

May 14, 1946.

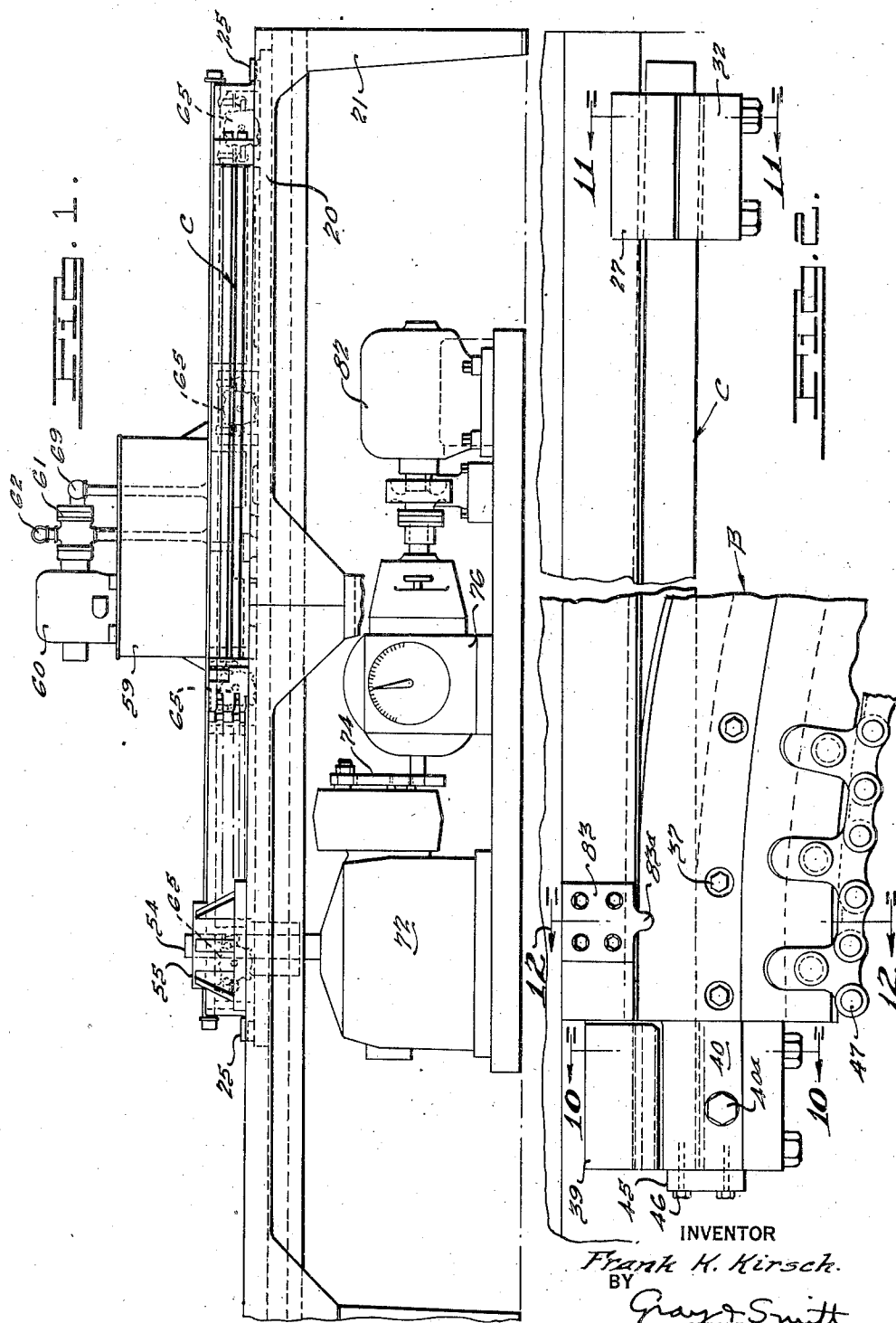
F. K. KIRSCH

2,400,151

BENDING MACHINE

Filed June 25, 1942

4 Sheets-Sheet 1



INVENTOR

