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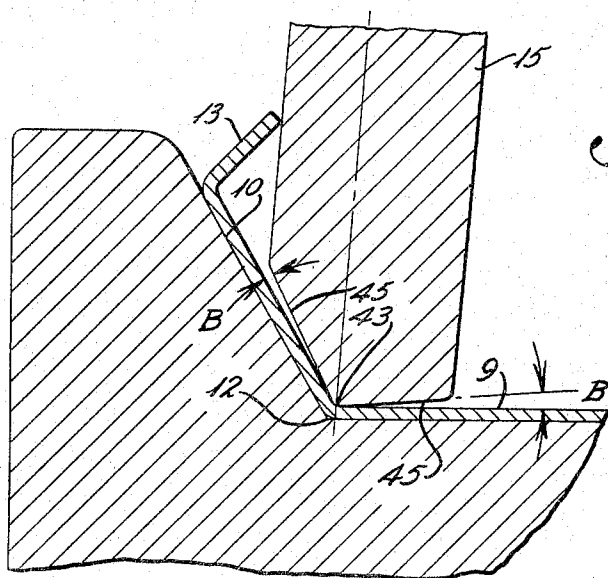
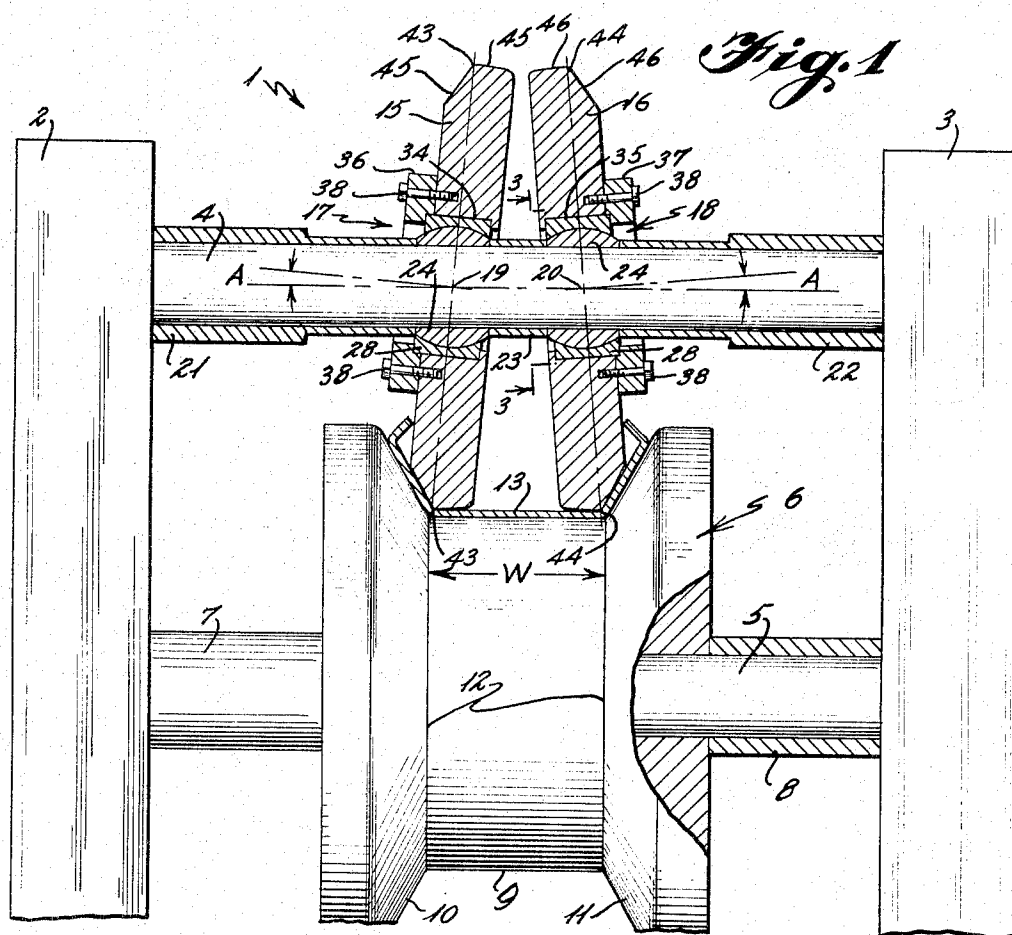
HIROSHI UTASHIRO ET AL

