May 23, 1950 W. P. HILL 2,508,518

APPARATUS FOR FORMING INTEGRAL FINS ON A LENGTH OF STOCK

Filed Sept. 2, 1947 2 Sheets-Sheet 1

FIG. 1

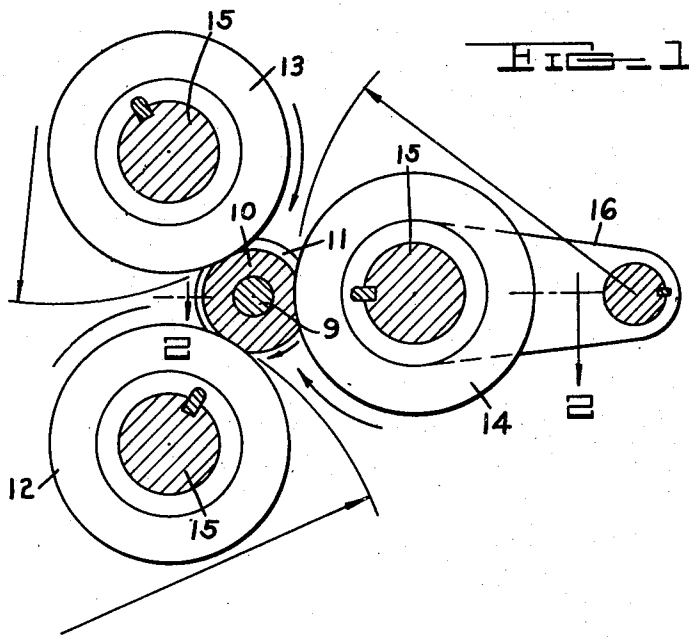


FIG. 2

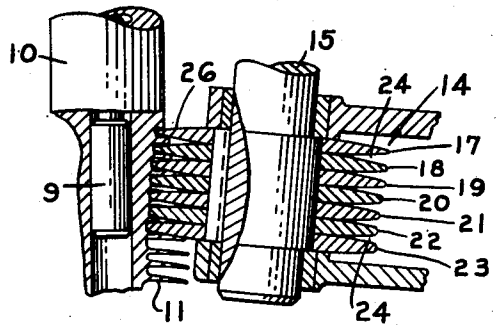
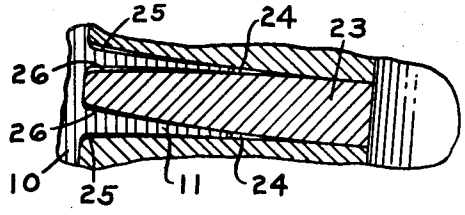