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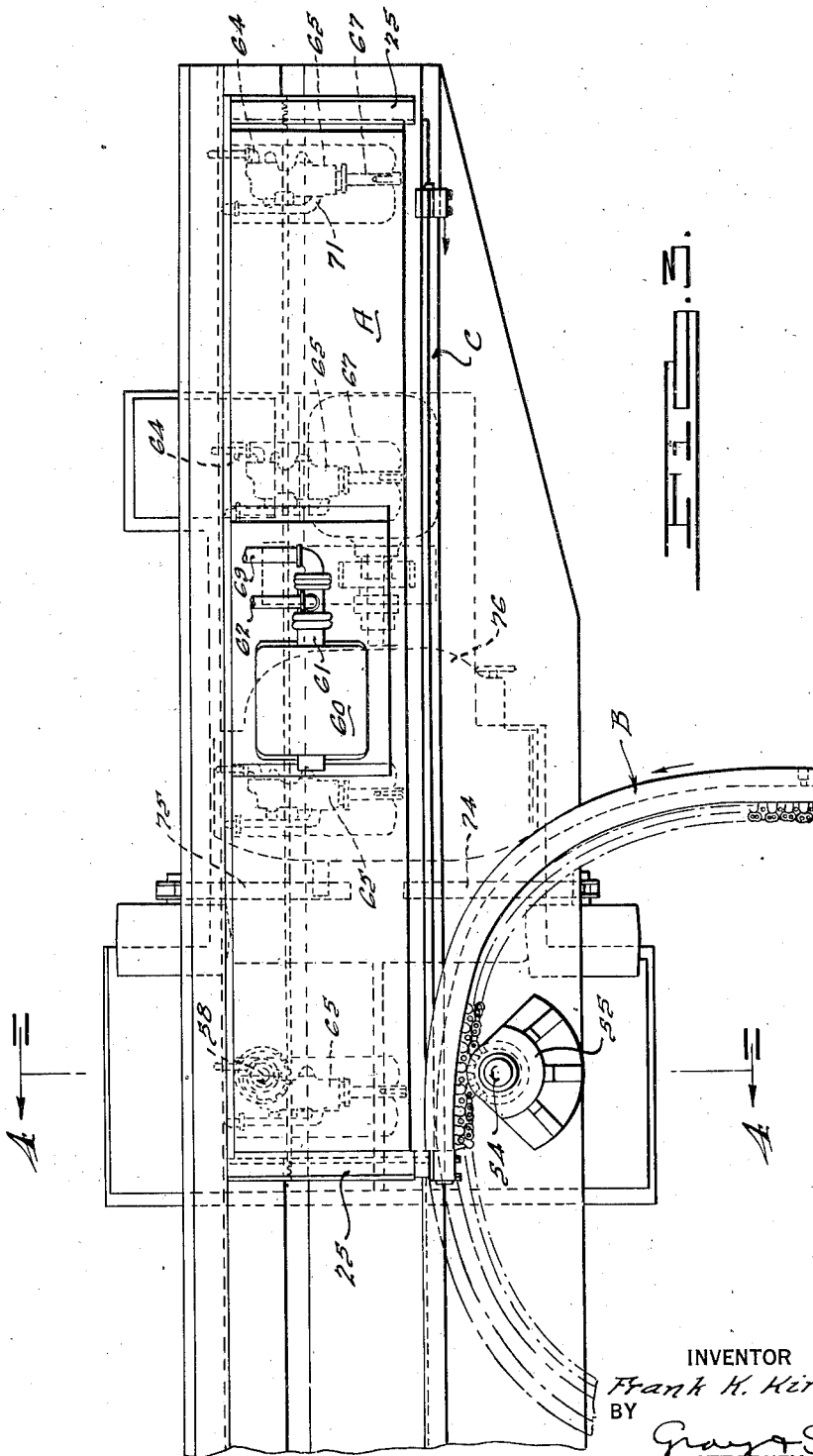
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4 Sheets-Sheet 2



