MACHINE FOR FORMING HEAT-EXCHANGER FINS

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ABSTRACT

Disclosed is a machine for forming T-shaped fins having a sealing gasket projecting from the leg portion of the T. The machine includes a first forming station which forms two parallel strips into angles. An assembly section guides the two angles into back-to-back relation with a strip of gasket material between the angles and with a flat metallic strip below the angles. A second forming station bends the lateral edges of the flat strip around the bases of the angles to complete the formation of the fin. The machine may also include a set of curling rolls to bend the fin into a curved configuration. One use of the formed fin is as a spiral seal between the inner and outer rolls of the fluid heat-exchanger type roll.

11 Claims, 19 Drawing Figures
MACHINE FOR FORMING HEAT-EXCHANGER FINS

Fluid heat-exchanger type rolls are used in many processes, for example to cool and/or heat paper, film, and other sheets. One form of heat-exchanger consists of a roll having an inner shell and an outer shell which are separated by an annular space through which the heat-exchange medium or fluid, such as water, is caused to flow. More efficient heat-exchange along the length of the roll is achieved by providing a spiraled gasket or seal between the inner and outer shells of the roll to force the fluid to flow in a spiral fashion along the roll.

It is the primary object of the present invention to provide a machine for forming a metal fin which has a sealing gasket. It is also an object of the invention to provide a machine which forms such a fin in a continuous manner. Such a fin is suitable for use as the spiral sealing member between the inner and outer shells of a heating and/or cooling roll.

In accordance with the principles of the invention, the objectives are achieved, in the preferred embodiments, by providing a machine which includes a first forming station which forms two flat metal strips into angles, an assembly station which assembles the angles in back-to-back relation with a strip of gasket material between the angles, and a second forming station which forms a flat strip around the lateral edges of the bases of the angles to lock the angles and gasket materials together thus forming the complete fin.

For a more complete understanding of the invention and of the objects and advantages thereof reference should be had to the following specification and the accompanying drawings wherein there is shown a preferred embodiment of the invention.

In the drawing:

FIG. 1, consisting of the parts A and B, is a plan view of the heat-exchanger fin forming machine of the present invention;

FIG. 2, consisting of two parts A and B, is a side elevational view of the fin forming machine;

FIGS. 3 - 7 are sectional views taken along the lines 3 - 3 to 7 - 7, respectively, of FIG. 1 and showing the successive stages in the forming of the heat exchanger fins;

FIG. 8 is a side elevational view, partially in section, of the second roll forming station of the machine;

FIG. 9 is a fragmentary sectional view taken along the line 9 - 9 of FIG. 1;

FIG. 10 is a side elevational view, on an enlarged scale, of the fin curling section of the machine;

FIG. 11 is a fragmentary vertical section taken along the line 11 - 11 of FIG. 10;

FIG. 12 is an elevational view of a roll employing the heat-exchanger fins formed on the machine of the present invention, with portions of the roll broken away to show the internal structure thereof;

FIGS. 13 - 17 are sectional views showing successive stages of the formation of a fin according to a modification of the invention.

The heat-exchanger fin forming machine includes a supply station 10 which supplies two flat metal strips to a first forming station 12. This forming station 12 bends the two strips into angles which then advance through a guiding and assembling section 14 where a strip of gasket material from a supply station 16 is inserted between the angles and a third flat metal strip from a supply station 18 is positioned along the base of the angles. The guiding and assembling section 14 also moves the formed angles on a convergent path to a second forming station 20 where the lateral edges of the third strip are bent to wrap around the base of the two angles, locking the angles together and retaining the gasket material between the adjacent flanges of the angles. The machine may also include a set of curling rolls 22 as its exit end for curving the formed fin. A take-up turn table 24 receives the formed fin from the machine.

The strip supply station 10 is provided with a coil 26 of flat metallic strip 28 and with a second and with a second roll (not shown) which supplies an identical flat metallic strip 30. The strips 28 and 30 are fed to the machine along spaced parallel paths.

