March 12, 1968 L. HARPER 3,372,456

MACHINE FOR FORMING DOUBLE VANES

Original Filed March 25, 1965 2 Sheets-Sheet 1

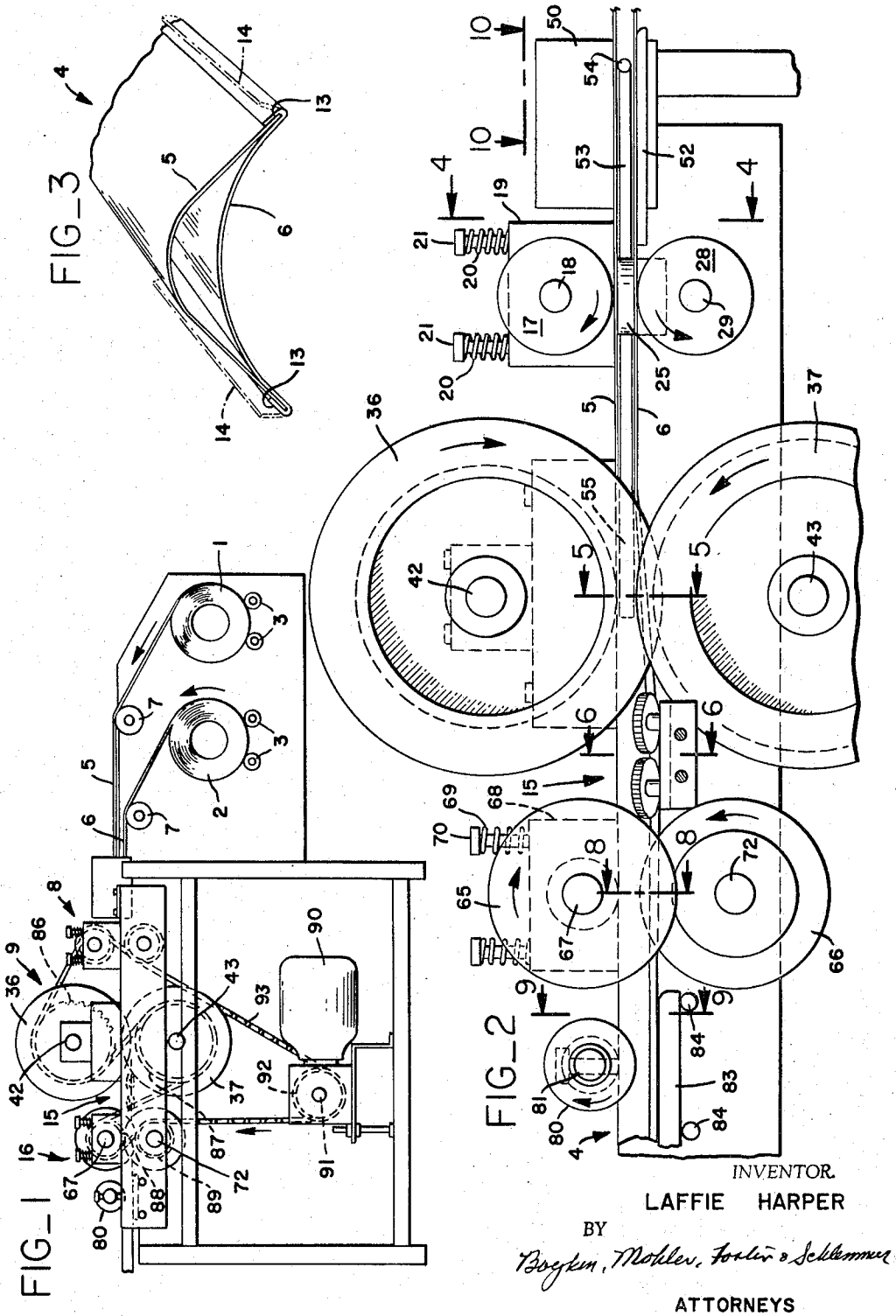


FIG_1

FIG_2

FIG_3

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FIG_4

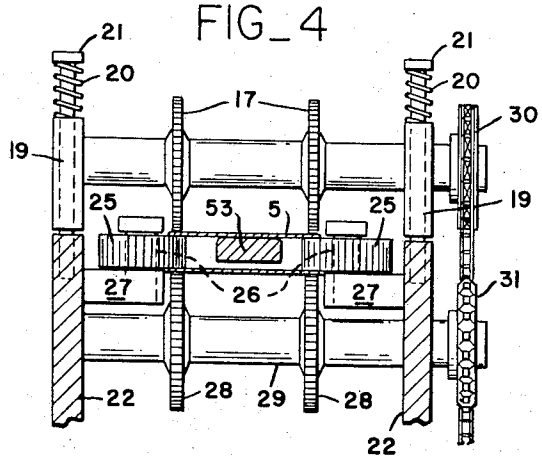


FIG_5

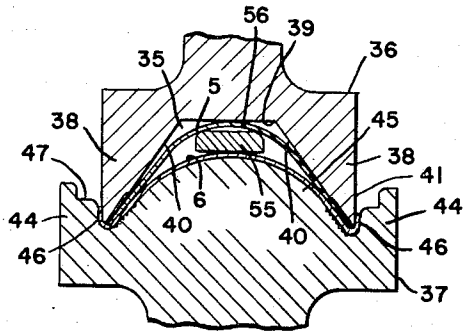


FIG_6

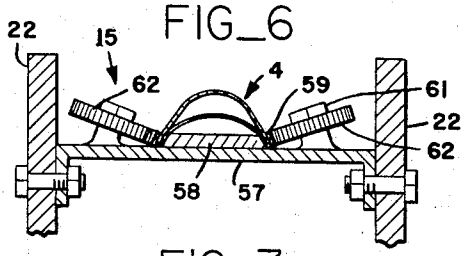


FIG_7

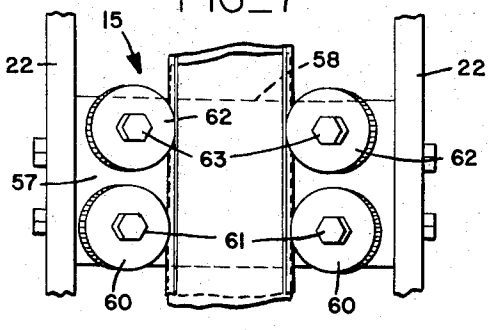


FIG_8

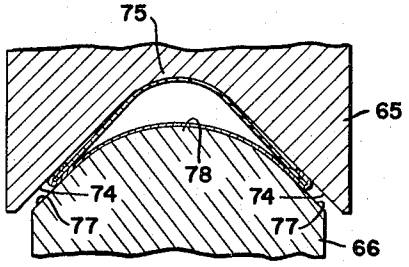


FIG_9

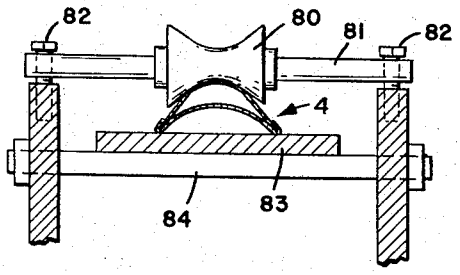
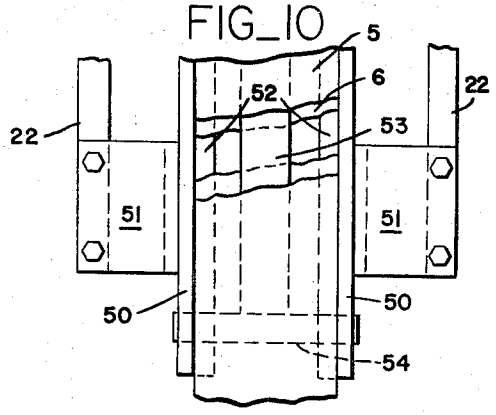


FIG_10



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MACHINE FOR FORMING DOUBLE VANES

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Original application Mar. 25, 1965, Ser. No. 442,689. Divided and this application June 15, 1967, Ser. No. 646,226

9 Claims. (Cl. 29—208)

ABSTRACT OF THE DISCLOSURE

A machine into which a pair of planar sheet metal strips of corresponding width are fed in opposedly facing relation, and means in the machine bows the strips transversely thereof to the same side to different degrees to provide a space between their central portions, and thereafter means is provided in said machine for securing the strips together along their edges, in said bowed condition to provide a hollow or double vane.

This invention relates to a machine for making double vanes for use in air conduits, and is a division of application Ser. No. 442,689, filed Mar. 25, 1965. Such vanes, in themselves, are old.

In the elbows of air conduits used in air conditioning systems, and elsewhere, which elbows are usually rectangular in cross section, a row of double vanes may be positioned to deflect or guide the air past the corner and to maintain uniform velocity of the air moving through the elbows.