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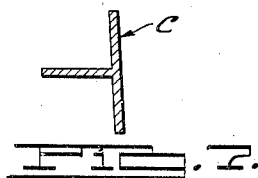
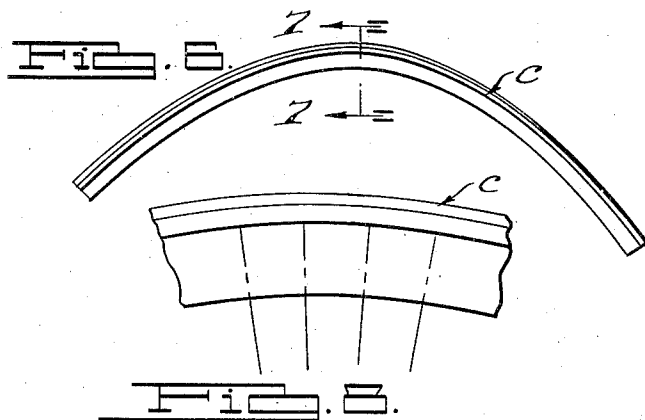
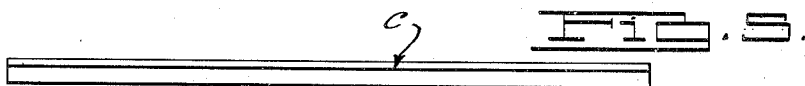
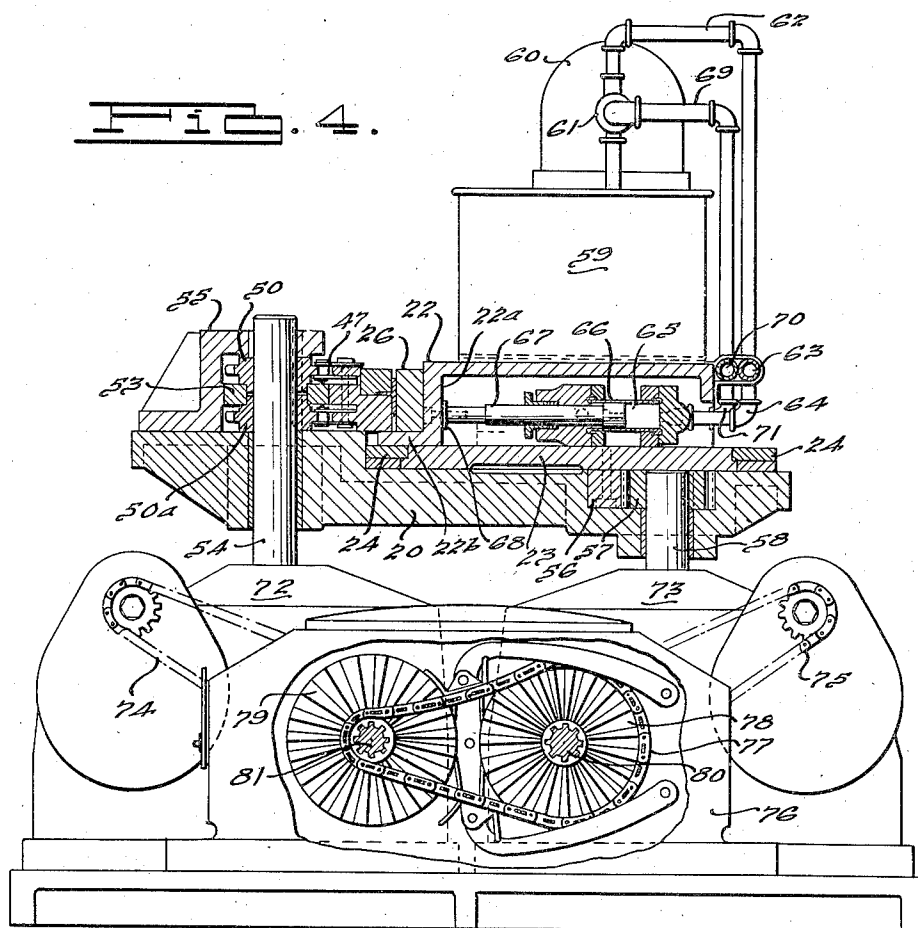
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BENDING MACHINE

