Nov. 24, 1942. C. C. MISFELDT 2,303,059

CONTOUR FORMING MACHINE

Filed June 4, 1940 4 Sheets-Sheet 1

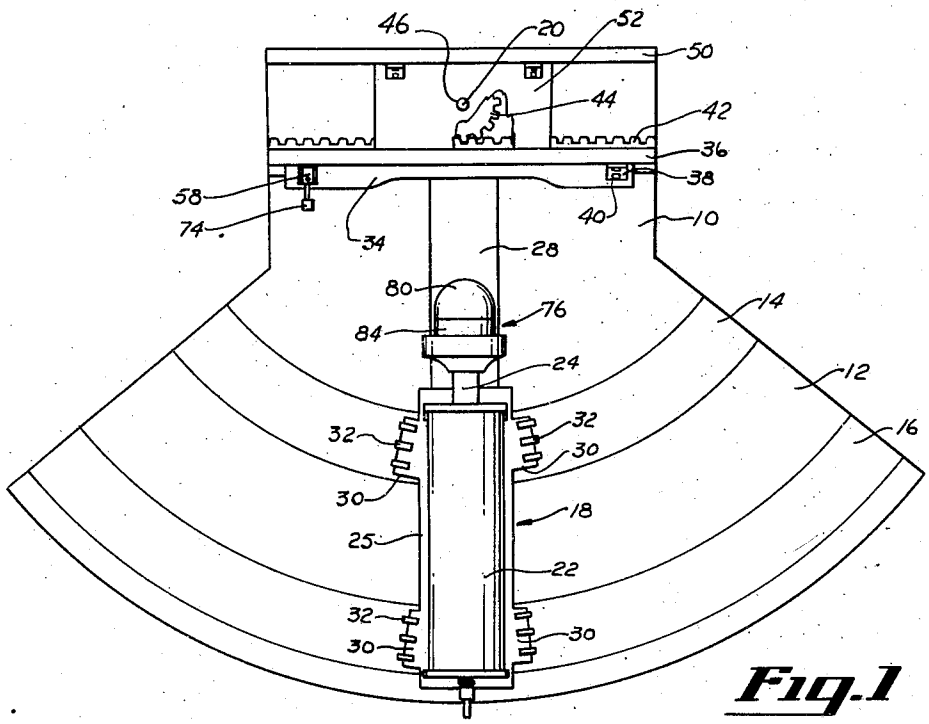


Fig. 1

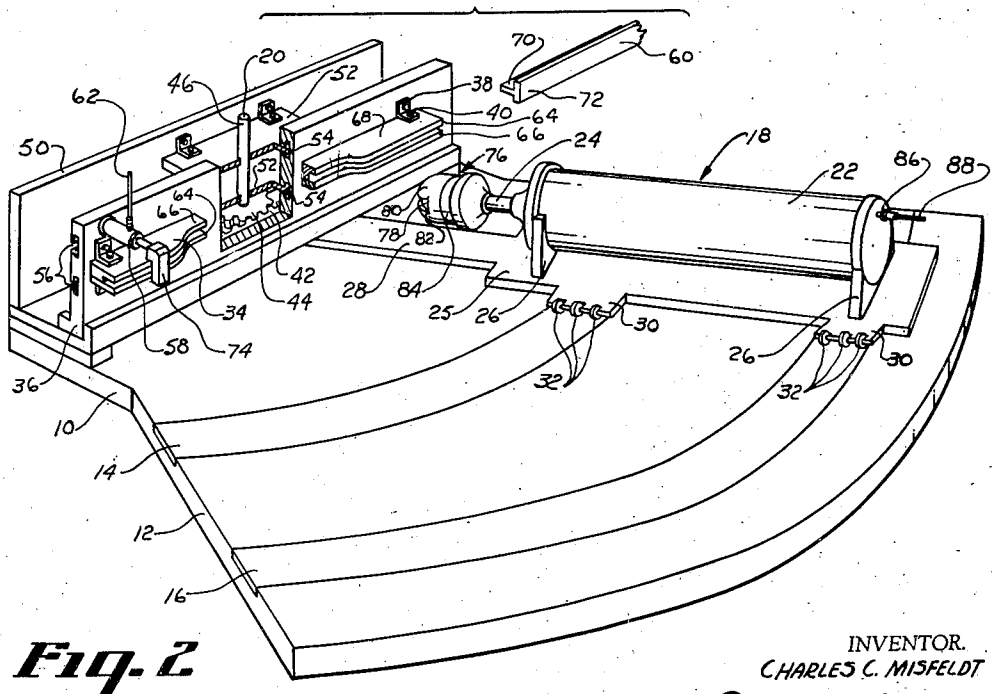


Fig. 2

INVENTOR.
CHARLES C. MISFELDT

BY J. Edwin Coates
ATTORNEY.