FIG. 3



INVENTOR.
WALTER P. HILL
BY
Whittemore, Hulbert & Belknap
ATTORNEYS

May 23, 1950 W. P. HILL 2,508,518

APPARATUS FOR FORMING INTEGRAL FINS ON A LENGTH OF STOCK

Filed Sept. 2, 1947 2 Sheets-Sheet 2

FIG. 5

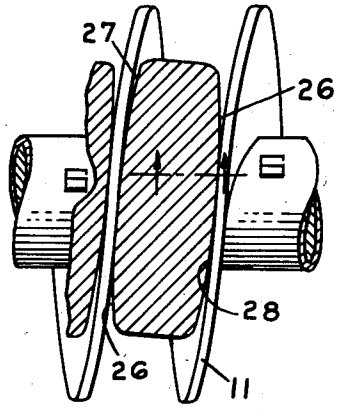


FIG. 6

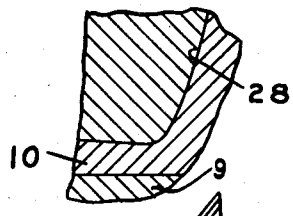
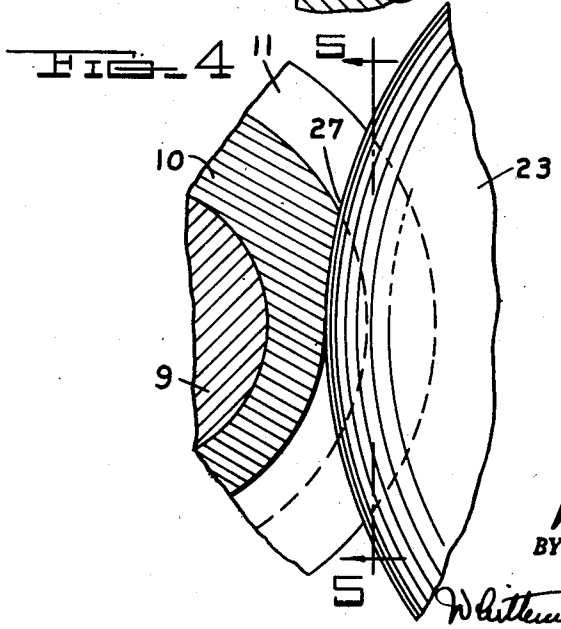


FIG. 4



INVENTOR.
WALTER P. HILL
BY
Whittemore Hulbert & Belknap
ATTORNEYS

Patented May 23, 1950 2,508,518

UNITED STATES PATENT OFFICE

2,508,518

APPARATUS FOR FORMING INTEGRAL FINS ON A LENGTH OF STOCK

Walter P. Hill, Detroit, Mich., assignor to Calumet and Hecla Consolidated Copper Company, Calumet, Mich., a corporation of Michigan

Application September 2, 1947, Serial No. 771,627

2 Claims. (Cl. 80—13)

1

The invention relates to an apparatus for forming integral fins on a length of stock and forms a continuation in part of my pending application for patent Serial No. 619,712 filed October 1, 1945. It is the primary object of the invention to avoid any appreciable rubbing and bending of the fins during the developing of the same which would have a detrimental effect in hardening and reducing the ductility of the material or otherwise overworking the same. To this end the invention consists in the novel method and apparatus as hereinafter set forth.

In the drawings:

Figure 1 is a semi-diagrammatic cross sectional view through a tube and one type of apparatus for forming fins on the tube;

Figure 2 is an exaggerated fragmentary sectional view showing one of the rollers in Figure 1 in fin forming operative relation to the tube and taken substantially on the line 2—2 of Figure 1;

Figure 3 is an enlarged fragmentary sectional view illustrating a part of one of the rollers in operative relation to the tube;

Figure 4 is a greatly enlarged fragmentary cross sectional view showing one of the roller sections in fin forming relationship with the tube;

Figure 5 is a sectional view taken substantially on the line 5—5 of Figure 4; and

Figure 6 is an enlarged sectional view taken on the line 6—6 of Figure 5.

In the present state of the art, methods and apparatus of two types have been used for the development of integral helical fins on plain tubing. In the one, the outer portion of the tube wall is scored to form a helical groove and the material between the adjacent convolutions of the groove is compressed axially to reduce the thickness thereof and to displace the same radially outwardly. In carrying out this method the metal is subjected to considerable working and may become hardened to such an extent as to damage the tube, especially in instances where fins of substantial height are formed. In the other method, which forms the subject matter of the application for patent above mentioned, a tubular blank is engaged by a plurality of forming rollers suitably supported for rotation with their respective axes extending in the general direction of the axis of the tubular blank and spaced equal distances from each other around the tubular blank. The axes of the rollers are arranged at such an angle to the axis of the tubular blank as to enable the rollers to travel a helical path around the blank corresponding to

2

the helix angle of the fin to be formed on the blank. Each roller comprises a plurality of axially spaced annular portions arranged to apply a generally radially inwardly directed pressure on axially spaced helically aligned peripheral portions of the blank of sufficient magnitude to displace material from the peripheral portion of the tubular blank and extrude the displaced material outwardly into the spaces or grooves provided between the axially spaced peripheral portions of the rollers to form a helical fin. This fin is fashioned to the desired cross sectional contour by the surfaces of the roller forming the opposite sides of the space or groove into which the material is extruded. It has been the practice in the past to form these roller surfaces conical and substantially straight in radial contour from the root to the periphery of the fin. However, the helicoidal surface of a fin thus developed is not conjugate to the surface of revolution of the roller, and consequently the latter tends to distort the former, producing a bending back and forth of the fin and a rubbing action thereon which has a hardening effect.