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4 Sheets-Sheet 3



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BENDING MACHINE

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4 Sheets-Sheet 4

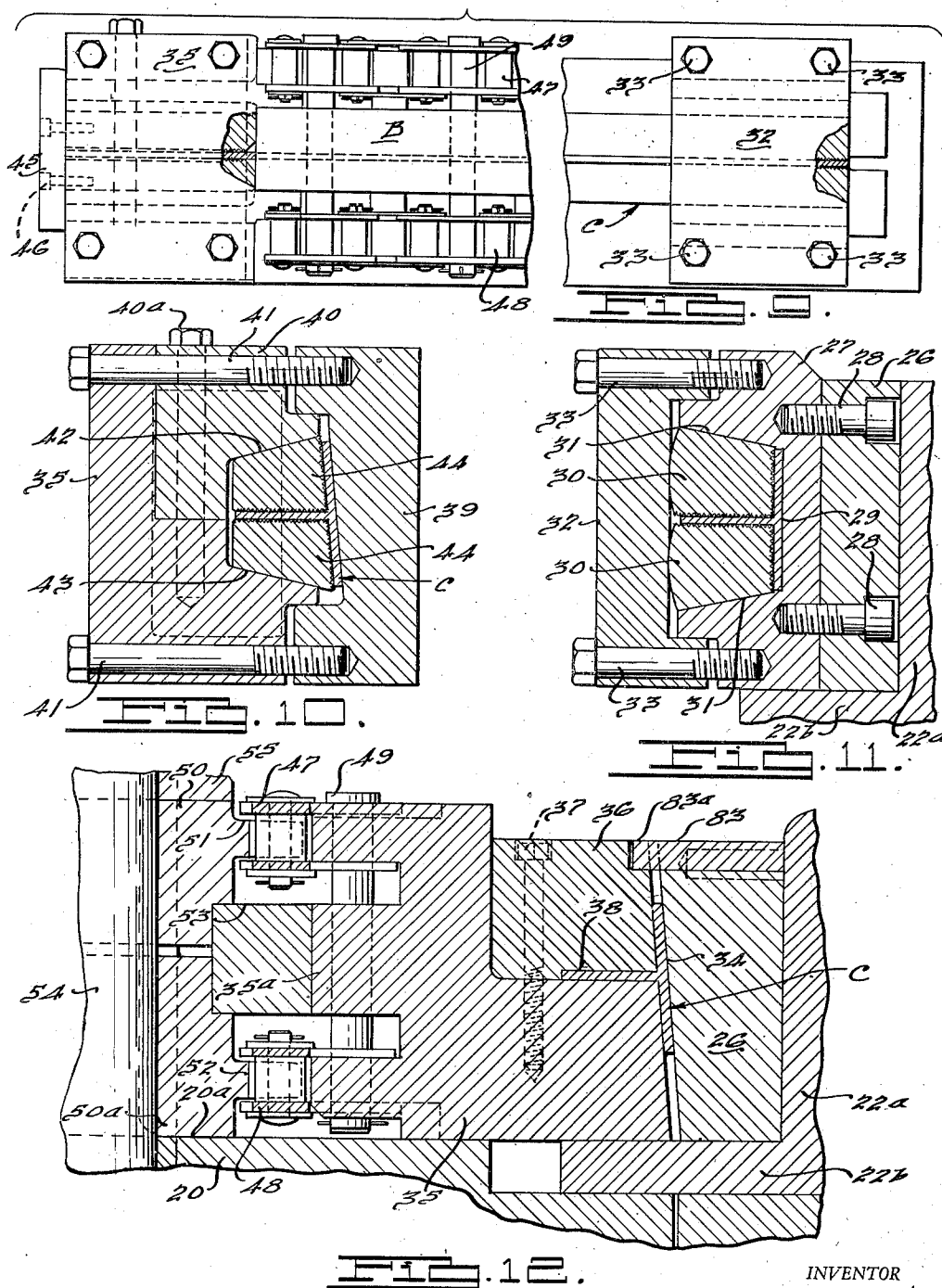


FIG. 12.

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2,400,151

BENDING MACHINE

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Application June 25, 1942, Serial No. 448,335

19 Claims. (Cl. 153—32)

This invention relates to the bending of metal and particularly lengths or strips of metal of various cross-sectional shapes or configurations, such as angles, channels, T sections, Z sections, as well as flat metal strips which are to be bent in the plane of the strips. The invention is especially applicable to the bending of any metal shapes where the metal strip or other piece is to be bent angularly, such as from a straight form to a curved form, and where ordinarily compressive stresses are set up in the member during the bending operation which tend to produce wrinkles, puckers or the like.

An object of the invention is to provide an improved machine for bending metallic members or sections of various cross-sectional shapes or configurations and in which the metal is subjected to a stretching action in such way as to eliminate the introduction of compressive stresses in the metal fibers and the formation of wrinkles, folds, puckers or the like, and also to eliminate or reduce materially any tendency of the metal to recoil or spring back thereby not retaining its desired bent shape and not taking the permanent set which is desired.

A further object of the invention is to provide a machine for bending metal strips or the like wherein a forming member is moved in a curvilinear path with respect to the strip to be bent which in turn is moved by a carrier in a path tangential with respect to the path of travel of the forming member, the strip being gripped at opposite ends by the forming member and the carrier and the rate of travel of the forming member being greater than that of the carrier thus causing the strip to be bent on the forming member and also stretched in its length in such manner as to avoid compressive stresses resulting in the accumulation of metal along the inner edge of the bent strip.

A further object of the invention is to provide a means for bending a metal strip, especially one that is irregular in cross-section, which consists in gripping one end portion of the strip in a forming member and causing the forming member to move in an angular path to wrap the strip thereon while the opposite end portion of the strip is retained and caused to travel toward the forming member at a different rate of speed than that of the forming member.

Another object of the invention is to provide a bending machine for metal strips or the like comprising a forming or bending member and a carrier member, each adapted to be attached to the metal strip, and in which these members are

fed or caused to travel angularly with respect to each other and at differential speeds whereby the strip is bent upon the forming member under tension with the elimination of any wrinkle or fold formations.

Still a further object of the invention is to bend a metal strip, such as one that is angular or irregular in cross-section, into a curved shape and in performing this operation to stretch the metal strip progressively along the outer edge portion of the strip thereby producing a smoothly bent strip free from wrinkles along the inner edge portion thereof.

Another object of the invention is to provide a machine for accomplishing the foregoing comprising two slides adapted to be clamped to opposite ends of the work piece or metal strip and shiftable along angularly related paths one tangential to the other and wherein means is provided for moving one slide at a different rate of speed than the other slide.

Another object of the invention is to provide a machine for bending a metal strip on a curve in a given plane while at the same time stretching or elongating portions of the strip to avoid wrinkles or folds during the bending operation and wherein the construction of the machine is such as to permit shaping of the strip during the bending operation.

A further object of the invention is to provide a metal strip bending and stretching mechanism of the foregoing type which is relatively simple and compact in construction, efficient in operation, durable and relatively easy to operate.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is a front elevation, partly broken away of a machine embodying the present invention and adapted to carry out the herein described method.

Fig. 2 is an enlarged fragmentary plan view of a portion of the bending mechanism.

Fig. 3 is a plan view of the machine illustrated in Fig. 1.

Fig. 4 is an enlarged section taken substantially through lines 4—4 of Fig. 3 looking in the direction of the arrows, parts not on the section line being shown in elevation.

Figs. 5 and 6 are views, respectively, of a metal strip before and after it has been bent.

Fig. 7 is an enlarged section taken substan-

tially through lines 7—7 of Fig. 6 looking in the direction of the arrows.