Nov. 24, 1942. C. C. MISFELDT 2,303,059

CONTOUR FORMING MACHINE

Filed June 4, 1940 4 Sheets-Sheet 2

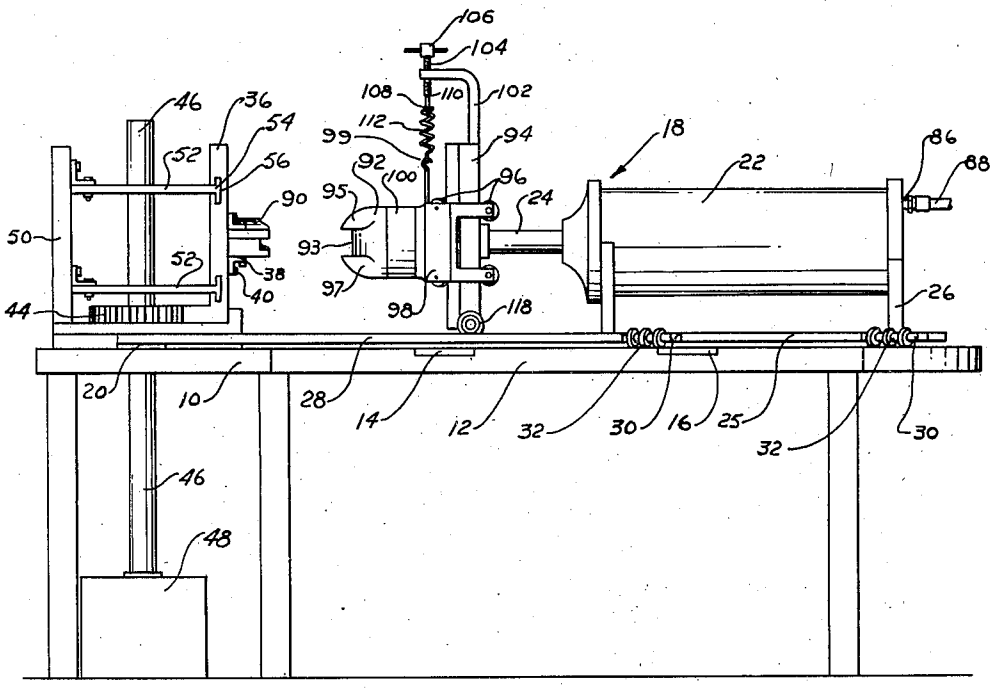


Fig. 3

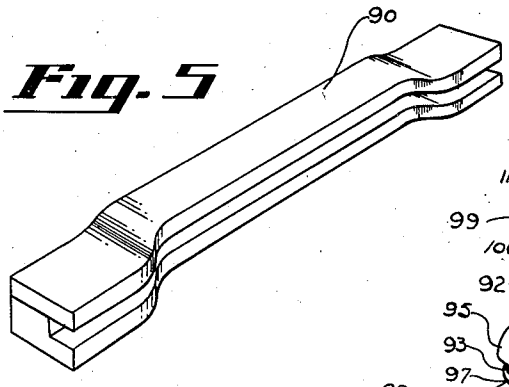


Fig. 5

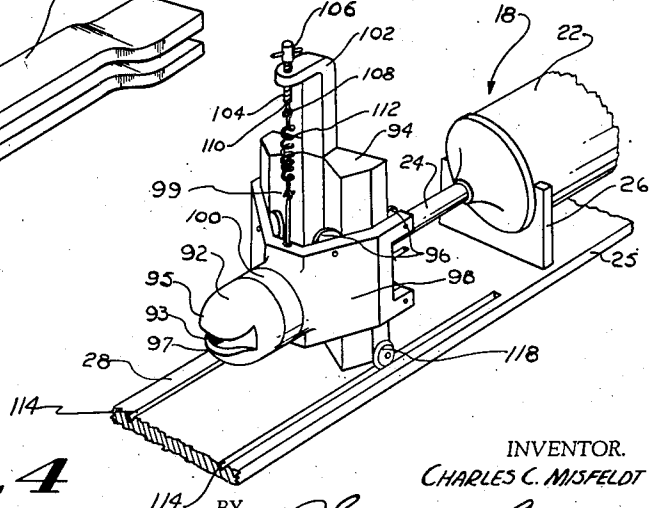


Fig. 4

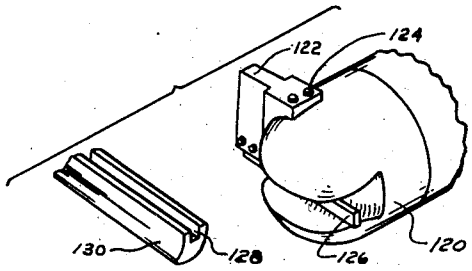
INVENTOR.
CHARLES C. MISFELDT
BY
J. Edwin Coates
ATTORNEY.

