means to permit beveling of the strip material in accordance with the working face.

8. A forming machine for strip material of structural cross-section comprising a forming mandrel having a working face defining the contour to which the material is to be formed; traveler means for engaging the strip material, means for applying tension between the traveler means and the strip material, and cable means connected to move the traveler means from an original position, independent of said tension applying means, to form the strip material around the working face, and the cable means being motor actuated and reversibly connected to move the traveler means between an original and any selected moved position.

RICHARD SEIFRIED.