Fig. 8 is a fragmentary view showing diagrammatically the manner in which the bending and stretching action takes place.

Fig. 9 is an enlarged fragmentary elevation showing the clamping or gripping devices adapted to be secured to opposite ends of the strip preparatory to the bending operation.

Fig. 10 is an enlarged section taken substantially through lines 10—10 of Fig. 2 looking in the direction of the arrows, this view illustrating the device for clamping the front or leading end of the strip.

Fig. 11 is an enlarged section taken substantially through lines 11—11 of Fig. 2 looking in the direction of the arrows, this view illustrating the device for clamping the rear or tail end of the strip.

Fig. 12 is an enlarged section taken substantially through lines 12—12 of Fig. 2 looking in the direction of the arrows.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring to the drawings, wherein I have illustrated, by way of example, one embodiment of the present invention, the machine therein shown comprises in general two main slides movable in predetermined angularly related paths for the purpose of bending a metallic strip to the desired shape while stretching the metal so as to eliminate any folds, wrinkles or the like which are likely to be formed on account of the setting up of compressive strains at certain localities of the strip. In the present machine a metal strip C of general T-shape in cross-section is bent into a curved shape and this bending takes place in the plane of the central web of the strip, see Figs. 5 to 7 inclusive. The machine comprises what may be termed a work piece carrying slide A which is adapted to clamp the tail end of the work piece, and also what may be termed a forming slide B which is adapted to clamp the forward or leading end of the metal strip. The work piece carrying slide is of duplex construction so that it may be shifted transversely to clamp the work piece against the forming slide at the tangential point of engagement of the two slides. Mechanism is provided for shifting the work piece carrying slide in a rectilinear path tangential to the curvilinear path of travel which is imparted by suitable mechanism to the forming slide. The mechanism for shifting the two slides is controlled through both a speed reducing means as well as a variable speed mechanism whereby the forming slide is adapted to travel in its curvilinear path at a greater rate of speed than the speed of travel of the work piece carrying slide. As a consequence, as the two slides move forwardly together, one tangentially with respect to the other, the metal strip is in effect wrapped upon the curved forming slide, and due to the differential speed between the two slides the metal strip will be stretched progressively. The amount of stretching is not uniform across the width of the strip, the greatest amount of stretching or elongation taking place along the outer edge of the

curved strip and the least amount of stretching occurring along the inner edge of the curved strip, this being illustrated in Fig. 8.

The present machine comprises a suitable table or bed 20 supported above the floor by means of legs 21. The work piece carrying slide A in the present instance comprises two slide members or plates 22 and 23. The upper slide plate 22, which is adapted to be shifted transversely on the lower slide plate 23, see Fig. 4, is hollow and spaced from the bottom slide plate 23 by means of a vertical wall 22a terminating in a bottom flange 22b which rests upon the slide plate 23. The plate 23 is adapted to slide longitudinally upon the table or bed 20 in ways 24. The cross slide plate 22 is adapted to be shifted transversely upon the plate 23 and is guided in this movement by ways 25, see Figs. 1 and 3.

Bolted to the outer face of the wall 22a of the slide plate 22 is a pressure plate or member 26. This pressure plate is of sufficient height to engage fully the upright flange of the metal strip C and has its lower edge resting upon the bottom flange 22b of the slide 22. The rear end of the pressure plate 26 is provided with a device for clamping the tail end of the metal strip C, the construction of this clamping device being particularly illustrated in Fig. 11. A block 27 is bolted at 28 to the face of the member 26 and is formed with a cavity having a vertical wall 29 against which the flange of the metal strip fits and also having tapering top and bottom walls 31 against which a pair of wedge-shaped clamping blocks 30 engage. The clamp device also comprises an outer clamping member 32 adapted to be secured to the clamping block 27 by bolts 33. The angular faces of the wedge blocks 30 may be serrated, as shown in Fig. 11, so as to grip more effectively the end of the strip C. After insertion of the end of the strip in the block 27 the bolts 33 may be tightened to force the clamping member 32 against the ends of the wedge blocks 30 and force them tightly into the cavity in the block 27 so as to firmly grip the end of the metal strip.

In the present machine the pressure plate 26 is constructed so as to shape the metal strip C by bending the flange of the strip angularly with respect to the web, as shown by comparing Figs. 10 and 11. Accordingly, the wall 34 of the pressure plate 26 is gradually tapered from its rear end toward the front end thereof and at the point of engagement of the two slides A and B, shown in Fig. 12, where the slide A is tangent to the slide B, the wall 34 of the pressure member 26 extends at a desired angle with respect to the perpendicular. As later described, operation of the cross slide to clamp the work piece between the two slides produces the angular bend of the work piece as illustrated.