3,355,922

ROLL FORMING MACHINE

Filed Sept. 28, 1965

2 Sheets-Sheet 1



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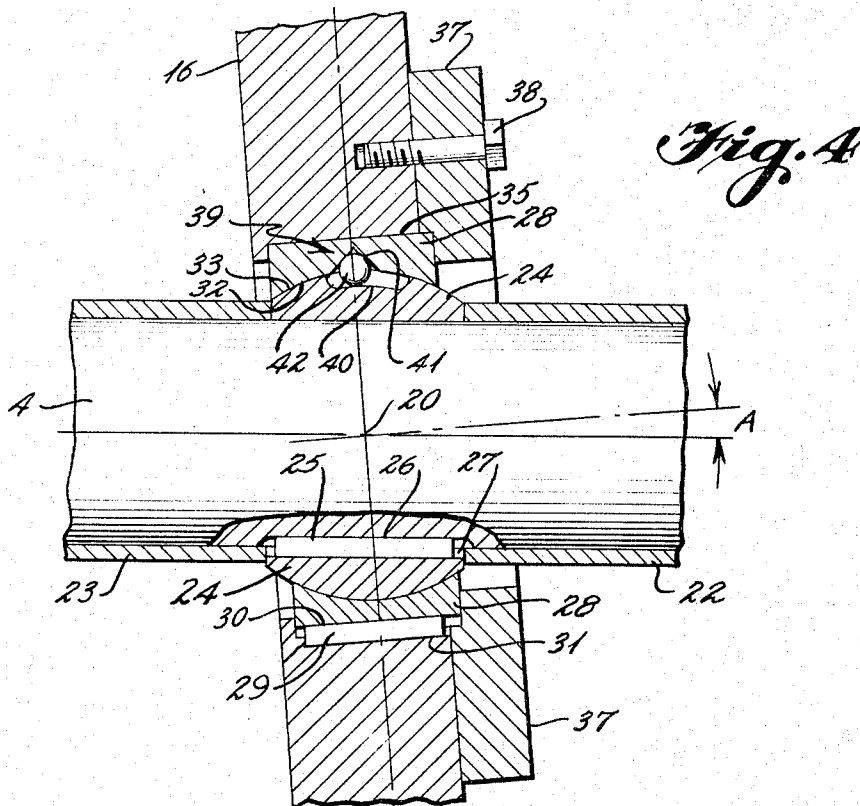
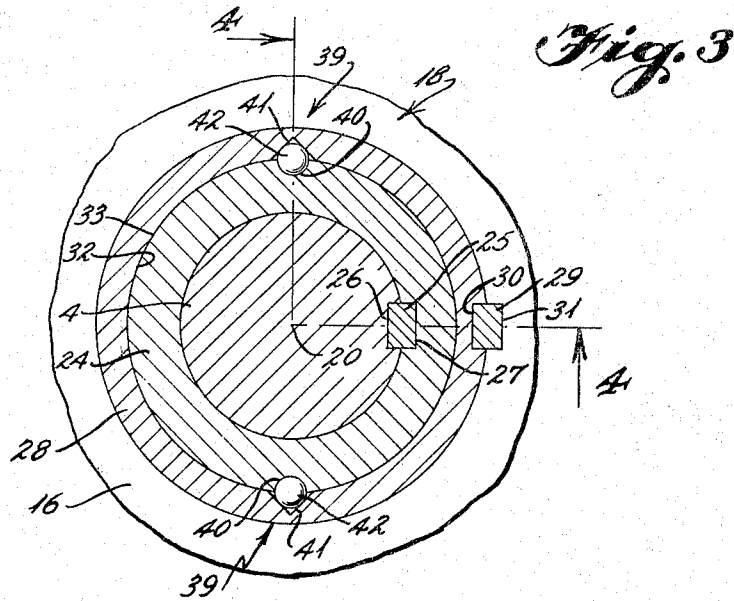
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1

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ROLL FORMING MACHINE

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The present invention relates to a machine for continuously forming a flat metal sheet or band into a desired shape by passing the band through successive rolling stations at each of which the band is progressively deformed. More particularly, the present invention relates to an improvement in a roll forming machine, wherein deforming roller elements at one or more of the rolling stations are relatively inclined.

Roll forming machines are well known and have been used extensively for effecting transverse bending of a flat strip or band of metal into a desired shape. Normally, the strip is passed successively through a plurality of rolling stations at each of which two or more rollers are employed to progressively deform the strip. The number of stations and the number of rollers at each station are normally determined by such considerations as the type and thickness of the material being rolled and the complexity or the number and degree of transverse bends or corners desired in the final product.