Nov. 24, 1942. C. C. MISFELDT 2,303,059

CONTOUR FORMING MACHINE

Filed June 4, 1940 4 Sheets-Sheet 3

Fig. 6



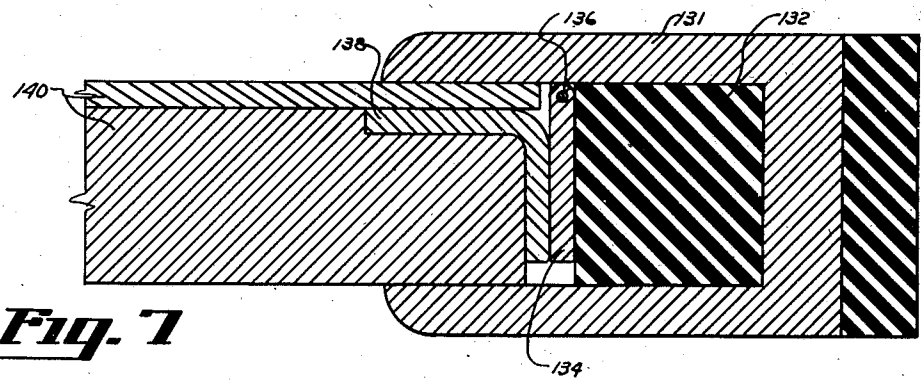


Fig. 7

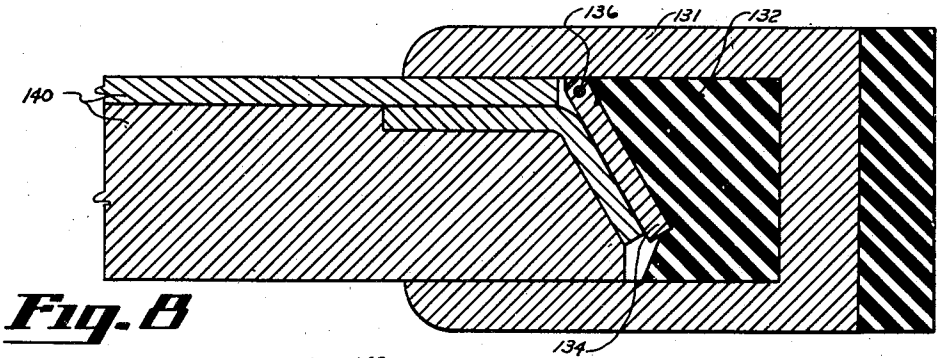


Fig. 8

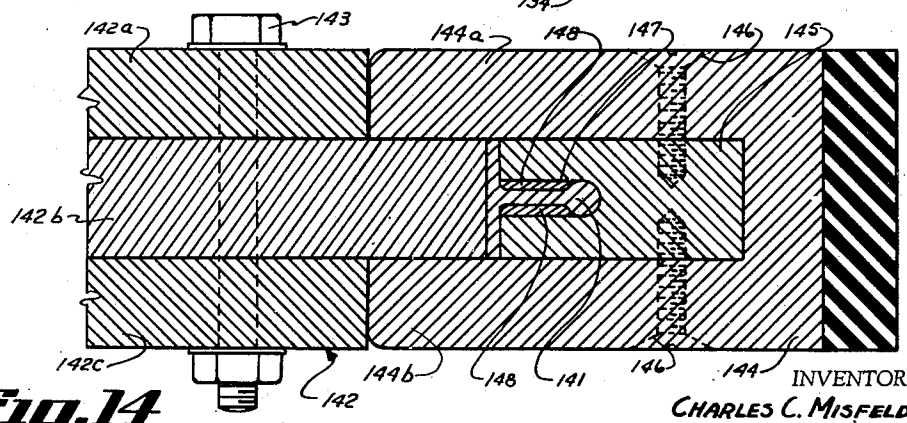


Fig. 14

INVENTOR.
CHARLES C. MISFELDT

BY J. Edwin Coates
ATTORNEY.

Nov. 24, 1942. C. C. MISFELDT 2,303,059

CONTOUR FORMING MACHINE

Filed June 4, 1940 4 Sheets-Sheet 4

Fig. 9

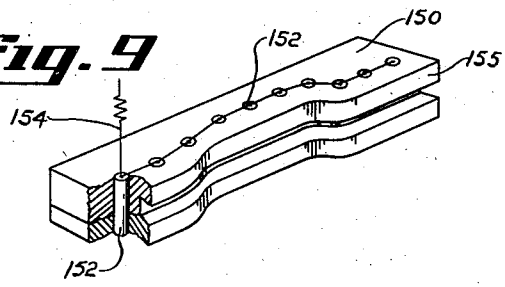
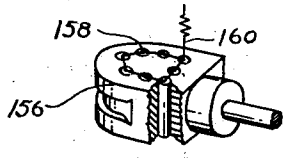


Fig. 10



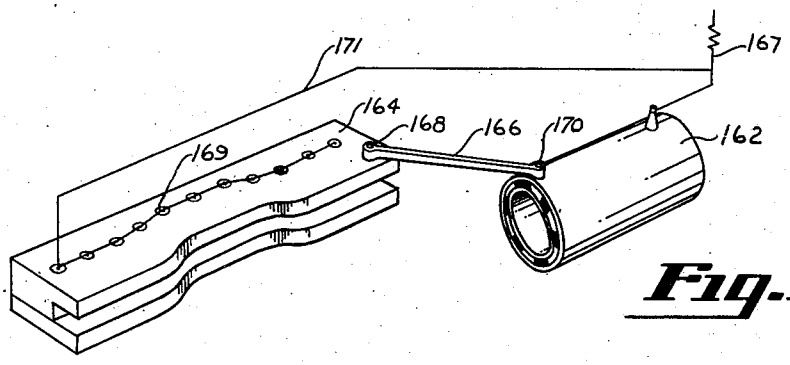


Fig. 11

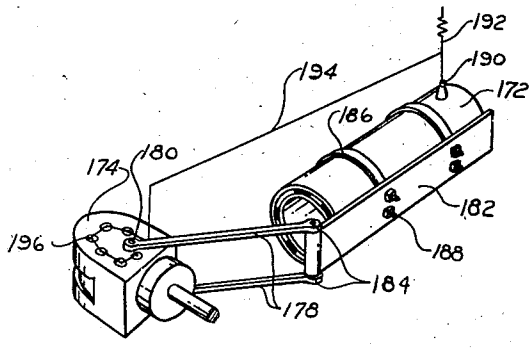


Fig. 12

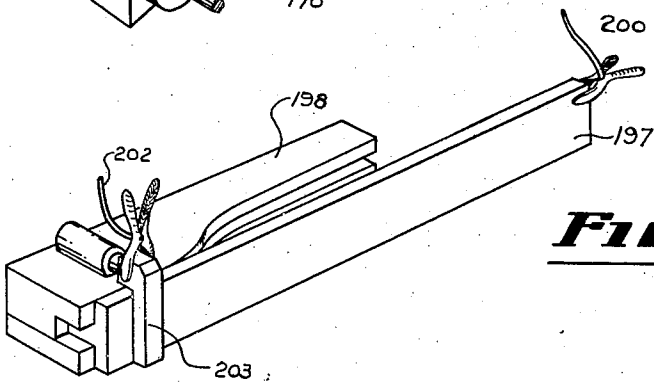


Fig. 13

INVENTOR.
CHARLES C. MISFELDT

BY J. Edwin Coates
ATTORNEY.

Patented Nov. 24, 1942

2,303,059

UNITED STATES PATENT OFFICE

2,303,059

CONTOUR FORMING MACHINE

Charles C. Misfeldt, Glendale, Calif., assignor to Douglas Aircraft Company, Inc., Santa Monica, Calif.

Application June 4, 1940, Serial No. 338,783

12 Claims. (Cl. 153—48)

My invention relates to a contour forming machine in which a piece of material may be forced to conform to the forming edge of a form block through the pressure of a yieldable pressure device.

With the machine of my invention, it is possible to form irregular and compound bends in tubular, rod, bar, extruded and sheet material without necessitating any of the laborious hand work which has previously been necessary to form such bends.

It is an important object of this invention to provide a compact contour forming machine composed of few simple parts and capable of easily and rapidly bending tubular, rod, bar, extruded and sheet material to a predetermined longitudinal contour.