The forming slide B comprises a curved slide bar or member 35 which is shaped at its face adjacent the slide A in accordance with the final shape of the work piece. This member is cut away to receive a strip 36 which is rigidly attached to the member 35 by bolts 37. The bottom of the strip 36 is formed with a notch 38 providing a recess within which the web of the metal of the work piece fits. The strip 36 and member 35 engage the flange of the work piece as well as the web thereof, as seen in Fig. 12, so as to hold the piece firmly in position during the bending operation.

The forming member 35 terminates at its forward end in a device for clamping or gripping

the leading end of the metal strip C. As illustrated in Fig. 10, this clamping device comprises a clamping block 39 located beyond the end of the member 26 when the parts are positioned, as shown in Fig. 2, at the beginning of an operation. The clamping block 39 is recessed to provide an inclined wall engageable with the flange of the work piece. Mounted in a notched portion of the member 35 is a block 40. The member 35 together with the block 40 is adapted to be secured to the clamp block 39 by bolts 41. The members 40 and 35 are provided with complementary recesses 42 and 43 which together form a cavity adapted to receive a pair of wedge blocks 44 engageable with the inclined walls of the cavity. Upon tightening the bolts 41 it will be understood that the end of the metal strip C will be clamped between the clamping block 39 and the wedge blocks 44, the latter preferably having serrated surfaces so as to effectively grip the surfaces of the metal strip. A cap or end plate 45 bolted at 46 to the members 40 and 35, see Fig. 2, may be provided for the purpose of holding the wedge blocks 44 in proper position with respect to the other parts of the clamp assembly.

The forming slide comprising the members 35 and 36 may be driven through the medium of a suitable sprocket and chain mechanism. In the present instance, as illustrated in Figs. 4 and 12, this drive comprises upper and lower sprocket chains 47 and 48 of any conventional type secured to the inner face of the forming member 35 by means of pins 49. The chains 47 and 48 are driven by upper and lower sprocket wheels 50 and 50a, the upper sprocket having teeth 51 meshing with the chain 47 and the lower sprocket having teeth 52 meshing with the chain 48. The intermediate hub portions of the sprockets 50 and 50a are recessed to receive a thrust bearing ring 53 which at one side engages a portion of a bracket 55 bolted to the bed 20 and at the other side engages a thrust portion 35a of the forming member 35. Thus, transverse pressure exerted by the pressure plate 26 against the flange of the work piece and thence transmitted to the forming member 35 is in turn transmitted to the fixed bracket 55 secured rigidly to the bed 20 of the machine. The bracket 55 is in the form of a housing having an upper portion overlying the sprockets and providing a bearing for the upper sprocket. This bracket has a hole to receive the upper end of a shaft 54 to which the sprockets 50 and 50a are keyed.

The slide plate 23 is adapted to be shifted in a straight line path, being guided in its reciprocating movement by the ways 24. This is accomplished in the present instance by a suitable rack and gear mechanism. Bolted to the underside of the slide plate 23 is a rack 56 and meshing with the teeth of this rack is a gear 57 secured to a vertical shaft 58 extending through the bed 20 of the machine. The rack 56 and gear 57 are suitably housed within a recess in the bed, as illustrated in Fig. 4. Thus rotation of the gear 57 in either direction will drive the rack 56 forwardly or rearwardly, thus imparting a rectilinear forward or rearward movement to the slide plate 23 and hence to the upper cross slide plate 22 which carries the pressure member 26 and the rear clamping device for the work piece.

Mounted upon the slide plate 22 is a control box 59 upon which is mounted a suitable hydraulic pump 60. Fluid is discharged by the pump under pressure through a pipe 61. A pipe 62 leads from the pipe 61 to a distributing pipe 63

extending along the rear side of the slide 22. Leading from the distributing pipe 63 at spaced intervals along the length of the slide 22 are pipes 64, each of which is connected and communicates with a hydraulic cylinder 65 housed beneath the slide 22 and supported upon the bottom slide plate 23, see Fig. 4. Reciprocable within each cylinder 65 is a piston 66 connected to a piston rod or plunger 67 which in turn is secured at its outer end at 68 to the wall 22a of the slide plate 22. Also communicating with the pipe 61 leading from the hydraulic pump is a pipe 69 which opens into a distributing pipe 70 parallel to the pipe 63 and in like manner communicating with a series of pipes 71 leading to the cylinders 65. The pipes 71, however, communicate with the cylinders 65 at the sides of the pistons 66 opposite to the pipes 64. Thus, when fluid under pressure is introduced into pipes 62, 63 and 64 the pistons 66 will be shifted forwardly thereby shifting the slide plate 22 toward the forming member 35, as illustrated in Fig. 4. The slide plate 22 may be reciprocated or shifted away from the forming member by introducing the fluid under pressure through the piping 69, 70 and 71, thus shifting the pistons 66 in the opposite direction within the cylinders 65.