Double vanes are formed from two strips of sheet metal, each uniformly bowed transversely from end to end, but with different arcs, and they are connected along their longitudinally extending edges with their concave sides facing in the same direction to form a hollow vane, one outer side of which hollow vane provides an outer concave surface and the other side of which provides an outer convex surface. The curvature of the concave surface is flatter than that of the convex surface, and the longitudinally extending marginal portions of the strip that provide the concave surface are bent over the edges of the strip that provide the convex surface.

In the trade, the two pieces of metal forming each double vane may be called "blades." The outer blade would be the one providing the convex surface, and the inner blade would be the one forming the concave surface, since the concave surface of each vane is the one facing the inner corner of the elbow of the conduit, when the vanes are in the elbow and the convex surface faces the outer corner.

Heretofore, insofar as I am aware, the most common method employed for making double vanes has been to cut strips of metal to predetermined lengths, and to then, separately, bend the strips transversely thereof in a press to provide the desired transverse curvature, after which the flanges are formed (also by a press operation) on the inner strip or blade, which flanges are to receive the edges of the outer strip or blade. Thereafter the outer blade is slipped into place over the inner blade, and finally the flanges on the inner blade are flattened against the marginal portions of the outer blade for holding the blades or strips together. The flanges, in some instances, have been formed on the inner strip or blade at the same time the inner blade is transversely bent. In each instance, of course, the blades must be over-bent transversely thereof, to compensate for the spring-back.

From the foregoing it is seen that, heretofore, at least four separate operations, including four separate handling of the pieces, is required before a double vane is finished.

One of the objects of the present invention is a machine adapted to continuously form a double vane from a pair of strips fed from rolls of said strips. After such vanes are formed they may be quickly and accurately cut to any desired length, thus eliminating the precutting of separate strips to length prior to forming the double vane, and thereby assuring double vanes in which both strips thereof are not only accurate in length but are in absolute register at their ends.

Another object of the invention is the provision of a machine for more accurately, and more rapidly making double vanes than heretofore, and which vanes are uniform in every respect and the blades of which are tightly and uniformly secured together continuously along their edges.

A still further object of the invention is the provision of a machine for continuously forming double vane structure from strips of metal in rolls thereof, and which vane structure is uniform throughout the length thereof in every respect.

Other objects and advantages will appear in the description and in the drawings.

FIG. 1 is a greatly reduced, side elevational view showing the vane forming machine in relation to rolls of sheet metal strips being fed to the machine.

FIG. 2 is an enlarged side elevational view of a portion of the machine of FIG. 1 with the near side of the frame removed and certain parts in cross section.

FIG. 3 is a fragmentary perspective view of a double vane after being formed by the machine.

FIG. 4 is a cross-sectional view taken approximately along line 4—4 of FIG. 2 showing the feed rollers in elevation and the frame of the machine and the strips that are to be formed to make the double vane, are in cross section.

FIG. 5 is an enlarged, fragmentary, cross-sectional view taken substantially along line 5—5 of FIG. 2 through the adjacent potrions of the first set of vane forming rollers. The vane strips and mandrel are also shown in cross section.

FIG. 6 is an enlarged, fragmentary, cross-sectional view at approximately line 6—6 of FIG. 2 showing the second set of bending rollers with the vane strips between pairs of said rollers.

FIG. 7 is a top plan view of the rollers of FIG. 6 showing their relationship to the vane.

FIG. 8 is an enlarged, fragmentary, cross-sectional view taken substantially along line 8—8 of FIG. 2 through the adjacent portions of the flattening rollers.

FIG. 9 is an enlarged, fragmentary, cross-sectional view taken substantially along line 9—9 of FIG. 2 of the discharge end of the machine.

FIG. 10 is a fragmentary, top plan view of the feed end of the machine of FIG. 2 substantially as seen from ilne 10—10 of FIG. 2.

The apparatus shown in FIG. 1 is simplified to enable a quick understanding of the invention, free from structural details that will be described later on. In both FIGS. 1 and 2, the direction of travel of the metal strips from which the vane structure is formed, is from right to left.

The aforesaid strips of sheet metal are in rolls 1 and 2 at the right hand end of the vane forming machine, which rolls are normally considerably larger than is indicated in FIG. 1 and may be separate from the machine.

The strips in rolls 1, 2 are of the same width, and said rolls 1, 2 are disposed vertically and are supported for rotation on rollers 3, or in any other suitable manner to facilitate easy withdrawal of lengths of the strips from the rolls. The strips so withdrawn are indicated at 5 and 6, the strip 5 being drawn from roll 1, and strip 6 from roll 2. Said strips may be drawn over rollers 7 for horizontal movement to the left to the vane forming machine, with strip 5 spaced above strip 6, irrespective of

the size of the rolls 1, 2. The vane that is ultimately formed from the strips is generally designated 4 (FIG. 3).