FIRST FORMING STATION 12

The first forming station 12 consists of two roll forming units 32 each of which has a series of upper and lower forming rolls 34 and 35 which progressively bend the strip stock to an angle configuration, in a manner well known in the roll forming art. The two strips 28 and 30 are formed into angles 36 and 38. Each of the angles 36 and 38 has a base portion 36a, 38a, respectively, and side portion 36b, 38b, respectively. The angles 36 and 38 are formed with their respective side portions toward the longitudinal center line of the machine. The angles thus emerge from the first forming station 12 with their side portions 36b and 38b in aligned parallel planes and with their base portions 36a and 38a directed away from one another.

It should be understood that, if different roll forming units are employed, the angle strips may be oriented at other angles. In such an arrangement suitable guides or rollers will be provided to twist the angles into the desired back-to-back relationship.

FORMING AND ASSEMBLING STATION 14

The forming and assembling station 14 includes guide rolls 40 which direct the two angles 36 and 38 along converging paths. A strip 42 of gasket material, preferably Teflon, is fed from a roll 44 carried by the supply station 16 through feed rollers 46 along the center line of the V between the converging angles 36 and 38. This strip of gasket material 42 is of greater height than the side portions 36b and 38b of the angles 36 and 38. The supply station 18 mounts a coil 48 of flat metallic strip 50 which is supplied to the guiding and assembling section 14 over a roller 52 to lie along the bases 36a and 38a of the angles 36 and 38. The width of the strip 50 is sufficiently greater than the combined widths of the bases 36a and 38a and the thickness of the gasket strip 42 to provide lateral edges of the strip 50 which project beyond the ends of the angle bases 36a and 38a. At the exit end of the guiding and assembling station 14 the angles 36 and 38 have been brought together with the strip of gasket material 42 between the sides of the angles and with the flat metal strip 50 against the base of the angles.

As the assembly of the angles 36 and 38, the gasket strip 42, and the flat metal strip 50 exists from the guiding and assembling station 14 it is supplied to the second forming station 20.

SECOND FORMING STATION 20

The second forming station 20 is shown in detail in FIGS. 8 and 9. The second forming station 20 is provided with a pair of spaced parallel vertical side frames 54 which rest on a suitable base 88 and which journal sets of upper and lower shafts 58 and 60, respectively. Forming rollers 62 are carried on the inner end of the upper shafts 58 and are spaced from the side frames 56 by spacers 64. The lower shafts 60 mount forming rollers 66 at their inner ends which are also separated from the side frames 56 by spacers 68. The forming station 20 is provided with a series of sets of upper and lower forming rolls and, in the manner well known to those skilled in the metal forming art, each set of rollers effects a successively greater deformation of the lateral edges of the flat strip 50 to gradually bend these edges up and over the lateral edges of the bases 36a and 38a of the angles 36 and 38.

FIG. 9 illustrates the last set of forming rollers at which point the lateral edges 50a of the strip 50 are bent completely around the lateral edges of the angle base 36a and 38a and the assembly is thus formed into the fin 54. The bent over edges 50a of the strip 50 serve both to secure the angles 36 and 38 together and to form the strip 42 of gasket material tightly between the side portions 36b and 38b of the angles to tightly anchor this gasket strip 42 in place.

In order to hold the assembly of the angles 36 and 38, the gasket material 42 and the flat metal strip 50 in their assembled relation as the strip and angles move through the forming station 20 and prior to the completion of the bending of the lateral edges of the strip 50 there are provided a pair of upper
guide plates 70 which extend the length of the forming station 20 and which project through the slot 72 between the upper forming rolls 62 and guide and hold the sides 36a and 38b of the angles. As will be seen from FIG. 9, the upper guide plates 70 are supported by a rail 78 and the lower guide plate 74 is supported by a rail 80. These rails 78 and 80 extend the length of the forming station 20 and are joined by end plates 80 and 82 which are supported by the base 88. The end plate 80 includes an entry opening 84 while the end plate 82 includes an exit opening 86. As the formed fin 54 emerges from the last set of forming rollers it is passed between a pair of dimpling rollers 90 which act on the side portions 36a and 38b of the angles to more tightly anchor the gasket strip 42 between these side portions.