The shaft 54, which drives the sprocket and chain mechanism 50, 50a, 47 and 48, is in turn driven from a speed reducing mechanism generally indicated at 72. In like manner, the shaft 58, which shifts the slide plates 22 and 23 longitudinally through the medium of the rack and gear mechanism 56 and 57, is driven from a suitable reducing mechanism 73. The speed reducing mechanism 72 and 73 may be of any suitable type and, therefore, no detailed description thereof is deemed necessary herein. The speed reducing mechanisms 72 and 73 receive their power from a suitable variable speed mechanism indicated in general by the reference numeral 76. The drive from the variable speed mechanism 76 to the speed reducing units 72 and 73 is accomplished respectively through chain drives 74 and 75, see Fig. 5. The variable speed mechanism by which shaft 54 may be rotated at a different speed than shaft 58 and whereby the differential speeds of these shafts may be changed or varied at will, may be of any commercial or conventional type. In the present instance the variable speed unit 76 is of the Link-Belt P. I. V. type, well known in the art. This unit comprises a self-pitching chain 77, the teeth of which engage mating radially grooved conical wheels 78 and 79 located on and secured to shafts 80 and 81. Change in speed is effected by moving suitable horizontal levers inwardly and outwardly by manually or mechanically turning a control screw (not shown). This brings one pair of wheels together, causing chain engagement farther from the shaft, and spreads the other pair of wheels apart, causing chain engagement closer to the shaft. The speed of the output shaft is governed by the ratio of the effective diameters of the two pairs of wheels 78 and 79, as is well known in the art. By the use of this mechanism a considerable variety of speeds may be obtained, namely, the relative speeds of the shafts 80 and 81 may be considerably varied. Since the chain 75 is driven from the shaft 80 and the chain 74 is driven from the shaft 81, it will be seen that the reduction gear units 72 and 73 may be driven from the variable speed unit 76 at different speeds, hence producing a differential speed of rotation of the shafts 54 and 58. The variable

speed unit 76 is powered from an electric motor 82, see Fig. 1.

In operation it will be understood that the straight strip C is first clamped in position at opposite ends in the clamping devices above described and illustrated in Figs. 10 and 11. To facilitate determination of the proper relative position of the slides at the starting point a gauge piece 83 may be fastened as by means of screws to the member 26. This gauge has a tooth 83a adapted to fit into a notch in the member 36, the tooth and notch being positioned so as to mesh at the starting position of the slides. After the piece has been clamped at opposite ends fluid under pressure is introduced through pipes 64 into the hydraulic cylinders 65, four being illustrated in the present instance, thus shifting the pistons 66 and hence the cross slide plate 22 and facilitate determination of the proper relative position causing the work piece C to be clamped tightly under pressure between the pressure member 26 and forming member 35, 36. In view of the inclined walls of these members the flange of the strip or work piece C will be correspondingly shaped and this inclined shape will be imparted to the flange progressively as the strip is fed forwardly by the slides and progressively wrapped on the forming slide. Since the rate of speed of the latter is a calculated amount greater than the rate of rectilinear travel of the slide plates 22, 23 the web of the strip C as well as the flange thereof will not only be bent in accordance with the curve of the forming slide but will be stretched as illustrated in Fig. 8, thus eliminating all wrinkles and producing a smoothly bent piece free from any compressive strains in the metal fibers.

I claim:

1. In a bending machine, a curved forming slide, a second slide arranged tangentially with respect to the forming slide, means for releasably attaching longitudinally spaced portions of a metal strip to said slides, means for relatively moving said slides to clamp the strip therebetween at their tangential point of engagement, means for shifting said forming slide in a curved path, and means for shifting the second slide in a straight line path.

2. In a bending machine, a curved forming slide, a second slide arranged tangentially with respect to the forming slide, means for releasably attaching longitudinally spaced portions of a metal strip to said slides, means for relatively moving said slides to clamp the strip therebetween at their tangential point of engagement, means for shifting said forming slide in a curved path, and means for shifting the second slide in a straight line path and at a rate of speed less than that of the forming slide.

3. In a bending machine, a curved forming slide, a second slide arranged tangentially with respect to the forming slide, means for releasably attaching longitudinally spaced portions of a metal strip to said slides, means for relatively moving said slides to clamp the strip therebetween at their tangential point of engagement, means for shifting said forming slide in a curved path, and means for shifting the second slide in a different path.

4. In a bending machine, a curved forming slide, a second slide arranged tangentially with respect to the forming slide, means for releasably attaching longitudinally spaced portions of a metal strip to said slides, means for relatively moving said slides to clamp the strip therebetween at their tangential point of engagement,

means for shifting said forming slide in a curved path, and means for shifting the second slide in a different path and at a lesser rate of speed than that of the forming slide.

5. In a bending machine, a curved forming slide, a second slide arranged tangentially with respect to the forming slide, means for releasably attaching longitudinally spaced portions of a metal strip to said slides, means for bodily shifting said forming slide in a curved path, means for shifting the second slide in a straight line path tangential to said curved path, and means for exerting clamping pressure on the strip at the locality of tangential engagement of the slides.

6. In a bending machine, a curved forming slide, a second slide arranged tangentially with respect to the forming slide, means for releasably attaching longitudinally spaced portions of a metal strip to said slides, means for bodily shifting said forming slide in a curved path, means for shifting the second slide in a straight line path tangential to said curved path and at a lesser rate of speed than that of the forming slide, and means for clamping the strip between the slides at their tangential point of engagement.