Another object of the invention is to provide a contour forming machine in which a straight piece of material may be formed with a compound bend in one operation.

Another object of the invention resides in the provision of a bending machine wherein a relatively straight piece of material, preformed to a predetermined cross sectional contour, may be formed with a predetermined longitudinal contour in one operation without destroying the cross sectional contour thereof.

A still further object of the invention is to provide a contour forming machine capable of bending a relatively straight piece of material to a predetermined longitudinal contour and of forming flanges of varying angularity thereon in one operation.

A further object of this invention resides in the provision of a bending machine wherein irregular and compound bends can be formed in pieces of material and heat can be applied constantly thereto during the forming operation in order that the forming qualities of the material may be improved and the spring-back tendencies retarded.

Other and further objects will become apparent after studying the following description and the drawings in which:

Figure 1 is a plan view of my contour forming machine showing the operative relationship between a translating form block and a swingable and yieldable pressure device.

Figure 2 is a perspective view of my contour forming machine showing tracks upon which the yieldable pressure device travels in an arcuate path and showing a cutaway portion through the translating form block and a back plate therefor in order to reveal a driving mechanism for the form block.

Figure 3 is an elevational view of the contour forming machine showing a universally movable forming shoe installed on the yieldable pressure device of Figures 1 and 2 in order that compound bends on the form block may be followed thereby.

Figure 4 is a perspective view showing the details of the universally movable forming shoe which may be installed on the yieldable pressure device for forming compound bends.

Figure 5 is a perspective view of a typical form block as used for forming a compound bend in a piece of material in cooperation with the universally movable forming shoe of Figure 4.

Figure 6 is a perspective view of a forming shoe carrying a mandrel for use in forming open-sectioned pieces of material.

Figure 7 is a sectional view in elevation of a forming shoe adapted to form flanges of varying angularity and showing the shoe in the process of forming a 90° flange.

Figure 8 is a sectional view in elevation of the shoe of Figure 7 in the process of forming a flange of wider angle than that shown in Figure 7.

Figure 9 is a perspective view of a form block for use on my machine, and showing electrical elements installed therein to heat the block.

Figure 10 is a perspective view of a forming shoe for use on my machine, and showing electrical elements installed therein to heat the shoe.

Figure 11 is a perspective view of a form block having heating elements installed therein and a heating element pivoted thereto for raising the temperature of pieces of material to be formed on the block.

Figure 12 is a perspective view of a forming shoe having heating elements installed therein and a heating element pivoted thereto for raising the temperature of pieces of material to be formed on a form block, and

Figure 13 is a perspective view showing a method of applying resistance heating to a piece of material to be formed on a non-conducting form block.

Figure 14 is a sectional view in elevation of a forming shoe and form block combination for use in forming light pieces of material.

With reference now to the drawings, a table or framework upon which my machine is mounted is indicated by the numeral 10. One portion 12 of the table is substantially fan-shaped to accommodate tracks 14 and 16 upon which a yieldable pressure device 18 may roll as it swings in an arcuate path about a pivot point 20.

The yieldable pressure device includes, in the present embodiment, a compressed air cylinder 22 having a reciprocating piston 24 therein. The cylinder is mounted upon a base 25 by means of brackets 26, and a continuation of this base in the form of a radius arm 28 extends to the pivotal point 20 about which it is freely swingable. At either side of the cylinder base 24 and near the front and rear thereof, laterally extending ears 30 provide a mounting for a plurality of rollers 32. These rollers are positioned to ride on the arcuate tracks 14, 16 as the entire pressure assembly swings from side to side. As a matter of fact, the rollers are primarily for the purpose of enhancing the freely swinging movement of the pressure device, this freedom of movement being essential to the proper operation of my machine.

At the smaller end of the table 10, a contour forming block 34 is mounted for translational movement. A vertically disposed back plate 36 serves as a mounting for the block, the block being attached thereto by lugs 38 and bolts 40. On the side of the back plate 36 opposite the pressure device 18 a gear rack 42 is placed to afford a means of transmitting motion to the back plate from a driving pinion 44.

The driving pinion is fixed to a vertical shaft 46 and is adapted to be rotated in a horizontal plane both in clockwise and counterclockwise directions by an electric motor or other power supply 48 shown in Figure 3. The teeth of the pinion meshing with the rack 42 impart a translational movement to the back plate 36 and the form block 34 mounted thereon when the motor revolves the vertical shaft 46. Clockwise rotation of the shaft drives the form block 34 translationally to the left on the table. Conversely, counterclockwise rotation drives the form block to the right.

The back plate 36 is held in its vertical position and guided in its translational movement by another vertical plate 50 and a pair of spacing plates 52. The plate 50 is spaced a short distance from the back plate 36 and extends parallel thereto. The spacing plates 52 are fixed to the plate 50 in horizontally parallel relation, one above the other, and their sides opposite the plate 50 are provided with T-shaped runners or guides 54. These runners are adapted to slide in matching T-shaped grooves 56 formed in the rear face of the back plate 36 as the plate 36 translates.

On the forward side of the plate 36, and at the left end thereof, a clamping device 58 is mounted. This device is provided for the purpose of clamping an end of a piece of material such as that shown at 60 to the form block 34 before beginning the forming operation as will be later described. This clamp may be of the pneumatic type as shown, having an air supply line at 62, or it may be any conventional type of clamp.

The form block 34 as illustrated in Figure 2 is adaptable for contouring a T-shaped section of material such as the piece 60. The block is constructed in two or more pieces 64, 66 loosely bolted together by the bolts 40 and so arranged as to form a groove 68 therebetween to accommodate the stem 70 of the T-shaped piece of material 60. In forming the piece 60 to the contour of the block 34, the end 72 of the piece of material is placed between a jaw 74 of the clamp 58 and the form block 34 with the stem 70 of the T nesting in the groove 68 of the block.

The back plate 36 carrying the form block 34 is moved by counterclockwise rotation of the pinion 44 to the extreme right end of its travel. Pressure is then applied to the piece of material 60 by the pressure device 18 as will be later described and the form block 34 is moved translationally to the left until the entire forming edge of the block passes the pressure device 18.