It is the object of the instant invention to overcome this defect by fashioning the extruded material with surfaces of revolution which are conjugate to the helicoidal surface of the fin developed thereby. This necessitates a change in the radial contour of said surface of revolution from a rectilinear to a predetermined nonrectilinear curved form. The term conjugate as used in this connection means that no portion of the roller surface which forms the fin will, during its continued rotation, interfere with or displace the fin fashioned thereby. In brief, the rollers thus modified will roll through the helical groove or space between adjacent convolutions of the fin without interference with the latter. Consequently, the fin thus formed is not work-hardened to a detrimental extent as is the case where non-conjugate rollers are used in its development.

As illustrated 10 is a tube suitably supported on a mandrel 9 and 11 is a helical fin formed on said tube by the operation of rollers 12, 13 and 14. The method and the apparatus of developing these fins are generally the same as in the above referred to application for patent, and may be briefly described as follows. The rollers 12, 13 and 14 may be substantially alike in construction and are distributed about the circumference of the tube, preferably spaced 120° apart. Each roller comprises a series of individual circular portions or discs centrally apertured to receive an

arbor 15 and having hubs keyed or otherwise secured to the arbor in juxtaposition to each other. The axes of the arbors 15, or in other words, the axes of the rollers are crossed with respect to the axis of the tube and are also arranged at such an angle to the axis of the tube 10 as to travel a helical path about the tube corresponding generally to the helix angle of the fin to be formed on the tube. The construction is such that the discs or circular portions on the respective rollers actually track with each other and cooperate to form a continuous helical fin on the peripheral surface of the tube in a manner to be more fully hereinafter described. In practice the arbors are respectively supported on swinging arms 16 enabling the rollers to be moved in directions toward and away from the axis of the tube. In the present instance the arbors are driven and suitable driving means (not shown) is universally connected to the swinging arbors for this purpose.

The number of discs embodied in each roller may vary considerably, but for the purpose of illustration, each roller is shown as comprising seven discs designated in Figure 2 of the drawings by the numerals 17 to 23 inclusive. The opposite sides of the peripheral portions of the discs are relieved to a manner to be more fully hereinafter described, to provide spaces or grooves 24 between adjacent discs. Also the peripheral portions of the discs are progressively increased in width slightly, say for example, .004 of an inch, from the first disc 17 to the final disc 23 with the result that the widths of the grooves 24 between the discs are correspondingly reduced. This dimension will, of course, vary considerably depending upon the type of finned tube to be formed.

In operation, after a length of tube 10 is properly supported on the mandrel 9, the arbors 15 together with the rollers are swung inwardly toward the periphery of the tube and are locked in their innermost positions shown in Figure 1 of the drawings by any suitable means not shown. Owing to the angular relationship between the axes of the rollers 12 and the tube 10, the roller discs progressively bite into the surface of the tube. By virtue of the frictional contact of the rotating roller discs with the surface of the tube, the latter is rotated and axially advanced, causing the rollers to traverse a helical path with respect to the tube axis. It has been pointed out above that the rollers are arranged to track with each other and actual practice has proven that this characteristic of the apparatus is facilitated by gradually increasing the diameter of the discs of each roller from the first disc 17 to the final disc 23. The diameter differential of the first two or three discs of each roller is preferably somewhat greater than the differential existing between the diameters of the remaining discs, so as to assist penetration of the first discs into the surface of the tube 10.

In any case the above construction is such that the roller discs apply a generally radially inwardly directed pressure on axially spaced helically aligned peripheral portions of the tube and depresses the material from which the tube is formed against the mandrel 9 sufficiently to displace this material first axially and then radially outwardly into the grooves 24 between adjacent roller discs. Although the form of the fin 11 is determined generally by the radial contour of the surfaces 26 forming opposite sides of the grooves 24, nevertheless the cross sectional contour of the fin does not conform exactly to the cross sectional contour of the grooves 24, as evidenced by the clearance spaces 25 shown in Figure 3 of the drawings. These clearance spaces result from displacement of the material axially of the tube during the extruding operation, and the existence of these spaces clearly indicates the lack of axial compression on the material during the forming operation.

