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O. G. BROTHEN

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MANUFACTURE OF INTEGRALLY FINNED TUBING

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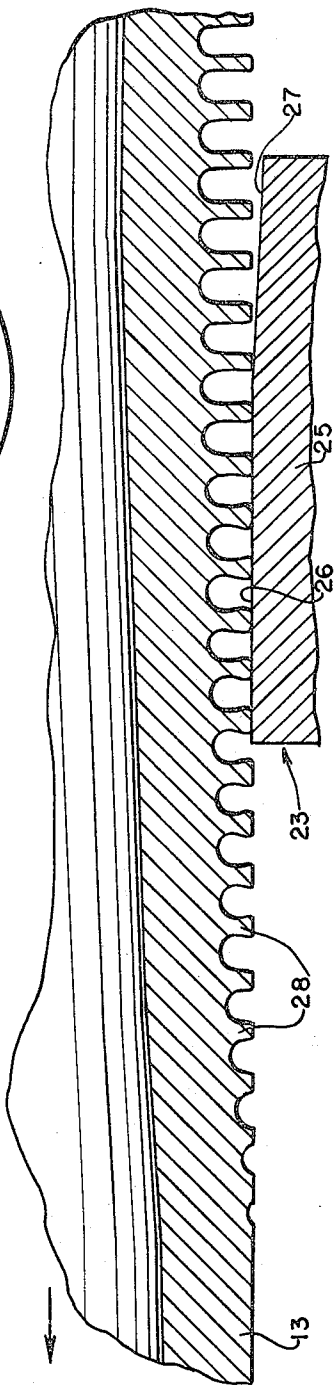
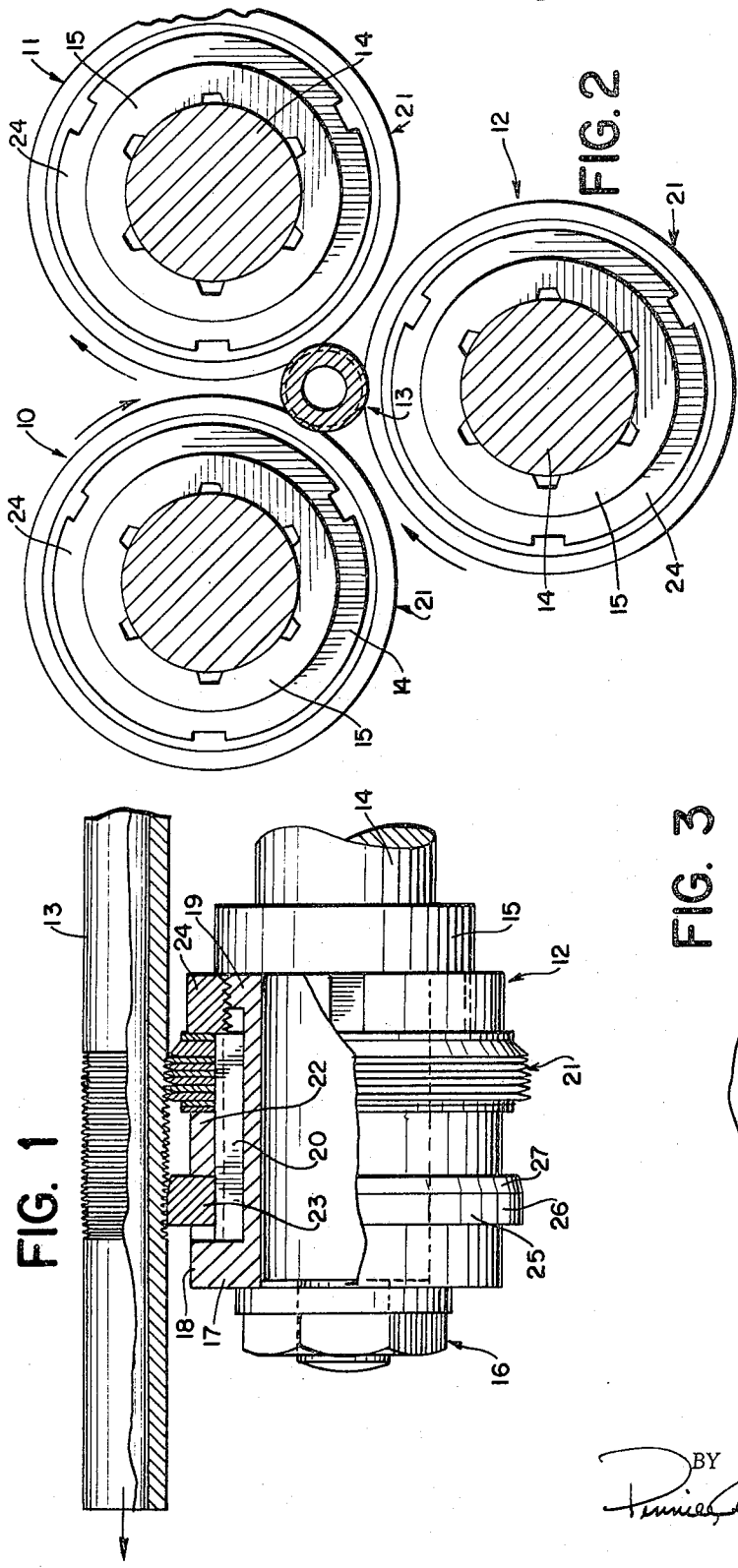