The vane forming machine provides an initial set of feed rollers 8 at the feed station which is at the right hand end portion of the machine, and there the longitudinally extending marginal portions of the strips 5, 6 are positively gripped by said rollers to drive the strips to the left to the initial bending station, having bending rollers for bending the strips.

The rollers of set 9 cooperate with each other and with a mandrel to bow both strips 5, 6 transversely thereof and at the same time the rollers of said set 9 function to bend the longitudinally extending marginal portions of the lower strip 6 upwardly to provide flanges that extend across the longitudinally extending edges of the upper strip 5.

Earlier it was explained that in the finished vanes the strips 5 and 6 are usually called "blades." In FIG. 3, the flanges for securing the blades together are shown in full lines at 13, but the rollers of set 9, however, only upset the marginal portions of strip of blade 6 to the dot-dash line positions 14 shown in FIG. 3.

Beyond the rollers of set 9 at the initial bending station is a flange bending station where rollers of a set 15 will function, in combination with a stationary member to progressively bend the flanges 13 to approximately the full line positions thereof shown in FIG. 3.

Beyond the flange bending station of the rollers of set 15 is a vane flattening station where flattening rollers of a set 16 are provided to flatten the flanges 14 and the adjoining portions of the blades to the form shown in FIG. 3, and which rollers also rectify any possible irregularities in the shape of the hollow vanes.

The rollers of the several sets, their relationship to each other and to other structural features of the machine will now be described in detail.

Referring specifically to FIGS. 2, 4, the rollers of set 8 comprise an upper part of vertical, horizontally spaced rollers 17 rigid on shaft 18 that, in turn, is journalled for rotation at its end portions in bearings carried by blocks 19 that are respectively spring urged downwardly by springs 20 reacting between the blocks and the heads 21 of bolts connecting said blocks with side frame members 22 of the rigid frame of the machine.

These rollers 17 are relatively thin, but flat, at their outer peripheries and said outer peripheries are preferably roughened or milled for gripping the upper surfaces of the marginal portions of the upper strip 5 (FIG. 4).

Disposed between the frame members 22 are a pair of horizontally disposed idler rollers 25 (FIG. 4). These are horizontally spaced apart and are respectively rotatable on vertical shafts 26 projecting upwardly from supporting blocks 27, one of the latter being rigidly secured to each side frame member 22.

The upper marginal surfaces of said rollers 25 are preferably roughened or milled, and the said roughened surface of each that is most remote from the sidewall 22 adjacent thereto is disposed below the lowermost outer periphery of each roller 17 so that the longitudinally extending marginal portions of the strip 5 will be tightly gripped between each pair of rollers 17, 25.

Directly below rollers 17 and in the same planes as the latter is a pair of rollers 28, which rollers have the same structure as rollers 17. The marginal portions of the lower strip 6 will be tightly gripped between the uppermost roughened outer peripheral surfaces of rollers 28 and the lower marginal surfaces of rollers 25, the latter surfaces also preferably being roughened to provide friction surfaces.

A horizontal shaft 29, rigid with rollers 28, has its end portions journalled for rotation in bearings carried by frame members 22. Sprocket wheels 30, 31 are secured on one of the corresponding end portions of shafts 18, 29 outwardly of one of the frame members 22 for driving by a sprocket chain so that the strips 5, 6 will be driven from right to left as seen in FIGS. 1, 2.

Strips 5, 6 are driven forwardly (right to left in FIGS. 1, 2) by the feed rollers 17, 25, 28, and to a position between the bending rollers 36, 37 of set 9, the said bending rollers comprising an upper, relatively large diameter roller 36 (FIGS. 1, 2) the outer periphery of which is formed to provide a radially outwardly opening relatively deep annular groove or channel 35 (FIG. 5) having sidewalls 38 and a bottom 39.

The inner generally opposed surfaces 40 of walls 38 and the bottom surface 39 are respectively flat in cross-sectional contour. Said surfaces 40 extend divergently outwardly from the bottom surface 39, and the oppositely outwardly facing surfaces 41 of the walls 38 are substantially at right angles to the axis of the roller.

Said rollers 36, 37 are respectively secured on horizontal shafts 42, 43. The end portions of shaft 42 are journalled for rotation in bearing blocks secured to side frame members 22, and the end portions of shaft 43 are journalled for rotation in bearings in said frame members.

The outer peripheral portion of the lower roller 37 is formed with a pair of radially outwardly projecting, horizontally spaced coaxial annular flanges 44. The outer portions of the sidewalls 38 of channel 15 in roller 36 are received between flanges 44 (FIG. 5).