The side surfaces 26 are not straight in radial contour from the root to the periphery of the fin as has been the practice in the past, but on the contrary, are spheroidal in contour, or in other words, are relieved by grinding or some other process so that the disc will pass through the helicoidal path between adjacent convolutions of the fin without laterally displacing the fin or working the material to such an extent that the latter is embrittled or otherwise affected. There is, of course, contact between the forming discs and material forming the fin 11. In Figures 4 and 5 of the drawings, a typical forming disc is shown in relation to the fin, and it will be noted that the spheroidal surface 26 at one side of the disc contacts the fin at 27 above the axis of the tube 10, and the spheroidal surface at the opposite side of the disc contacts the fin at 28 below the axis of the tube. However, the curvature of the spheroidal surfaces on opposite sides of the discs is such that no part of either surface will interfere with or displace the formed fin 11. Thus, regardless of the diameter of the fins being formed, the rollers do not execessively work harden the extruded material during the fin forming operation, but on the other hand, merely serve to, in effect, guide the material as it is extruded outwardly into the grooves 24. Consequently, finned tubing having such great height as to result in a ratio of outside to inside area of 10 to 1 or greater may be readily formed without the danger of detrimentally work hardening the metal forming the fins, and thus one of the chief causes of cracks or checks developing in the tubing during use is eliminated.

Attention is further called to the fact that while the spaces or grooves 24 progressively decrease in width from the first groove between the adjacent discs 17 and 18 to the last groove between the adjacent discs 22 and 23, nevertheless, no appreciable axial compression of the displaced material takes place because the shape of the radial surfaces 26 and the depth of the grooves are such that the material flows relatively freely into the grooves during the extruding operation. Thus the density of the material forming the fins is very little, if any, greater than the normal density of tne material prior to the finning operation.

What I claim as my invention is:

1. A roll for rolling up from the peripheral surface of a length of stock of circular cross section a helically extending fin that has a small helix angle in comparison to its radial height, said roll comprising a mounting affording an axis of rotation and a series of projections effectively forming a plurality of annular rings axially spaced along said mounting creating annular spaces therebetween, each of said rings being defined by an edge portion at the periphery of the roll and an annular side portion at each side of said edge, said rings, when the mounting is at crossed axis with the length of stock, creating a rolling pressure on the stock to progressively displace material from the stock into said annular spaces to form the helical fin, the annular side portions of said rings being convex on a curve extending radially of said rings and to an extent at least equal to the height of a formed fin, the

convexity extending completely around said annular rings and said convexity being so shaped with respect to the fin to be formed that it will generate a helical path for the free but confined movement of the fin through the spaces between the rings.

2. Apparatus for rolling up from the peripheral surface of a length of stock of circular cross section a helically extending fin that has a small helix angle in comparison to its height, comprising a plurality of rolls distributed around the length of stock with their axes extending generally in the direction of the length of the stock, each roll comprising a mounting affording an axis of rotation and a series of projections effectively forming a plurality of annular rings axially spaced along said mounting creating annular spaces therebetween, each of said rings being defined by an edge portion at the periphery of the roll and an annular side portion at each side of said edge, said rings, when the mounting is at crossed axis with the length of stock, creating a rolling pressure on the stock to progressively displace material from the stock into said annular

spaces to form the helical fin, the annular side portions of said rings being convex on a curve extending radially of said rings and to an extent at least equal to the height of a formed fin, the convexity extending completely around said annular rings and said covexity being so shaped with respect to the fin to be formed that it will generate a helical path for the free but confined movement of the fin through the spaces between the rings.

WALTER P. HILL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,761,733	Locke	June 3, 1930
1,865,575	Locke	July 5, 1932
1,901,516	Hopkins	Mar. 14, 1933
1,909,005	Paugh	May 16, 1933
2,238,798	Lenk	Apr. 15, 1941