7. In a bending machine, a curved forming slide, a second slide, means for shifting the second slide toward and transversely to the forming slide into operative engagement therewith to clamp a metal strip therebetween, means for shifting the second slide tangentially to the forming slide, means for shifting the forming slide in a curvilinear path to bend the strip thereon, and means for varying the relative rates of travel of said slides.

8. In a bending machine, a curved forming slide, a second slide shiftable toward and transversely to the forming slide into operative engagement with the latter to clamp a metal strip therebetween, means for shifting the second slide tangentially to the forming slide, and means for shifting the forming slide in a curvilinear path and at a greater rate of speed than that of the second slide to bend the strip thereon and also stretch the strip.

9. In a bending machine, a forming slide, means for shifting it in a curvilinear path, a second slide, means for shifting the second slide in a path tangential to the said curvilinear path, a third slide mounted on the second slide and shiftable therewith, means for shifting the third slide transversely to the second slide to grip a metal strip between the forming slide and second slide, and means for releasably attaching opposite ends of the strip to the forming slide and to one of the other two slides.

10. In a bending machine, a forming slide, means for shifting it in a curvilinear path, a second slide, means for shifting the second slide in a path tangential to the said curvilinear path and at a different rate of speed than that of the forming slide, a third slide mounted on the second slide and shiftable therewith, means for shifting the third slide transversely to the second slide to grip a metal strip between the forming slide and second slide, and means for releasably attaching opposite ends of the strip to the forming slide and to one of the other two slides.

11. In a bending machine, a curvilinear forming slide terminating in ends separated one from the other, a second slide, means for clamping one end of a work piece or strip to the forward end of the forming slide, means for clamp-

ing another portion of the work piece to the second slide, means for shifting the second slide generally tangentially with respect to the forming slide, means for shifting the forming slide endwise, both of said clamping means moving bodily with the slides during the shifting of the slides.

12. In a bending machine, a pair of devices attachable to a metal strip at longitudinally spaced points on the strip, mechanism for simultaneously shifting said devices in angularly related paths and one at a different rate of speed from the other, a forming member associated with each of said devices and shiftable therewith, and means for relatively shifting said forming members to clamp the strip therebetween and to maintain the forming members in operative engagement with the strip intermediate the points of attachment of said devices to the strip during travel of the strip between the forming members during the forming operation.

13. In a bending machine, a pair of forming devices having means for attachment to a metal strip at longitudinally spaced points on the strip, mechanism for simultaneously shifting said devices in angularly related paths and one at a different rate of speed from the other, and means for maintaining one of said forming devices in position to exert pressure against the other forming device to clamp the strip therebetween during the travel of the strip in the forming operation.

14. In a bending machine, a pair of forming devices having means for attachment to a metal strip at longitudinally spaced points on the strip, mechanism for simultaneously shifting one device in a rectilinear path and the other device in a curvilinear path and one at a different rate of speed from the other, and means for shifting one of said forming devices into operative engagement with the other forming device to clamp the strip intermediate the points of attachment of said devices to the strip during travel of the strip in the forming operation.

15. In a bending machine, a pair of forming devices having means for attachment to a metal strip at longitudinally spaced points on the strip, mechanism for simultaneously shifting one device in a rectilinear path and the other device in a curvilinear path at a greater rate of speed

than the other, and means for shifting one of said forming devices into operative engagement with the other forming device to clamp the strip intermediate the points of attachment of said devices to the strip during travel of the strip in the forming operation.

16. In a bending machine, a pair of forming devices having means for attachment to a metal strip at longitudinally spaced points on the strip, mechanism for shifting one device in a rectilinear path and the other device in a curvilinear path, means for varying the rate of travel of one device with respect to the other, and means for maintaining one device in operative engagement with the other device to clamp the strip between the devices at the point of operative engagement thereof.

17. In a bending machine, a pair of forming devices having means for attachment to a metal strip at longitudinally spaced points on the strip, mechanism for simultaneously shifting one device and its attaching means in a rectilinear path and the other device and its attaching means in a curvilinear path, and means for maintaining one device in operative engagement with the other device to clamp the strip between the devices at the point of operative engagement thereof.

18. In a bending machine, a pair of forming devices, means for releasably attaching longitudinally spaced portions of a metal strip to said devices, means for operatively engaging said devices to clamp the strip therebetween at the locality of their engagement, and means for simultaneously shifting said devices in angularly related paths while maintaining said forming devices in clamping relation to the strip at said locality.

19. In a bending machine, a curved forming member, a slide, means for releasably attaching longitudinally spaced portions of a strip to said slide and member, means for relatively shifting the slide and member transversely into operative engagement to clamp the strip therebetween, means for shifting the slide longitudinally and tangentially to the forming member, and means for shifting the forming member in a curvilinear path to bend the strip thereon.

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