It is contemplated that a single forming roll may be used in place of the pair of rolls 66. In such an arrangement, the lower guide plate 74 may be omitted.

FIN CURLING STATION

The embodiment of the forming machine illustrated in FIGS. 1 and 2 also includes a fin curling station 22 which is shown in detail in FIGS. 10 and 11. A horizontal arm 92 is attached to and projects from the exit side of the forming station 20 above the path of travel of the fin 54. The arm 92 may carry one or more guide rollers 94 on its lower edge for guiding the advancing fin 54. At the end of the arm 92 there is provided a pair of rolls 96 and 98. As will be seen from FIG. 11, the upper roll 96 consists of two side portions 96a separated by a spacer 96b to provide clearance for the leg portion of the fin 54. The rolls 96 and 98 are keyed to shafts 100 and 102, respectively. The opposed ends of the shafts 100 and 102 provided with meshing gears 104 and 106. The shaft 100 also carries a gear 108 which is driven by a chain 110 from a sprocket 112 keyed to a jack shaft 114. A second sprocket 116 on the shaft 114 is driven, through suitable sprockets and chains, for example, from the forming roll drive of the second forming station 20. The rolls 96 and 98 thus rotate uniformly and in opposite directions and serve to positively feed the fin 54 into the curling station 22.

Mounted at the end of the horizontal arm 92 is a vertical support plate 118 which is provided with three slides 120, 122, and 124. The first slide assembly 120 is located immediately adjacent the feed rolls 96 and 98. This assembly includes a sliding bar 126 guided for vertical movement in ways 128 mounted on the support plate 118. The position of the sliding bar 126 is determined by a screw 130 received in a bearing block 132 also fastened to the support plate 118. The lower end of the sliding bar 126 carries a roll 134. This roll 134 engages the lower or base portion of the fin 54 as it emerges from the feed rolls 96 and 98. The second slide assembly 122 again includes a sliding bar 136 carried in ways 138 and positioned by a screw 140. The bar 136 is slidable along a pathway angled slightly from the vertical. A roll 142 is provided at the lower end of the sliding bar 136. This roll 142 is of the same type as the roll 96, that is, the roll is provided with a groove to provide clearance for the leg portion of the fin 54. The roll 142 engages the upper edge of the fin 54 and, as will be seen from FIG. 10, is positioned below the roll 96 so that the fin 54 is forced into a curved path from the rolls 96 and 98 over the roll 134 and under the roll 142. The third slide assembly 124 includes a sliding bar 144 carried in ways 146 and adjustable by means of a screw 148. The lower end of this sliding bar 144 carries a roll 150 which engages the lower or base portion of the fin 54 after it has passed under the roll 142. A second pair of driven rolls 152 and 154 are provided at the end of the one forming station. Again, the roll 152 is provided with an annular slot to receive the leg portion of the fin 54. The rolls 152 and 154 are carried on a bracket 156 which, in turn, is carried on an arm 158 which is pivotally mounted to the jack shaft 114 at the upper end of the horizontal arm 92. A sprocket 160 keyed to the shaft 114 drives the roll 152 through suitable sprockets and chains. The fin 54 is advanced smoothly through the fin curling station without any tendency to twist, bunch, or pull. The speed of the take up roll 152 may be varied slightly, if necessary, to compensate for slippage of the fin.

At the take up station 24 the formed and curved fin 54 is wound onto a turn table 160. It is contemplated that the fin curling station may be arranged to curl the fin in the opposite direction, that is, with the leg portion 54 of the fin on the inside of the curl rather than on the outside as shown.