The outer portions of the pair of flanges 44 are relieved along the adjacent sides at 47 (FIG. 5) to provide relatively narrow, annular opposedly facing surfaces 46 that will be in opposed relation to the portions of outer surfaces 41 on sidewalls 38.

The outer peripheral part of lower roller 37 that extends between flanges 44 is convexly curved to provide a convex surface 45 that is substantially complementary to the cross-sectional contour of the lower blade 6 of the vane 4.

The spacing between the outer portion of upper roller 36 including the surfaces of the outwardly opening channel 35 therein, and the outer portion of lower roller 37, including the curved surface 45, and surfaces 46, are such that a double vane will fit between them with the flanges or marginal portions 13 of the vane against the surfaces 46 and with the central portion of the upper blade 5 substantially against the central portion of the bottom surface 39 of the channel 35, while the lower blade 6 will be against the curved surface 45 of the lower roller 37.

Inasmuch as the upper and lower rollers 36, 37 alone would be inoperative for bending the strips 5, 6 transversely to the approximate final curved form, the additional structure essential to the desired bending will now be described, including the means for guiding the flat strips 5, 6 to the rollers 36, 37.

A pair of vertical, spaced, opposed side plates 50 (FIGS. 2, 10) are supported by brackets 51 (FIG. 10) in a position centrally between side frame members 22. The space between plates 50 is equal to the width of strips 5, 6, and they extend substantially to the feed rollers 17, 28. A pair of parallel, inwardly projecting rails 52 (FIG. 10) on side plates 50 slidably support the lower strip 6 at the level of the upper surface of the lower feed rollers 28 so the lower strip will be gripped between the lower marginal surfaces of rollers 25 and the upper surfaces of feed rollers 28 for feeding the strip 6 to the bending rollers 36, 37.

Above the upper level of rails 52 is a horizontally elongated flat bar 53 (FIGS. 2, 4, 10) that extends from the feed end of the machine to and between the feed rollers 36, 37. The end of this bar at the feed end of the machine is rigidly secured, centrally, to a cross head 54, the ends of which are cylindrical and are pivotally supported in coaxial openings in side plates 50 so that the upper surfaces of the cross head and bar 53 are at a level that will support the upper blade or strip 5 for movement to a position between the lower periphery of upper feed rollers 17 and the upper marginal surfaces of rollers 25.

The portion 55 of the bar 53 that extends between the bending rollers 36, 37 is a mandrel, having rounded upper corners (FIG. 5), and the thickness of this mandrel is

such as to permit the lower strip 6 to centrally slide over the rounded convex surface 45 of the lower bending roller 37 while the latter is being transversely bent over said surface, and to elevate the central part of upper strip 5 a sufficient distance so that the longitudinally extending edges of the strip 5 will be drawn to a position, inwardly, past the lateral surfaces 41 of the sides 38 of the channel 35 in the upper roller and so that the marginal portions of the upper strip 5 will not be bent with flanges 13, but, instead, the flanges 13 will be bent over the marginal portions of the upper strip.

In the absence of the mandrel 55 both strips would be bent substantially alike. It should be noted that the ultimate shape of the double vane as seen in FIG. 5 fairly closely conforms to the ultimate desire dshape of the finished vane of FIG. 3, but the vane leaving the bending rollers is still in the process of being formed, and the bowed portion of the upper strip 5 indicated at 56 (FIG. 5) is preferably free from engagement with the mandrel, the strip 5 being in engagement with the mandrel only at the two rounded edges of the latter, hence there is a minimum of friction between the strip and the mandrel.

The mandrel itself and the bar, are floatingly supported, in that the bar 53 and mandrel 55 are free to pivot, as a unit, about the axis of the cross head 54. When no strips are between rollers 36, 37, the mandrel 55 rides on the central portion of the lower bending roller 37.

The bending operation of the bending rollers 36, 37 in combination with the mandrel 55 is believed to be apparent from the structure. The strips 5, 6 cannot shift laterally, being held between guide plates 50. Upon the leading ends of the strips (which are spaced apart by the mandrel 55) reaching the rollers 36, 37, the longitudinally extending marginal portions of both strips 5, 6 are progressively forced downwardly, but since the mandrel holds the upper strip 5 spaced above strip 6 the former strip will have a sharper bend at 56 than the bend of the lower, and the edges of strip 5 will be drawn inwardly across the marginal portions of the lower strip 6. The upper and lower rollers 36, 37 are formed so that the marginal portions of the lower strip, which project past the edges of the upper strip, after the strips are bowed as described, will be bent upwardly by engagement with the inner surfaces 46 of the sidewalls 38 of channel 35 of upper roller 36. Once these marginal portions of strip 6 are bent upwardly to the positions 14 (FIG. 3) the strips 5, 6 will be driven as a unit to the rollers of set 15 (FIGS. 1, 2, 6, 7).