FIG. 1

FIG. 2

FIG. 3

INVENTOR
OSCAR G. BROTHEN

BY *James E. Martin, Taylor & Hays*
ATTORNEYS

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MANUFACTURE OF INTEGRALLY FINNED TUBING

Oscar G. Brothen, Kenosha, Wis., assignor to Anaconda American Brass Company, a corporation of Connecticut
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ABSTRACT OF THE DISCLOSURE

An improvement in apparatus for forming axially spaced integral annular fins on a length of tubing which includes a sizing collar mounted on each of a plurality of roll assemblies and axially spaced from the roll assemblies in the direction of advance of the tubing a sufficient distance to allow the forming roll assemblies to be closed in relation to each other in their fin forming position when the collar contacts the tube. The sizing collar is of a diameter such that in the fin forming position of the assemblies the sizing collars define the maximum size of the fins to be formed and are mounted to circumferentially roll down the peripheral surfaces of fins which exceed the maximum size.

This invention relates to the manufacture of integrally finned tubing, and more particularly it relates to improved forming roll assemblies in apparatus for forming integral annular fins on tubing without an increase in diameter of the tubing and to a method of making such tubing.

Integral annular external fins are formed on lengths of tubing by subjecting the tubing to a circumferential rolling pressure radially inward against axially spaced peripheral portions of a tubing to extrude material from the wall of the tubing radially outward to form fins. The apparatus for forming fins on tubing generally consists of a plurality of forming roll assemblies which are positioned spaced about the tube and are mounted to move toward the tube to contact a tube positioned therebetween. Each forming roll assembly has die means which define axially spaced peripheral portions with grooves formed therebetween. The die means are commonly discs which are graduated in diameter and width to progressively form fins of the desired size and height. A slight skew angle on the axes results in axial feeding of the tube through the apparatus as the fins are formed on the tube.

In forming an integral low fin type of surface on heat exchanger tubes, a short section of the tube on each end is left plain or unfinned so that the tube can be fastened into the tube sheets in the customary manner. In this installation the entire length of the tube must be pushed through a hole in the front head plate until the far end enters the corresponding hole in the rear plate. To accomplish this it is, of course, essential that the diameter defined by the periphery of the fins should not exceed the diameter of the unfinned end portions or the diameter of the hole in the plate.

With tubes having a small wall thickness the fin height can sometimes be held below the required maximum because the excess height caused by outward extrusion of the metal can be taken up by reduction of the internal diameter of the finned portion of the tube. As the wall thickness of the tube is increased in proportion to the tube diameter, a point is finally reached where it is impossible, particularly at the initial point of finning, to keep the fin height low enough.

Often the die used consists of a plurality of graduated diameter discs and since the largest diameter discs, which comprise the finishing sector of the dies and are designed to enter the deepest into the wall of the tube, are the first to contact the tube, the instant this sector of the dies

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touches the tube the material extrudes outward between the peaks and escapes forward axially of the dies as a rudimentary fin of oversize diameter. This occurs after initial contact but before complete closure of the dies has had an opportunity to cause a general collapse of the inside diameter to compensate for the increase in outside diameter resulting from fin formation.

Heretofore, this problem has been rectified after the finning operation by starting with a tube which is undersize in diameter and, after finning, expanding the unfinned end portions up to the proper diameter by further and costly treatment.

I have found that a tube having axially spaced integral annular fins of the same diameter as lengths of unfinned portions of the tube can be formed in a single operation by rolling down the peaks of the fins, which exceed the diameter of the unfinned portions, immediately after they are formed, and flatten the peaks to a diameter about equal to the diameter of the unfinned portions of the tube. The improvement is in a method of forming integral annular fins on a length of tubing wherein the tubing is subjected to a circumferential rolling pressure radially inward against spaced peripheral portions of a tubing to extrude material from the wall of the tubing radially outward to form said fins. The improvement lies in controlling the maximum size of the fins by applying a circumferential rolling pressure against the peripheral surfaces of the fins that exceed a maximum diameter so as to flatten the tips to a diameter equal to the diameter of the unfinned diameter of the tube.