The piston 24 of the pressure device 18 is equipped on its exterior end with a forming shoe 76 the face of which is slotted at 78 in a manner such that the forming edge of the form block 34 and the piece of material 60 may nest therein, the upper and lower flanges 80, 82 of the shoe lapping over the block. A semi-flexible connection between the shoe and the piston is obtained through the use of a connecting block 84 of a rubbery compound or the like, thus permitting the shoe proper to move relative to the piston to a slight degree.

As previously stated, the cylinder 22 is of the compressed air type in which the piston 24 reciprocates. At one end of the cylinder a port 86 is provided for the connection of an air supply line 88. It is understood that fluids other than air may be used to operate the piston and I do not wish to be limited to the use of a compressed air cylinder. In the present embodiment, air under pressure enters the cylinder through the port 86, confronts the piston and moves same outward or toward the forming block.

Assuming then, in the operation of the machine, that the forming block has been carried sufficiently to the right by the driving pinion 44 to permit the forming shoe to contact the forming edge of the block at a point just to the right of the clamp 58, it may be seen that with the piston 24 extended sufficiently to contact the forming edge at the above mentioned location, the pressure device 18 will be in a position substantially normal to the form block edge at the location of contact. Before moving the piston into contact as just mentioned, however, the end of the piece of material 60 should be placed under the clamp jaw 74 with the stem of the T nesting in the groove 68 of the form block. The clamp should then be tightened to securely grip the material to the block in the position stated.

It is now time to release air pressure to the cylinder 22 to force the piston 24 outward until the shoe 76 nests with the form block and the piece of material and exerts a pressure thereon tending to grip the material to the block. At this time, the pressure device is in a position normal to the point of contact of the shoe and the block as stated and all parts of the machine are stationary.

The next operation is to start the motor or other power supply 48 so that it will drive the shaft 46 and pinion 44 fixed thereto in a clockwise direction. Inasmuch as the pinion is in mesh with the gear rack 42, it is evident that the back plate 36 and the contour form block will be moved translationally to the left. The T-shaped runners 54 of the spacing plates 52 riding in the matching grooves 56 of the plate 36 will guide the plate in its translational movement.

As the movement begins, the contour form block and the piece of material 60 clamped thereto will move relative to the forming shoe. Looking now at Figure 2, it will be evident that the forming edge of the block takes a dip inward, or away from the forming shoe 76, at a point slightly to the right of the clamp jaw 74. Therefore, as the block 34 is moving to the left relative to the shoe 76, the shoe will necessarily be forced by the compressed air cylinder

22 to move into the dip. Inasmuch as the shoe is in flat-faced contact with the piece of material 60, the shoe following the inward dip will force the semi-flexible connecting block 84 to twist on a vertical axis. Because of the elasticity of the block 84, it will try to straighten itself out and the straightening force exerted thereby will be transmitted to the entire pressure device 18. The pressure device, being mounted on the tracks and rollers as described and being freely swingable will be forced to swing in a counterclockwise direction about its pivot point 20 until the twist in the connecting block 84 has straightened out. In this case, the pressure device will have been moved sufficiently to bring it into the same position relative to the form block edge as it was when the forming movement began or, in other words, in a position normal to the edge, thus permitting the compressed air cylinder to exert a direct forming pressure through the shoe 76 to the piece of material 60. As the forming block continues its translational movement, the shoe 76 will again be twisted back to a position parallel with the back plate 36 and this opposite twist introduced into the elastic connecting block 84 will force the pressure device 18 to be swung back about its pivotal axis 20 in a clockwise direction until it is again perpendicular to the point of forming at which location the twist in the block 84 will again have straightened out.

The remainder of the forming operation is evident. When the forming edge of the form block again curves outward another twist will occur in the block 84, thus moving the pressure device 18 still further clockwise and, as the forming edge straightens out, the device 18 will move counterclockwise until it assumes a position identical to that in which it started.

The forming shoe has now passed over the entire forming edge of the block 34 and the piece of material 60 has thereby been caused to assume the contour of the block. The motor 48 is stopped as soon as the forming is completed and the air pressure in the cylinder 22 is relieved, permitting the piston to be retracted out of contact with the form block. The clamp jaw 74 is then released and the formed piece 60 may be removed. The motor 48 is now started to move the backing plate 36, carrying the block 34, translationally to the right and the machine is ready to form another piece of material.

The relative movements just described constitute the basic operating principle of my invention and through the use of various type of form blocks and forming shoes, innumerable bends and contours can be formed easily and quickly.

For example, if it is desired to form compound bends in a piece of material a form block 90, on the order of that illustrated in Figure 5, may be used. On this block the forming edge extends horizontally a certain distance then rises, leaving its original plane, and curves inward simultaneously. After rising and curving inwardly, it again straightens out in a horizontal plane and then begins to curve outwardly, dropping down to its original starting plane. The contour of this block 90 is only exemplary of any number of compound bends which may be necessitated in solving manufacturing problems.

In forming material to such a bend as that to be had on the block 90 or similar compound bend blocks it is necessary to use a substantially universally movable forming shoe such as that shown at 92 in Figure 4. This shoe is substantially identical to the shoe 76, having a slotted face 93 and upper and lower flanges 95, 97. To make a compound bend, it is, of course, necessary that the forming shoe move both in a plurality of horizontal planes and in a vertical plane, and such a shoe is disclosed in my copending application, Serial No. 323,411, filed March 11, 1940, and will be described again here.