Referring to FIGS. 2, 6 the rollers of set 15 are supported for rotation on a horizontally disposed plate 57 that extends between and is rigidly secured to side frame members 22 just beyond the bending rollers 36, 37. The upper surface of this plate is at substantially the same level as the lower edges of the vane as it leaves the bending rollers, so that the vane will slide over the central portion of said plate. Rigid on the central portion of said plate 57, and extending longitudinally of the vane, which is indicated at 4, is a horizontally disposed, flat ridge 58, the edges 59 which are slanted upwardly toward each other to substantially correspond to the inclination of the marginal portions of the strip 5 after the latter have left the bending rollers, and the said edges are so spaced as to substantially slidably engage inclined surfaces of the vane along its lower edges (FIG. 6).

The rollers 60 of a first pair of generally horizontally disposed, but slightly tilted rollers, are rotatably supported on shafts 61 along the opposite edges of the ridge 58 at the end of the ridge nearest the bending rollers 36, 37. The tilt of these rollers is such that the flat outer peripheral surfaces of said rollers will be generally of the same incline as the inclination of the edge of ridge 58 nearest thereto and said outer peripheral surfaces of rollers 60 will be substantially opposed to said edges of the ridge 58 so that the flanges on the lower strip 6, which are substantially in position 14 (FIG. 3) will be bent toward the inclined edges of the ridge 58 as the vane is driven past said rollers 60.

Adjacent to the pair of rollers 60 is a second pair of rollers 62, mounted on shafts 63 carried by plate 57. The rollers 62 are spaced from rollers 60 in the direction of movement of the vane, and they are slightly closer to the ridge 58 so as to complete the bend of flanges 13 to gripping relation with the marginal portions of the upper strip 5. The rollers 62 are, structurally, the same as rollers 60.

The last set 16 of rollers comprises an upper flattening roller 65 and a lower flattening roller 66, the cross sectional contours of their adjacent rims being shown in FIG. 8 in association with the vane or strips 5, 6.

Upper roller 65 is secured on a shaft 67 that, in turn, is rotatable at its ends in bearing blocks 68 that are spring urged downwardly by springs 69 around the upper ends of rods or bolts 70 on which the blocks are slidable, in the same manner as blocks 19 for the upper drive roller.

Lower roller 66 is secured on shaft 72, the ends of the latter being journalled for rotation at its ends in bearings carried by sidewalls 22.

The outer periphery of the roller 65 is generally channel shaped having divergently outwardly extending flat side surfaces 74 and a concavely rounded axial surface 75, the contour of which exactly corresponds to the desired outer contour of the strip 5.

The outer periphery of the lower roller 66 has flattened surfaces 77 that are in substantially parallel opposed relation to the flat surfaces 74 on the upper roller 65 along the outer edges of the latter, and it has a convexly curved central surface 78 that exactly corresponds to the desired concave curvature of the lower strip 6. These rollers are power driven, as will later be explained, and when the vane leaving the rollers of set 15 pass between the flattening rollers 65, 66 of set 16, the flanges 13 are not only tightly bent to grip the marginal portions of strip 5, but the portions of the vane along said flanges are given the desired flattening, and the curved portions of the strips are precisely bent or formed to have exactly the right curvatures.

There are times when the vane as it leaves the flattening rollers may tend to curve upwardly, in which case, a roller 80 (FIGS. 1, 2, 9) is rotatably supported on a horizontal shaft 81 over the vane to straighten the latter as the vane is moved outwardly of the discharge end of the machine. Shaft 81 is adjustable as to height by screws 82 that slidably extend through openings in the ends of the shaft and into the side frame members 22. A platform 83 is rigid with and supported by rods 84 from side frame members 22 in a position for slidably supporting the lower edges of the vane 4 thereon.

As seen in FIG. 4, sprocket wheels 30, 31 are respectively secured on shafts 18, 29 of the feed rollers 17, 28. On the same side of the machine, sprocket wheels 86, 87 are respectively secured on shafts 42, 43 of the bending rollers of set 9, and sprocket wheels 88, 89 are respectively secured on shafts 67, 72 of the flattening rollers of set 16.