The apparatus of the invention is of the type for forming axially spaced integral annular fins on a length of tubing; it has a plurality of forming roll assemblies mounted spaced from one another about a length of tubing and die means are provided on the assemblies which define axially spaced peripheral portions with grooves formed therebetween. The assemblies are mounted to move in relation to one another to contact tubing positioned therebetween for forming the annular fins and axially advancing the tubing through the apparatus. Broadly stated, the improvement is comprised of a sizing collar mounted on said roll assemblies and axially spaced from the die means in the direction of advance of said tubing a sufficient distance to allow the forming roll assemblies to be closed relative to each other in their fin forming position when the sizing collar contacts the tube. The sizing collar has a diameter such that in the fin forming position of the assemblies, the sizing collars define the maximum size of the fins to be formed and are mounted to circumferentially roll down the peripheral surfaces of fins which exceed the maximum size.

Preferably three forming roll assemblies are mounted with their axes essentially parallel to each other but spaced about 120° apart. The forming roll assemblies are movable toward and away from each other to a fin forming position where they are closest together so that their dies contact a tube positioned therebetween with a circumferential rolling pressure and to an open position spaced from a tube positioned therebetween. The axes of the rolls are at a slight skew angle in the customary manner so that the tube will be advanced through the apparatus. The sizing collars are of a diameter such that in the fin forming position nothing larger than the specified diameter of the tube can pass between them. The slight skew angle of the assemblies and their rotation is ideal to roll down any oversize fins to the exact dimension.

A preferred embodiment of the invention is described hereinbelow with reference to the drawing wherein:

FIG. 1 is a side elevation partly in section of a forming roll assembly of the invention;

FIG. 2 is an end elevation showing three forming roll assemblies positioned about a tubing; and

FIG. 3 is an enlarged fragmentary section of a sizing collar rolling down fins having an enlarged diameter.

The basic apparatus for forming integral annular fins on a length of tubing is of standard construction and consists of three forming roll assemblies 10, 11 and 12 which are shown in FIG. 2 with their axes essentially parallel and spaced from each other 120° circumferentially about a tube 13.

The forming roll assemblies, as shown in FIG. 1, each consist of a spindle 14 which is constantly rotated and mounted to move radially toward and away from the tube positioned therebetween at a tube forming station. Thus, the spindles can be brought together so that the dies are caused to bear upon the portions of the tube desired to be formed and opened to permit portions which are not to be finned to pass therethrough. A slight skew angle on the axes in the customary manner permits the tube to be fed through the apparatus while it is being worked on.

The spindle has an enlarged diameter portion 15 adjacent one end thereof and a clamp arrangement 16 at the opposite end. The clamp arrangement can simply be a nut and washer threaded on a stud extending from the end of the spindle. The fin forming means are held between the clamp arrangement 16 and the enlarged portion 15. A generally cylindrical member 17 with enlarged diameter end portions 18 and 19 is mounted on the spindle to rotate with it, for example by means of a splined spindle and a matching interlocking configuration on the cylindrical member. A sleeve 20 is keyed to the middle portion of the cylindrical member and has a die 21 keyed to it which is formed by a group of annular discs which are graduated in diameter and thickness in the conventional way. A spacer 22 is also keyed to the sleeve 20 and a sizing collar 23 is keyed on the sleeve with the spacer between it and the die. The collar, spacer and die are held axially together by a lock nut 24 which is threaded on one of the enlarged end portions 19 of the cylindrical member 17.

The sizing collar has a generally cylindrical peripheral portion 25 defining a substantially flat peripheral surface 26 and an inwardly bevelled annular marginal edge portion 27 along the edge axially closest to the die. The sizing collar has a diameter such that in the fin forming position of the assemblies, the maximum size of the fins to be formed is defined by the minimum space between the collars.

When the graduated diameter dies of the respective forming roll assemblies are moved toward each other in their thin forming position in contact with the wall of the tube, the discs having the largest diameter and which define the finishing sector of the die are the first to contact the wall of the tube. When this sector touches the tube the material extrudes outward between the peaks of the disc at the finishing zone and escapes forward axially out of the dies as a fin of a diameter greater than the original diameter of the tube. This is particularly the case with tubes having a rather heavy wall compared to its diameter, for example .75 inch O.D. by .095 inch wall thickness. With these heavier tubes the structural form of the tube tends to resist collapse of the inside of the diameter to the extent that the formation of fins tends to cause the major diameter of the fin tube to be greater than that of unfinned portions. Thus there is a transitory section formed in the tube between the plain end portions of the tube and the finned portions which have been formed with the assemblies in their closed fin forming position; this transitory section is characterized by having fins 28 of a larger diameter than the diameter of the unfinned portions of the tube. When the assemblies are in their closed fin forming position the die means are so configured that the fins will not exceed a specified diameter.