To attach the shoe 92 to the piston 24 for universal movement with respect thereto, a vertical track 94 is fixed to the piston. Mounted on the track through rollers 96 is a support 98 for the shoe and this support, carrying the shoe, is adapted to roll up and down on the vertical track in order that the shoe may move from one horizontal plane to another. The shoe itself is held to the support by a semi-flexible connecting block 100, similar to the block 84 described in the first embodiment. To balance the weight of the shoe and support in order that it may be readily movable, an arm 102 extends upward and forwardly from the vertical track 94 being rigidly connected thereto. At the end of the forwardly extending portion of the arm, provisions are made to accommodate a threaded rod 104 adapted to be moved upwardly and downwardly with respect to the arm by turning an adjusting handle 106. A hook 108 is pivotally connected at 110 to the lower extremity of the rod 104 and provides an attachment for an end of a tension spring 112. The other end of the spring is, in turn, connected to a hook 99 attached to the support 98.

Inasmuch as the flexible shoe mounting just described is necessarily of greater weight than the shoe mounting 76 of the first embodiment, it is advisable to redesign the radius arm 28 shown in Figures 1 and 2 to incorporate a pair of tracks 114 which may comprise merely V-shaped grooves as shown in Figure 4. Then rollers 118 having V-shaped rims to match the track grooves are mounted at the lower extremity of the vertical track 94. With this arrangement, the flexible shoe mounting will be supported on the tracks 114 and may roll back and forth thereon as the piston 24 reciprocates.

Using the universally movable shoe 92 in conjunction with the compound bend block 90 shown in Figure 5, the operation is as follows:

Assume first that the block 90 has been bolted to the back plate 36, Figure 2, in place of the block 34, and that the shoe and mounting 92 has replaced the shoe and mounting 76 as shown in Figure 3. A piece of material, such as the piece 60 is started on the block 90 and gripped thereto by the jaw 74 of the clamp 58 and the universally movable shoe 92 is moved by the piston 24 into engagement with the material and the block, exerting pressure thereon. At this time, the pressure device 18 is again in a position normal to the point of contact of the shoe and the block as described in the operation of the previous embodiment. The motor 48 is started to drive the pinion 44 thus imparting translational movement to the block 90 to move same to the left.

As the movement begins, the contour forming block and the piece of material will move relative to the forming shoe. Looking now at Figure 5 and following the movement of the pressure device 18 through the compound bend, the shoe 92 riding on the block's forming edge will twist on a vertical axis through the elastic connecting

block 100 as it enters the inward dip of the form block. Inasmuch as the forming edge also rises, the shoe, following same, will also introduce a rotative twist in the elastic block on a horizontal axis. Both twists will try to straighten out through the elastic qualities of the mounting block but only the vertical axis twist is able to succeed. This is made possible through the freely swinging qualities of the pressure device 18 pivoting about the point 20. The elastic force will pull the pressure device around to maintain the perpendicular relationship between the form block edge at the location of forming and the pressure device. This maintenance of perpendicular relationship has been thoroughly described with reference to the first embodiment making it unnecessary to repeat same here. The only new movements introduced in the forming of a compound bend are the rising and falling movements of the shoe.

As the shoe is twisted on its horizontal axis in entering the form block rise, continuation of the translational movement of the form block will force the shoe to continue rising. This introduces an upward force and consequently, the balanced shoe support 98 will roll upward on the vertical track 94 to remain in the plane of the forming edge of the block. Likewise, as the shoe starts downward on the right side of the block, a downward force will be exerted through the shoe and the support will roll downwardly. The reciprocation of the piston 24 as it follows the inward and outward turnings of the form block will, of course, cause the entire shoe mounting to roll forward and aft in the V-shaped tracks 114.

Various other accessories and adaptations readily lend themselves to use in my contour forming machine in order to widen the versatility thereof. For example, if it is desired to form pieces of material having open sections therein a mandrel on the order of that depicted by Figure 6 may be used.

In this figure, a typical forming shoe head is indicated at 120 and a small bracket 122 is mounted on the top side thereof as by screws 124. An arm of the bracket extends outwardly and downwardly from the shoe and serves as an attachment for a mandrel 126. The mandrel is of a length just sufficient to ride in a groove 128 of a typical open-sectioned piece of material 130 and to remain in the forming area at all times to prevent the groove from closing as the piece of material is bent. The mandrel is preferably constructed of laminated spring steel in order that it may be pliable to readily slide in the groove as the piece of material moves with its forming block and with respect to the mandrel and the shoe.

Another advantageous variation lies in a specially constructed forming shoe. This shoe is shown in Figure 7 and may be substituted for the shoes shown in either Figure 2 or Figure 4 when it is desired to form a piece of material having, for example, a flange, the angularity of which varies throughout the length of the piece.

Figure 7 shows a cross section of a shoe adapted for forming flanges of such varying angularity. The shoe is in the form of a yoke 131, and deep in the mouth thereof a block of elastic or rubbery material 132 is placed. A flap 134 is swingably hung on a hinge pin 136 from the top leg of the yoke and this flap constitutes the forming face of the shoe. The block 132 lies behind the flap and when in its normal uncompressed position, it maintains the flap in a vertically hanging position. In this position, the flap will properly urge in flat-faced relation against a 90° flange. A piece of material having a 90° flange is also shown in cross section at 138 together with a forming block 140 therefor.

In Figure 8, I show a cross section of the same shoe as Figure 7 but in this view, the shoe is in the process of forming a flange of lesser sharpness than the flange in Figure 7. In the drawings, the flatter angle of the forming block has forced the flop 134 to swing inward about its hinge point compressing the block 132 sufficiently to again enable the flap to maintain a flat-faced relationship to the form block 140 and the piece of material 138, both of which are again shown in cross section at another location on the form block edge.

In short, a form block adapted to form both open and closed angle flanges may be used with a shoe of this type and the shoe will automatically vary its forming face to always maintain a flat faced relationship at the point of forming.

Many times, it might be desirable to form relatively light stock bulb angles or the like on my machine. When forming material of any kind, it is always best to utilize as much pressure on the forming shoe ram as is feasible, for the reason that the bending operation is improved with respect to both the forming of the piece of material to the block and the movement of the entire pressure assembly in the maintenance of the perpendicular application of force. However, many times it might be desirable to form relatively light stock bulb angles or the like on my machine in which case, the application of high pressure might mar the light stock. This is particularly true when forming any of the softer metals such as aluminum or aluminum alloy. In order to make possible the utilization of the desirable high pressure without the danger of marring such material, I have designed a forming block and shoe arrangement whereby the high pressure forces are borne largely by the forming block itself and only a pressure sufficient to form the piece of material is applied thereto.