One use of the formed fins 54 is shown in FIG. 12. This FIG. illustrates a heat-exchanger roll 162 which consists of an outer shell 164, an inner shell 166 separated from the outer shell by a space 168, and end plates 170 joining the inner and outer shells and sealing the annular space 168. The end plates 170 are provided with journals 172. Bores 174 extend inwardly from the outer ends from the journals 172 and communicate with passages 176 in the end plates 170. The passages 176 also communicate with the annular space 168 between the outer shell 164 and the inner shell 166. For heat-exchange purposes fluid is forced through one of the bores 174 and the passages 176 to flow through the annular space 168 and exit through the passages 176 in the opposite end plate and the bore 174 in the opposite journal 172. In order to provide more uniform and efficient heat-exchange along the entire length of the roll a fin 178 is wound in spiral fashion along the outer surface of the inner shell 166 to provide a spiraling fluid passage between the inner and outer shells. The fin 54 formed by the machine described above may be used to provide this fin on the inner shell. The base portion of the fin 54 may be welded, brazed, or otherwise secured in a spiral fashion along the outer circumference of the inner shell 166, prior to the insertion of the inner shell into the outer roll shell 164. The Teflon sealing gasket 42 will be somewhat deflected by the outer shell 164 as the inner shell is inserted and will thus form an effective fluid tight seal between the two shells without requiring the inner surface of the outer shell 164 to be maintained to close precision tolerances.

In certain circumstances it may be preferable to secure the fin 54 to the inner surface of the outer shell 164. In such an arrangement a fin curled in the opposite direction, i.e., with the leg portion of the fin directed toward the inside of the curve, has its base brazed or welded to the inner surface of the shell 164. The sealing gasket 42 bears against the outer surface of the inner shell 166 to form the spiral passage.

An alternate method for forming the fin employing only a single metal strip is shown in FIGS. 13 - 17. In this embodiment of the invention, a flat metal strip 180 is supplied to a forming station which first bends the lateral edges of the strip 180 into the configuration of FIG. 14 with the lateral edges 182 extending at right angles to the main portion of the strip 180. The forming station subsequently bends the strip to the configuration of FIG. 15 with the lateral edges again being horizontal and with intermediate portions 184. Further bending along the line between the center portion 184 and the intermediate portions 186 brings the intermediate portions 186 into overlapping relation with the base portion 184 and brings the edge portions 182 toward one another, resulting in the configuration of FIG. 16. At this time, a strip of gasket material 188 is inserted between the edge portions 182. Subsequent additional bending between the base portion 184 and the intermediate portions 186 produces the T-shaped fin with the edge portions 182 and the gasket 188 forming the leg of the T.
and the base portion 184 and the overlapped intermediate portions 186 forming the base of the fin. The formed fin may be crimped to more securely anchor the gasket strip 188 in place.

It will be understood that further changes may be made in and to the described embodiment of the invention. For example, the first forming station 12 of the first embodiment may be omitted and a different angle stock used to form the heat-exchanger fin. The strips and the gasket material may vary in width to form fins of different sizes. It will also be understood that other uses may be had for the fins formed by the machinery described above. The basic idea, however, is to form a T-shaped fin having an all metallic base and leg portion with a gasket extending from the top thereof supported and retained in position by the angled sides of the metal portion of the fin.

It will also be understood that while the use of the fin 54 to form the spiral cooling fluid passage in a heat exchanger roll is the preferred use of this fin, the fin may also be used for other purposes. Among the potential uses of the fin 54 is its use as a spiral fin on a web expander roll employed to stretch a web of cloth laterally.

While only the best known embodiments of the invention have been described and illustrated in detail, the invention is not so limited. The true scope of the invention is defined in the following claims.