Normally, when it is desired to form a conventional rolled structural element, such as one of U-shaped cross-sectional design, each rolling station comprises a pair of co-acting upper and lower rollers which are mounted on parallel spaced shafts, the shafts at one or all of the stations being powered to convey the strip through the machine. The lower or back-up roller is conventionally formed with a central cylindrical drum portion and a pair of conical, enlarged end portions; the surfaces of the drum and end portions acting to define corners to which a strip being rolled is to be conformed. The upper or deforming roller is conventionally formed with a central cylindrical drum portion and a pair of inwardly tapered end portions, which portions are normally disposed parallel to the respective portions of the lower roller and are spaced therefrom a distance determined by the thickness of the strip being rolled.

In successive stations the axial length of the cylindrical drum portions and the number and/or the relative inclination of the end portions of the upper and lower rollers are progressively varied to form the structural member with the desired number of transverse bends or corners. Normally one or more of the stations adjacent the end of the machine are employed to insure that the bends or corners of the structural element are sharp or possess a prescribed roundness.

It has been found that after extended operation the sharp angled intersections or deforming surface portions defined by the drum and end portions of the upper or deforming roller are progressively worn away, whereby the corners of the structural element are formed with a progressively larger radius of curvature than is desired. Since the wearing away of the upper roller is progressive, the customary periodic replacement of such rollers does not result in a uniform product.

A further disadvantage of conventional roll forming machines arises when the intersections or forming surface portions of the deforming roller wear unevenly or experience swaying defacement about the periphery of the roller. This results in successive variations in the radius of curvature of the corner of the structural element longitudinally thereof. In conventional machines, when roller wear of this nature occurs, there is no alternative but to replace the roller.

2

It is therefore an object of the present invention to provide an improvement in conventional roll forming machines, whereby sharp angle bends of a given radius of curvature may be continuously formed in a strip being rolled even through the deforming surface portion of the upper roller or rollers is uniformly worn away or swaying defacement of the roller arises.

It is a specific object of the present invention to provide in a roll forming station having parallel spaced shafts and a lower or back-up roller disposed on one of the shafts, the improvement which includes the provision of a bearing on the other shaft which permits a deforming roller element carried thereon to be selectively tilted with respect to the axis of the shafts, whereby a corner of the strip being rolled may be subjected to components of compressive force both normal and parallel to the axis of the shafts to ensure a desired degree of curvature.

A further object of the present invention is to provide in a roll forming station having a pair of parallel shafts and a lower or back-up roller carried on one of the shafts, the improvement which includes the provision of a pair of spherical bearings on the other shaft which permit deforming roller elements carried thereto to be progressively tilted to compensate for wear thereof and to thus ensure a desired radius of curvature of the corners of the strip being rolled without exerting unbalanced forces axially of the shafts.

A still further object of the present invention is to provide an improvement in a roll forming machine wherein spherical bearings, provided on a driven shaft, are adapted to transmit rotary motion of the shaft to deforming roller elements carried on the bearings while permitting the roller elements to be tilted with respect to the axis of the shaft.

Other objects and features of the present invention will become apparent from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a front elevational view of a rolling station having portions broken away to illustrate the improvement of the present invention, and showing one embodiment of the spherical bearing employed;

FIG. 2 is a fragmentary enlarged view showing an upper forming roll element in engagement with a corner of a strip being rolled;

FIG. 3 is a sectional view taken generally along the line 3-3 of FIG. 1, but showing an alternative and preferred structure of spherical bearing employed in the practice of the present invention; and

FIG. 4 is a sectional view taken generally along the line 4-4 of FIG. 3.

In FIG. 1, there is illustrated a roll forming station, generally shown as 1, which incorporates the improvement of the present invention. Station 1 includes conventional structure in the form of a pair of support columns or standards 2 and 3, which are employed to rotatably support a pair of parallel spaced apart shafts 4 and 5 by means of suitable bearings, not shown. Depending upon which embodiment of the improvement of the present invention is to be employed, shafts 4 and 5 may be braked or positively driven by suitable gearing, not shown. A conventional lower or back-up roller, generally shown as 6, is provided on shafts 5 and is suitably keyed for rotation therewith by suitable means not shown. Roller 6 is maintained in predetermined spacing with respect to columns 2 and 3 by means of cylindrical spacing elements 7 and 8. Roller 6 comprises a cylindrical drum portion 9 and a pair of frusto-conical end portions 10 and 11 which co-act to define corners 12 to which a strip 13, continuously fed through station 1, is to be conformed. Suitable means carried by columns 2 and 3, such as adjustment screws, not shown, are employed to control the distance between