The sizing collar 23 is spaced from the die 21 by the spacer 22, a distance such that it will not contact the fins along this transitory section until the assemblies are in their closed fin forming position. The collar is spaced from the die in the direction of travel of the tube and as shown

in FIG. 3 as the tube is fed through the apparatus, the enlarged fins along the transitory section first come in contact with the bevelled edge portions 27 and the rotating collar begins to roll the peaks of the enlarged fins and flatten them to or below the maximum diameter size required. In the fin forming position the collars of the assemblies define a minimum diameter and any fin portion of the tube in excess of this diameter will be rolled down to the required diameter size. Of course, once the portion of the tube which is properly finned passes through the collars, no rolling of the peaks of the fins is necessary or will occur. By this means a constant and uniform outside diameter can be maintained over the entire length of the tube.

I claim:

1. In apparatus for forming axially spaced integral annular fins on a length of tubing of the type having a plurality of forming roll assemblies mounted spaced from one another about a length of tubing, said assemblies having die means defining axially spaced peripheral portions with grooves formed therebetween, said assemblies mounted to move in relation to one another to contact the tubing therebetween for forming said annular fins and axially advancing the tubing through the apparatus, the improvement in combination therewith comprising a sizing collar mounted on said roll assemblies and axially spaced from said die means in the direction of advance of said tubing a sufficient distance to allow the forming roll assemblies to be closed in relation to each other in their fin forming position when the collar contacts the tube, said sizing collar having a diameter such that in the fin forming position of the assemblies the sizing collars define the maximum size of the fins to be formed and are mounted to circumferentially roll down the peripheral surfaces of fins which exceed said maximum size.

2. Apparatus according to claim 1 wherein three forming roll assemblies are positioned spaced about 120° from each other, said forming roll assemblies being movable toward and away from each other relative to a tube finning station defined therebetween.

3. Apparatus according to claim 1 wherein said die means comprise a plurality of discs graduated in diameter with the largest diameter discs nearest said collar.

4. Apparatus according to claim 1 wherein said collar has a substantially flat peripheral surface portion and an inwardly bevelled annular marginal edge portion axially closest to said die means.

5. Apparatus according to claim 1 wherein said collars of said assemblies have diameters such that in their closed position they define a minimum opening equal to the diameter of unfinned tube.

6. In apparatus for forming axially spaced integral annular fins on a length of tubing of the type having a plurality of forming roll assemblies mounted spaced from one another about a length of tubing, said assemblies having die means defining axially spaced peripheral portions with grooves formed therebetween, said assemblies mounted to move in relation to one another to contact the tubing therebetween for forming annular fins and axially advancing the tubing through the apparatus, the improvement in said roll-forming assemblies in combination therewith comprising a spindle on which said die means are mounted, a sizing collar mounted on said spindle, a spacer positioned between said collar and said die means for maintaining said collar spaced from said die means in the direction of advance of said tubing a sufficient distance to allow the forming roll assemblies to be closed in relation to each other in their fin forming position when the collar contacts the tube, said sizing collar having a diameter such that in the fin forming position of the assemblies the maximum size of the fins to be formed is defined by the minimum space between the collars, and said sizing collars are configured and are mounted to roll down the tips of fins which exceed said maximum size.

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7. In apparatus for forming axially spaced integral annular fins of a length of tubing of the type have three roll-forming assemblies positioned spaced about 120° from each other about a fin forming station at which a length of tubing is positioned, said assemblies having die means defining axially spaced peripheral portions with grooves formed therebetween, said assemblies mounted to move in relation to one another to contact the tubing therebetween for forming annular fins and axially advancing the tubing through the apparatus, the improvement in said roll-forming assemblies combination therewith comprising a spindle on which said die means are mounted, a sizing collar mounted on said spindle, a spacer positioned between said collar and said die means for maintaining said collar spaced from said die means in the direction of advance of said tubing a sufficient distance to allow the forming roll assemblies to be closed relative to each other in their fin forming position when the collar contacts the tube, said die means consisting of

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a plurality of discs graduated in diameter with the largest diameter discs nearest said collar, said collar having a substantially flat peripheral surface portion and an inwardly bevelled annular marginal edge portion nearest said die means, said sizing collar having a diameter such that in the fin forming position of the assemblies the maximum size of the fins to be formed is defined by the minimum space between the collars, and said sizing collars are configured and mounted to roll down that tips of fins which exceed said maximum size.

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RICHARD J. HERBST, *Primary Examiner*.