The frame of the machine carries a motor 90, connected with a gear box having a driven shaft 91 on which a sprocket wheel 92 is secured. A sprocket chain 93 connects the sprocket wheel 92 with sprocket wheels 30, 31, 86–89 for driving the drive rollers 17, 28 and bending rollers 36, 37 and flattening rollers 65, 66 at a synchronous speed in directions for moving the strips 5, 6 through the machine from right to left as seen in FIGS. 1, 2, both before and after the double vane is formed. Rollers 25, 60, 62 and 80 are idler rollers.

The machine provides means for moving a pair of respectively planar sheet metal strips of substantially the same width longitudinally thereof in separate paths of travel with one of the sides of the strips of the pair in opposed, substantially parallel relation at a point in said paths, such as at the set 8 of feed rollers, and they are

spaced apart by mandrel 55 at said point a distance substantially less than the width of each strip so that the edges of the strip 5 will engage the side of the strip 6 spaced from the edges of the latter when said strip 5 is bent transversely thereof to a greater degree than strip 6 is bent.

The machine also provides means by which the planar strips 5, 6 are progressively bowed to one side of the pair of strips with the strip remote from said one side being bowed to a substantially greater degree than the other and until its longitudinally extending edges engage the side of said other strip along lines spaced between and parallel with the longitudinally extending edges of said other strip, this progressive bowing of the strips occurring while the strips are moving longitudinally thereof.

After the strips are bowed as above described, means is provided for engaging the marginal portions of said other strip that are outwardly of the lines of engagement between the edges of strip 5 and the side strip 6 and said marginal portions are bent over and in tight engagement with the marginal portions of said one strip for holding the strips together along their longitudinally extending marginal portions and for holding the strips of said pair spaced apart a predetermined uniform distance between the bowed central portions of the strips.

By the aforesaid means in said machine a continuous vane can be formed from continuous strips of a pair, and later the vane will be cut off transversely thereof to the desired lengths for installation in an air conduit.

The rollers 60, 62 provide means for flattening the said strips along their marginal portions outwardly of their bowed central portions in planes extending convergently from the adjacent longitudinally extending edges of said strips toward said bowed central portions.

The important feature is that the strips are progressively connected as they move longitudinally thereof from the rolls and are formed into a double vane during said movement, thus eliminating the many different and separate, time consuming steps heretofore deemed necessary. To accomplish this while also maintaining the spacing between the strips in the final double vane is quite important.

It is to be understood that the scope of the invention is not intended to be limited by the precise example hereinbefore described, but only by the following claims.

I claim:

1. In a vane forming machine for continuously forming a hollow double vane from a pair of opposed correspondingly extending sheet metal strips of substantially the same width and which machine includes a pair of bending rollers supported one over the other for rotation about parallel axes with their outer peripheral surfaces in strip engaging relation with means thereon for bending said strips transversely thereof to form a hollow double vane when said rollers are rotated with said strips between them extending transversely of their said axes:

(a) a mandrel extending between said rollers for spacing the central longitudinally extending portions of said strips from each other to form the hollow portion of said vane during rotation of said rollers;

(b) means connected with said mandrel for holding it between said rollers against movement with said strips;

(c) means connected with said rollers for rotating them when their said outer peripheral surfaces are in said strip engaging relation.

2. In a structure as defined in claim 1:

(d) said means connected with said mandrel for holding it between said rollers including a pivot swingably supporting said mandrel for swinging movement thereof in the plane of said rollers.

3. In a structure as defined in claim 1:

(d) said means connected with said mandrel including a stationary frame supporting said shafts for rotation of the latter;

(e) power means on said frame connected with said rollers for rotating them oppositely to drive said strips therebetween and past said mandrel in one direction from one side of said rollers;

(f) a plurality of drive rollers supported by said frame at said one side of said pair of bending rollers in positions for driving engagement with the longitudinally extending marginal portions of said pair of strips and connected with said power means for driving said strips longitudinally thereof and at opposite sides of said mandrel to between said bending rollers for said bending of the latter by said bending rollers.

4. Vane forming apparatus for forming a hollow, double vane for use in an elbow of air conduit comprising, in combination:

(a) a pair of strip bending rollers supported for rotation about parallel axes and disposed one over the other, said rollers having generally complementarily formed outer peripheral surfaces for engagement with and for similarly bending a pair of spaced, opposed, correspondingly extending sheet metal strips transversely of their lengths to one side of said pair of strips for connection of their longitudinally extending marginal portions upon rotation of said rollers oppositely with said pair of strips normal to the axes of said rollers and extending between said outer peripheral surfaces;

(b) a frame supporting said rollers for said rotation thereof in positions in which their said peripheral surfaces are in said strip engaging and bending relation at the adjacent sides of said rollers;

(c) means connected with said frame for supporting said pair of strips in generally parallel, spaced, opposed relation for movement of said strips to between said outer peripheral surfaces including a member extending between said outer peripheral surfaces for spacing the central longitudinally extending portions of said strip from each other during bending of said marginal portions of said strip into connection with each other.