3

shafts 4 and 5, and thus the pressure applied to sheet 13 passing between back-up roller 6 and the upper roller assembly, which is generally indicated as 14, and forms the improvement of the present invention. While back-up roller 6 is illustrated as being one piece construction, it will be apparent that in some instances it may be desirable to divide the roller in the area of drum portion 9 and to space apart the thus formed halves of the roller by suitable means similar to spacers 7 and 8.

The upper roller assembly 14 includes a pair of deforming roller elements 15 and 16, which are supported on spherical bearings, generally shown as 17 and 18; the bearings being spaced axially of shaft 4 and having their centers placed at 19 and 20, respectively. As will be seen by referring to FIG. 1, bearings 17 and 18, and thus centers of rotation 19 and 20, are selectively positioned with respect to the corners 12 of roller 6 and with respect to each other by removable cylindrical spacers 21, 22 and 23, respectively.

In the first embodiment of the present invention, generally illustrated in FIG. 1, deforming roller elements 15 and 16 are frictionally driven by surface contact with strip 13; the bearings 17 and 18 permitting the roller elements to freely rotate relative to shaft 4, which if desired may idle or be braked against rotation by means, not shown. In the second and preferred embodiment, generally illustrated in FIGS. 3 and 4, deforming roller elements 15 and 16 are positively driven by shaft 4 acting through bearings 17 and 18. Generally it is desirable to positively drive the strip being rolled by positively driving the deforming roller elements to prevent buckling of the strip immediately before the station. Also, positive driving of the deforming roller elements insures that the peripheral speed of such roller elements may more evenly be matched with the speed of the strip to retard swaying defacement of the roller elements.

In both embodiments of the present invention, bearings 17 and 18 each include an inner part 24, which is affixed for rotation with shaft 4 by means of key 25 received within slots 26 and 27 provided in shaft 4 and inner part 24, respectively, and an outer part 28, which is affixed for rotation with roller elements 15 or 16 by means of key 29 received within slots 30 and 31 provided in outer part 28 and roller elements 15 and 16, respectively. Both the inner parts 24 and outer parts 28 are provided with co-acting peripheral surface portions 32 and 33, respectively. Bearings 17 and 18 may be assembled in any desired manner, as for instance by forming outer part 28 in two parts which are joined by bolts or welding.

As will be seen by referring to FIGS. 1 and 4, roller elements 15 and 16 are each provided with bore openings 34 and 35, respectively, to receive outer bearing parts 28. Parts 28 are retained within bore openings 34 and 35 by means of annular bearing covers 36 and 37 which are removably affixed to roller elements 15 and 16 by means of threaded bolts 38. This construction permits the roller elements when worn beyond use to be removed from bearings 17 and 18 without disturbing the positioning of the bearings on shaft 4.

In the first embodiment of the present invention, spherical surface portions 32 and 33 permit universal motion of bearing parts 24 and 28, and thus both relative rotatable and tilting motion of roller elements 15 and 16 with respect to the axis of shaft 4 about centers 19 and 20.

In the second and preferred embodiment of the present invention key means, generally indicated as 39, are provided to lock inner parts 24 and outer parts 28, and thus roller elements 15 and 16, for rotation with shaft 4, while permitting roller elements 15 and 16 to be tilted with respect to the axis of shaft 4 about centers 19 and 20, as shown generally in FIG. 1. Key means 39 includes a slot 40 provided in the spherical surface portions 32 of inner parts 24, a conical or hemispherical recess 41 provided in the spherical surface portions 33 of outer parts 28, and a ball bearing 42. Ball bearing 42 is received for relative ro-

4

tary movement within recess 41 and for relative rotary and sliding movement within slot 40. It will be appreciated that the positioning of slot 40 and recess 41 on parts 24 and 28 may be reversed if desired.

As shown in the drawings, roller elements 15 and 16 are provided, respectively, with annular peripheral deforming surface portions 43 and 44 which co-act with the back-up roller 6 to deform sheet 13 in the area of corners 12. Roller elements 15 and 16 are also provided with oppositely and inwardly inclined surface portions 45 and 46, which bound deforming surface portions 43 and 44, respectively. It has been found desirable to incline surface portions 45 and 46 with respect to portions 9, 10 and 11 of back-up roller 6 at an angle B, which is equal to the angle A at which roller elements 15 and 16 are tilted with respect to the axis of shaft 4. Angle A is desirably limited to between 5 and 15°.