Such a block and shoe arrangement is shown in Figure 14 wherein a relatively light T-shaped bulb angle 141 is adapted to be formed. In forming this piece, a laminated form block 142 comprising layers 142*a*, 142*b* and 142*c* is used, held together as by a bolt 143. The central layer 142*b* thereof protrudes outwardly, beyond the vertical plane in which the edges of the other two layers 142*a* and 142*c* lie. The forming shoe 144 used with this type of block is shaped similarly to those previously described, upper and lower portions 144*a* and 144*b* thereof being spaced to accommodate the protruding portion of form block layer 142*b* therebetween, and being adapted to squarely abut the edges of the upper and lower form block layers 142*a* and 142*c*. For forming the particular T-shaped bulb angle 141 shown in the drawings, a filler block 145 is placed in the mouth of the forming shoe and is held therein as by screws 146. A U-shaped cut is formed throughout the left face of the block at 147 and the radius at the bottom of the U is of a size permitting the bulb of the angle 141 to nest therein. Likewise the depth of the U is just sufficient to permit the T-portion of the angle to rest against the face of the filler block and still maintain the nesting relation between the bulb and the radius at the bottom of the U. The relation between the meeting points of the protruding layer of the forming block and the T-portion of

Search Room

the angle as it is held thereagainst by the filler block, and the meeting points of the shoe portions 144a and 144b with the upper and lower form block layers 142a and 142c is such that the major portion of the pressure exerted by the shoe is distributed over the large contact area at these meeting points just mentioned, and only pressure in an amount sufficient to hold the angle 141 snugly in position for forming is applied thereto by the filler block of the shoe. Thus a high pressure condition is utilized to enhance the operation of the bending machine in general and only a relatively low pressure is used in the actual contact with the piece of material to be formed, thereby precluding the marring thereof.

On pieces of material of certain cross-sectional configuration, it may be desirable to use a mandrel together with the forming shoe to aid in properly holding the piece in position. If such is desired, a flexible mandrel, or pair of mandrels 148 somewhat as previously described may be inserted in the filler block 145 around the piece being formed as shown in the drawings. The mandrel is carried by the shoe as before and merely slides with respect to the angle 141 as the shoe moves relative to the form block.

In forming metal to form blocks having certain contours, spring-back difficulties often arise necessitating either precise spring-back calculations in the design of the block or the application of heat to the piece of material being formed in order to increase the ductility and forming qualities thereof.

In addition, it is difficult to form metal of various non-ferrous alloys such as "Dowmetal," magnesium alloys and certain aluminum alloys without applying heat thereto.

Inasmuch as it is desirable to keep tooling costs as low as possible in any line of manufacture, the use of precisely calculated form blocks must be discarded as a solution to the spring-back problems, thus leaving the use of heat as the proper method of compensating spring-back correction. Fortunately, the use of heat also widens the usefulness of the contour forming machine in that it immediately permits the forming of the above mentioned non-ferrous alloys.

Various methods of applying heat to my contour forming machine and to the material to be formed are illustrated in Figures 9 through 13.

If the form block is of metal such as the block 150 illustrated in Figure 9, a plurality of interconnected heating elements 152 may be imbedded in the block and grounded thereto. The current is supplied by means of a wire 154 connected to any suitable electrical supply, not shown. It is of course, preferable that the elements 152 be installed as closely as possible to the forming edge 155 of the block in order that the face may be heated quickly. A conventional rheostat or thermostatic control can be readily applied so that the block may be manually or automatically maintained at any desired forming temperature.

In Figure 10 I have shown an electrically heated shoe 156 suitable for attachment to the yieldable pressure device 18 either through the connection 84 or the universal support 98. Here, again, a plurality of interconnected heating elements 158 are imbedded in the shoe and supplied with electrical current by a wire 160.

In order that the piece of material to be formed may be heated, I provide, in Figure 11, a cylindrical heating unit 162. The unit is pivotally connected to an end of a form block 164 in the manner of a pantograph arm, comprising a rod 166 pivoted to the block 164 at 168 and to the unit 162 at 170. This means of attachment permits freedom of movement of the heating unit with respect to the block. The piece of material to be formed is fed through the heating unit and heated thereby as it passes therethrough just prior to being forced into contact with the edge of the form block by the forming shoe of the machine. Thus it may be seen that any whipping of the piece of material occasioned by the movement of the shoe following the contour of the forming edge of the block may cause a corresponding movement of the heating unit by reason of its flexible mounting.

The cylindrical heating unit 162 may comprise a steel tube suitable for induction heat, a steel tube suitable for resistance heat, or a steel tube wound with nichrome wire or the like to serve as a heating element. The electrical current is supplied to the unit by a wire 167 and to the form block elements 169 by a wire 171.

In Figure 12, I have shown a cylindrical heating unit 172 which is similar to the unit 162. In this embodiment the unit is carried by the forming shoe 174 and is adapted to move relative thereto by reason of a pantograph arm connection comprising a pair of parallel links 178 pivoted both to the shoe at 180 and to a supporting piece 182 at 184. The support 182 serves as an attachment for the heating unit which is held thereon by straps 186 bolted to the support at 188.

The material to be formed is fed through the heating unit 172 in the same manner as that described for the embodiment of Figure 11 and the pivoted links 178 permit the unit 172 to move relative to the forming shoe 174 as the shoe follows the contour of a form block edge. In this embodiment, the electrical current is supplied to the heating unit at 190 from a wire 192, and a branch wire 194 leads to heating elements embedded in the shoe proper.