What is claimed is:

1. Apparatus for forming a member of indefinite length which has a metallic base portion and a leg portion extending perpendicular to the base portion and consisting of parallel metallic sides formed of upward extensions of the base and a gasket material strip retained between and projecting beyond the metallic sides, comprising:
   first supply means furnishing metallic strip to the apparatus;
   second supply means furnishing the gasket material strip to the apparatus;
   forming means receiving metallic strip from the first supply means and bending the lateral edges thereof to form the base portion and sides of the leg portion of the member;
   and
   guide means receiving the gasket material strip and positioned the strip between the metallic sides of the leg portion at a point prior to the completion of the bending of the metallic strip.

2. Apparatus according to claim 1 wherein the forming means includes a roll forming device having a series of sets of forming rolls, each set of forming rolls effecting a successively greater bending of the strip.

3. Apparatus according to claim 1 wherein the first supply means includes means supplying a pair of metallic angle strips to the apparatus and means supplying a flat metallic strip to the apparatus; the guide means includes means to align the angle strips in back-to-back relationship, means to position the gasket material strip between the aligned angles, and means to position the flat metallic strip along the bases of the aligned angles; and the forming means includes a forming station receiving the aligned angles and strips from the guide means and bending the lateral edges of the flat metallic strip into overlapping relation around the bases of the angles.

4. Apparatus according to claim 3 further including aligning means extending the length of the forming station for maintaining the pair of angles and the flat strips in aligned relationship to one another during the forming operation.

5. Apparatus according to claim 4 wherein the aligning means includes a pair of upper aligning plates extending the length of the forming station in spaced parallel relationship to one another and receiving the adjacent side portions of the angles between the plates, and a lower aligning plate extending the length of the forming station for supporting the flat metallic strip against the bases of the angles.

6. Apparatus according to claim 3 wherein the first supply means includes a pair of additional supply means each furnishing a flat metallic strip to the apparatus and a pair of additional forming stations each receiving one of the strips from the additional supply means and bending the strip into an angle, the additional forming stations being mounted in side-by-side relationship and forming the pair of angles with their side portions parallel to one another and with their base portions directed away from one another.

7. Apparatus according to claim 1 further including means receiving the formed member from the forming means for uniformly curling the formed member.

8. Apparatus according to claim 7 wherein the curling means includes a first pair of rolls engaging the upper and lower surfaces of the base of the formed member, and at least one additional roll engaging one surface of the base of the formed member, the additional roll being offset from the path of travel of the formed member between the forming means and the formed member between the forming means and the first pair of rolls, the formed member passing between the first pair of rolls and being deflected into a curled configuration by the additional rolls.

9. Apparatus according to claim 8 wherein the curling means further includes a second pair of rolls engaging opposite surfaces of the base of the formed member, the second pair of rolls being located after the additional rolls, the first pair of rolls, additional rolls, and second pair of rolls forming a curved path to impart a curl to the formed member, the additional rolls and second pair of rolls being adjustably located to vary the curvature of the path and the amount of curvature imparted to the formed member, the first and second pairs of rolls being positively driven to advance the formed member through the curling means.

10. Apparatus according to claim 9 wherein the curling means further includes guide rolls between each of the pairs of rolls and each of the additional rolls, the guide rolls engaging the opposite surfaces of the formed member from that engaged by the additional rolls, the location of the guide rolls being variable to conform to the curved path established by the pairs of rolls and the additional rolls.

11. Apparatus for forming a heat-exchanger fin having a T-shaped configuration and a gasket secured to the leg portion of the fin, comprising:
   first and second supply reels for holding and supplying first and second coils of strip;
   and
   first and second forming means acting respectively on the first and second strips to form the strips into angles, a third supply reel for holding and supplying a coil of gasket material in strip form;
   guide means receiving the formed angles and the gasket material and positioning the angles in back-to-back relationship on opposite sides of the strip of gasket material; a fourth supply reel for holding and supplying a strip of greater width than the combined widths of the bases of the angles and the thickness of the gasket material; additional guide means receiving and positioning the third strip in centered relation on the base of the angles and gasket material; a third forming station acting on the third strip to bend the lateral edges thereof in overlapping relation around the bases of the angles; and means for receiving the formed fin from the third forming station.