In setting up the present invention in a roll forming station, bearings 17 and 18 are placed on shaft 4 and a spacer 23 of sufficient length is chosen to space centers 19 and 20 a distance apart, which will permit roller elements 15 and 16 to tilt from between 5 and 15 degrees with respect to the axis of shaft 4 when deforming surface portions 43 and 44 engage strip 13 in the areas of corners 12, the latter being spaced a predetermined distance apart W. Preferably, centers 19 and 20 are spaced equi-distant from and on opposite sides of a plane drawn equi-distant from corners 12 to prevent unbalance forces axially of the shafts.

It will be apparent that when shaft 4 is forced toward shaft 5, as by suitable adjustment screws, the roller elements 15 and 16 are forced apart as illustrated in FIG. 1, thereby deforming surface portions 43 and 44 exert a compressive force on strip 13 in the area of corners 12, the force having components both normal and parallel to the axis of shafts 4 and 5. As will also be apparent, the relative axial placement of centers 19 and 20 with respect to corners 12 determines the magnitude of the individual force components.

Accordingly, it will be seen that as abrasion of deforming surfaces 43 and 44 proceeds the points or surfaces at which the roller elements 15 and 16 engage strip 13 are forced outwardly against the corners 12, whereby the sharpness or degree of roundness of the strip corner is not changed and the life of the roller elements is prolonged. Also, it will be apparent that by positively forcing the roller elements outwardly any swaying defacement which may arise on the roller elements is compensated for.

The number of stations in the roll forming machine at which the improvement of the present invention is employed and the placement of such stations will normally be determined by the desired cross-sectional design to which the strip is to be formed and the thickness of the strip being formed. However, in a conventional eight station machine employed to form U-shaped or box channel structural members, normally one station employing the improvement is provided and such station placed in 6th of 7th station position. In twenty or more station machines, normally stations thirteen to sixteen are provided with the improvement of the present invention.

While the improvement of the present invention has been illustrated and described as including a pair of spherical bearings, which are axially spaced from each other and disposed in a prescribed relationship with respect to a pair of corners formed on a back-up roller, and a pair of deforming roller elements carried one on each of the spherical bearings, it will be appreciated that the improvement may include only one spherical bearing, it will be appreciated that the improvement may include only one spherical bearing-roller element assembly or a group having three or more of such assemblies, depending on the number of corners to be formed in the strip being rolled. Further, in cases where the angles of the several corners to be formed or the thickness of the portions of

5

the strip being rolled adjacent to the corners varies, the spacing between the respective spherical bearings and their corresponding corners may be varied. Thus, since these and other modifications of the improvement of the present invention may occur to persons skilled in the art in view of the present disclosure, we wish our protection to be limited only by the scope of the appended claims.

What is claimed is:

1. In a roll forming machine including at least one rolling station having parallel spaced apart shafts and roller means carried on one of said shafts, said roller means having a plurality of relatively inclined surface portions adapted to define at least one corner to which a strip being rolled is to be conformed, the improvement which comprises at least one bearing means carried on the other of said shafts and a roller element carried one on each of said bearing means, said roller element having a deforming surface portion adapted to coact with said corner to effect deformation of a strip being rolled, said bearing means permitting said roller element to be tilted with respect to the axis of said other shaft, whereby upon the forcing together of said shafts said deforming surface portion is adapted to exert a compressive force on a strip being rolled in the area of said corner, said force having components both parallel and normal to the axes of said shafts.

2. The roll forming machine of claim 1 wherein said bearing means includes a first part keyed for rotation with said other shaft and a second part keyed for rotation with said roller element, said parts having cooperating spherical surface portions to permit relative sliding movement of said parts and, said roller element is driven by frictional engagement with a strip being rolled.

3. The roll forming machine of claim 1 wherein said other shaft is powered and said bearing means is adapted to transmit motion of said other shaft to said roller element.

4. The roll forming machine of claim 3 wherein said bearing includes a first part keyed for rotation with said other shaft, a second part keyed for rotation with said roller element, said parts having cooperating spherical surface portions, and means to key said parts together for simultaneous rotational movement about the axis of said other shaft, said key means permitting relative sliding movement of said parts whereby said roller element may be tilted with respect to the axis of said other shaft.