5. The combination as defined in claim 4 that includes:

(d) roll supporting means for supporting said pair of strips in a pair of rolls thereof for rotation of said rolls upon such strips being moved to between said pair of strip bending rollers;

(e) strip driving means between said strip bending rollers and said pair of rolls in positions for frictionally engaging the marginal portions of each of such strips for driving said pair of strips in said generally parallel, spaced, opposed relation to between said pair of strip bending rollers;

(f) power means connected with said strip driving means for actuating the latter to drive said pair of strips to between said pair of strip bending rollers.

6. In the combination as defined in claim 5:

(g) said means for supporting said pair of strips in generally parallel, spaced, opposed relation extending horizontally for supporting said strips generally horizontal with one spaced above the other;

(h) said strip driving means including a pair of horizontally disposed circular rollers supported on said frame for rotation about their vertical axes in positions adjacent to the opposite longitudinally extending edges of said strips and outwardly of said strips but projecting between said strips along opposite longitudinally extending marginal portions of the latter at the portions of said pair of rollers that are closest to each other; and

(i) a pair of vertical drive rollers respectively spaced above and below each of said last-mentioned portions of said horizontally disposed rollers and rotatably supported on said frame for rotation about parallel horizontal axes extending normal to the length of such strips with their outer peripheries respec-

tively in driving engagement with the marginal portions of said pair of strips for holding said marginal portions in engagement with said portions of said horizontally disposed pair of rollers, and said vertical drive rollers being connected with said power means for driving them.

7. In a vane forming machine for continuously forming a double vane from a pair of sheet metal strips of substantially the same width:

(a) a pair of bending rollers disposed one over the other between which said pair of strips is adapted to be driven in a direction longitudinally of said strips for bending thereby;

(b) one roller of said pair being formed with a radially outwardly opening channel in its outer periphery providing a pair of generally opposed spaced sidewalls and a bottom and into which channel said strips are adapted to be bowed transversely thereof;

(c) the other roller of said pair having a pair of coaxial, spaced, radially outwardly projecting annular flanges between which said strips are adapted to extend for bowing thereof into said channel;

(d) an intermediate portion on the outer periphery of said other roller convexly curved in cross-sectional contour to substantially conform to the contour of one of said strips, when transversely bowed, projecting into said channel but centrally spaced from said bottom wall to provide a space into which the other of said strips is adapted to be transversely bowed centraly between its marginal portions when said one strip is bowed by said intermediate portion;

(e) shafts supporting said rollers coplanar for rotation about their axes with said intermediate portion projecting into said channel and with the said sidewalls disposed between said flanges;

(f) a mandrel extending into said channel between the bottom of said channel and said intermediate portion and between said strips when the latter are driven between said rollers for spacing the central bowed portions of said strips; and

(g) means for holding said mandrel between said rollers during movement when said strips are driven between said rollers.

8. A vane forming machine for forming a double vane from a pair of sheet metal strips of equal width, comprising, in combination:

(a) a stationary frame having a feed end and a discharge end;

(b) guide means at said feed end for supporting said pair of sheet metal strips generally horizontally for movement from said feed end toward said discharge end with one strip spaced above the other;

(c) strip driving means adjacent to said feed end for simultaneously driving said pair of strips toward said discharge end with said one strip spaced above the other;

(d) strip bowing means on said frame between said strip driving means and said discharge end of said frame for engaging and bowing said strips transversely of their length to one side of said pair of strips to different degrees and to connect said strips along their longitudinally extending marginal portions for forming a hollow vane;

(e) margin bending means between said strip bowing means and said discharge end for bending one of the marginal portions of one of said strips over and in engagement with the marginal portions of the other strips;

(f) flattening means between said margin bending means and said discharge end for flattening the portions of said holow vane along said marginal portions of said strips in planes extending convergently relative to each other in directions from said marginal portions of said strip toward their central longitudinally extending portions that are intermediate said marginal portions; and

(g) vane straightening means adjacent to said discharge end for straightening the vane after leaving said flattening means.

9. In the combination as defined in claim 8:

(h) said strip driving means, said strip bowing means, and said strip flattening means respectively including separate pairs of rollers supported in positions for driving engagement with said strips to drive said strips from said feed end to said discharge end; and

(i) power means connected with the rollers of said separate pairs for rotating them in directions for moving said strips from said feed end to said discharge end upon such rotation.

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