Figure 13 illustrates a method of applying resistance heating to a piece of material 197 to be formed. If the form block is of non-conducting material such as the block 198 two electrical wires 200, 202 are used, the wire 200 being clamped to an end of the piece of material and the wire 202 being fastened to the clamp 203 which holds the piece 197 to the form block. This type of heating is satisfactory only for relatively small pieces of material and it is necessary that the forming shoe be of higher resistance material than the piece being formed in order to prevent the electrical current from "bypassing" through the shoe. In addition, it will be necessary to insulate the shoe from the rest of the machine.

In all the embodiments where heat is used in forming, it is preferable that the form block, forming shoe and piece of material to be formed be of substantially the same temperature but this is not absolutely essential because forming of some pieces of material may be done satisfactorily as described, on a wooden form block, using a high resistance, insulated forming shoe.

A sample of the versatility of my machine through the use of accessories has been shown and described and other variations will become apparent to those skilled in the art after understanding my invention.

I claim:

1. In a machine for contouring a piece of material, a movable form block having an irregular forming edge to which said piece of ma-

terial is formed, and reciprocable yieldable means for urging said piece of material in contact with said forming edge, the irregular contour of said edge reciprocating said last named means as said form block moves, said yieldable means being mounted to swing in an arc about a fixed point, said point being located substantially at the point of forming contact.

2. In a machine for contouring a piece of material, a translatable form block having an irregular forming edge to which said piece of material is formed, means to move said form block in translation with respect to said machine, and reciprocable yieldable means for urging said piece of material in contact with said forming edge, said last named means being mounted to pivot about a fixed axis close to the point of forming and adapted to be reciprocated by the irregular contour of said edge as said form block moves translationally, and simultaneously swung in an arc about said point of forming in order to maintain a position substantially normal to any portion of said form block forming edge with which said means is in contact.

3. In a machine for contouring a piece of material, a translatable form block to which said piece of material is formed, means to move said form block in translation with respect to said machine, a shoe for said piece of material and holding it against said form block, and a freely swinging yieldable means for urging said shoe against said piece of material, said yieldable means including an arm mounted to swing about a fixed point close to the point of contact between said shoe and said material.

4. In a machine for contouring a piece of material, a translatable form block having an irregular forming edge to which said piece of material is formed, means to move said form block in translation with respect to said machine, reciprocable yieldable means for urging said piece of material in contact with said forming edge, said means being reciprocated by the irregular contour of said edge as said form block moves translationally, and supporting means mounted on a fixed pivot and carrying said first named means in a substantially arcuate path about said point of forming to maintain the longitudinal axis of said first named means substantially normal to said forming edge at said point of forming.

5. In a machine for contouring a piece of material having a hollow portion extending substantially throughout its length, a translatable form block having an irregular forming edge to which said piece of material is formed, means to move said form block in translation with respect to said machine, reciprocable yieldable means for urging said piece of material in contact with said forming edge, said means being reciprocated by the irregular contour of said edge as said form block moves translationally, pivoted supporting means carrying said first named means in a substantially arcuate path about a fixed point substantially at said point of forming to maintain the longitudinal axis of said first named means substantially normal to said forming edge at the point of forming, and means serving as a mandrel riding in the hollow portion of the piece being formed to prevent said hollow portion from closing during the forming operation, said last named means being carried by said yieldable means.

6. In a machine for forming a compound bend in a piece of material, a translatable form block having an irregular and nonplanar forming edge to which the piece of material is formed, means to move said form block in translation with respect to said machine, a shoe for holding said piece of material in contact with said forming edge, yieldable means for urging said shoe toward said form block, and resilient means forming a flexible connection between said shoe and said yieldable means whereby said shoe may move both with said means and universally with respect thereto as said shoe follows the irregular forming edge of said translationally moving form block.

7. In a machine for forming a compound bend in a piece of material, a translatable form block having an irregular and nonplanar forming edge to which the piece of material is formed, means to move said form block in translation with respect to said machine, a shoe for holding said piece of material in contact with said forming edge, yieldable means for urging said shoe toward said form block, means mounting said shoe on said yieldable means for horizontal, vertical and rotative movement with respect thereto, and pivotal means carrying said yieldable means in a substantially arcuate path about said forming contact to maintain said yieldable means in a position substantially normal to said forming edge at said forming contact as said form block moves translationally, carrying said irregular forming edge past said forming shoe.

8. In a machine for forming a compound bend in a piece of material, a translatable form block having an irregular and nonplanar forming edge to which the piece of material is formed, means to move said form block in translation with respect to said machine, resilient pressure applying means for forcing said piece of material to conform to said forming edge and pivoted means carrying said pressure means whereby said pressure means may move with respect to said form block to apply force in a direction substantially normal to the forming area on said irregular and nonplanar forming edge as said form block moves translationally.

9. In a machine for contouring a piece of material, a form block having a forming edge of non-uniform contour to which said piece of material is formed, yieldable means for urging said piece to be formed against said forming edge, means for moving said form block with respect to said yieldable means, and means carried by said yieldable means and movable therewith and with said piece of material during said forming operation to heat said piece of material and thus to improve the forming qualities thereof, movement of said heating means being effected by movement of said piece of material.

10. In a contour forming machine in which a piece of material is forced to assume the contour of a form block carried by said machine, a pressure exerting shoe adapted to urge said material against said form block, and means mounting said shoe in pressure exerting position comprising a support member and resilient means connecting said shoe to said support member to provide universal movement therebetween.

11. In a contour forming machine in which a piece of material is forced to assume the contour of a form block carried by said machine, a pressure exerting shoe adapted to urge said material against said form block, and means mounting said shoe in pressure exerting position comprising a first support member, a second support member carried by and vertically movable with

Search Room

respect to said first support member, and means connecting said shoe to said second support member for universal movement with respect thereto.

12. In a machine for forming a strip of material with a flange of varying angularity; a movable form block having a forming edge of varying angularity and a shoe for holding said strip of material against said forming edge, said shoe comprising upper and lower fixed jaws of substantially rigid material, a relatively movable member of substantially rigid material extending between said jaws and adapted to press against said strip, and resilient means carried by said shoe to yieldingly urge said member against said strip in accordance with the angularity of said forming edge.

CHARLES C. MISFELDT.