5. The roll forming machine of claim 4 wherein said key means includes a slot provided in the spherical surface portion of one of said parts, a recess provided in the spherical surface portion of the other of said parts, and a ball bearing, said ball bearing being received for relative rotational movement within said recess and received for relative rotational and sliding movement within said slot.

6. In a roll forming machine including at least one rolling station having parallel spaced apart shafts and roller means carried on one of said shafts, said roller means having relatively inclined surface portions adapted to define spaced corners to which a strip being rolled is to be conformed, the improvement which comprises a plurality of bearings carried on and spaced axially of the other of said shafts and a plurality of roller elements carried one on each of said bearings, each of said roller elements having a deforming surface portion adapted to coact with one of said corners to effect deformation of a strip being rolled, said bearings permitting said roller elements to be inclined with respect to the axis of said other shaft, whereby upon the forcing together of said shafts the deforming surface portions of said roller elements are adapted to exert compressive forces on a strip being rolled in the area of said corners, said forces having components both parallel and normal to the axes of said shafts.

7. The improvement in a roll forming machine according to claim 6, wherein means are provided to selectively position said bearings axially with respect to each

6

other and said bearings axially with respect to said corners on said roller means.

8. In a roll forming machine including at least one rolling station having parallel spaced apart shafts and a contoured roller carried on one of said shafts, said contoured roller having relatively inclined surface portions adapted to define a pair of corners to which a strip being rolled is to be conformed, the improvement which comprises a pair of bearings carried on and spaced axially of the other of said shafts, the distance between said bearings being less than the distance between said corners on said contoured roller and said bearings being disposed equidistant from and on opposite sides of a plane drawn equidistant from said corners, and a pair of roller elements carried one on each of said bearings, each of said roller elements having an annular peripheral deforming surface portion adapted to co-act with one of said corners to effect deformation of a strip being rolled, said bearings permitting said roller elements to be tilted in opposite directions with respect to the axis of said other shaft, whereby upon the forcing together of said shafts the deforming surface portions of said roller elements are adapted to exert compressive forces on a strip being rolled in the areas of said corners, said forces having components both parallel and normal to the axis of said shafts and said parallel components being equal and opposite.

9. The improvement in a roll forming machine according to claim 8 wherein said roller elements are tilted at an angle of from between 5 and 15 degrees with respect to the axis of said other shaft.

10. The improvement in a roll forming machine according to claim 9 wherein said deforming surface portion of each roller element is bounded by annular radially inwardly and oppositely inclined surface portions, said inclined surface portions of said roller elements being inclined with respect to said corner defining inclined surface portions of said contoured roller at an angle corresponding to the angle at which said roller elements are tilted.

11. In a roll forming machine including at least one rolling station having parallel spaced apart shafts and a contoured roller carried on one of said shafts, said contoured roller having relatively inclined surface portions adapted to define spaced corners to which a strip being rolled is to be conformed, the improvement which comprises a pair of spherical bearings carried on and spaced axially of the other of said shafts, the distance between said bearings being less than the distance between said corners on said contoured roller, and a pair of roller elements carried one on each of said bearings, each of said roller elements having a deforming surface portion adapted to coact with one of said corners to effect the deformation of a strip being rolled, said bearings permitting said roller elements to be tilted in opposite directions with respect to the axis of said other shaft, whereby upon the forcing together of said shafts the deforming surface portions of said roller elements are adapted to exert compressive forces on a strip being rolled in the area of said corners, said forces having components both parallel and normal to the axis of said shafts.

12. The improvement in a roll forming machine according to claim 11, wherein said bearings are disposed equidistant from and on opposite sides of a plane drawn equidistant from said corners.

13. The improvement in a roller forming machine according to claim 12, wherein means are provided to vary the distance between said bearings.

14. The improvement in a roll forming machine according to claim 12, wherein said other shaft is powered and said bearings are adapted to transmit motion of said other shaft to said roller elements, and each said bearing includes a first part keyed for rotation with said other shaft, a second part keyed for rotation with said roller element, said parts having cooperating spherical surface por-

tions, and means to key said parts together for simultaneous rotational movement about the axis of said other shaft, said key means including a slot provided in the spherical surface portion of one of said parts, a recess provided in the spherical surface portion of the other of said parts, and a ball bearing being received for relative rotational movement within said recess and for relative rotational and sliding movement within said slot.

References Cited

UNITED STATES PATENTS

2,352,675 7/1944 Yoder ----- 72—181

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