Sept. 2, 1969 A. ZUBAL ET AL 3,464,101

METHOD AND APPARATUS FOR HELICALLY WINDING STRIP MATERIAL

Filed March 30, 1967 3 Sheets-Sheet 1

FIG.2

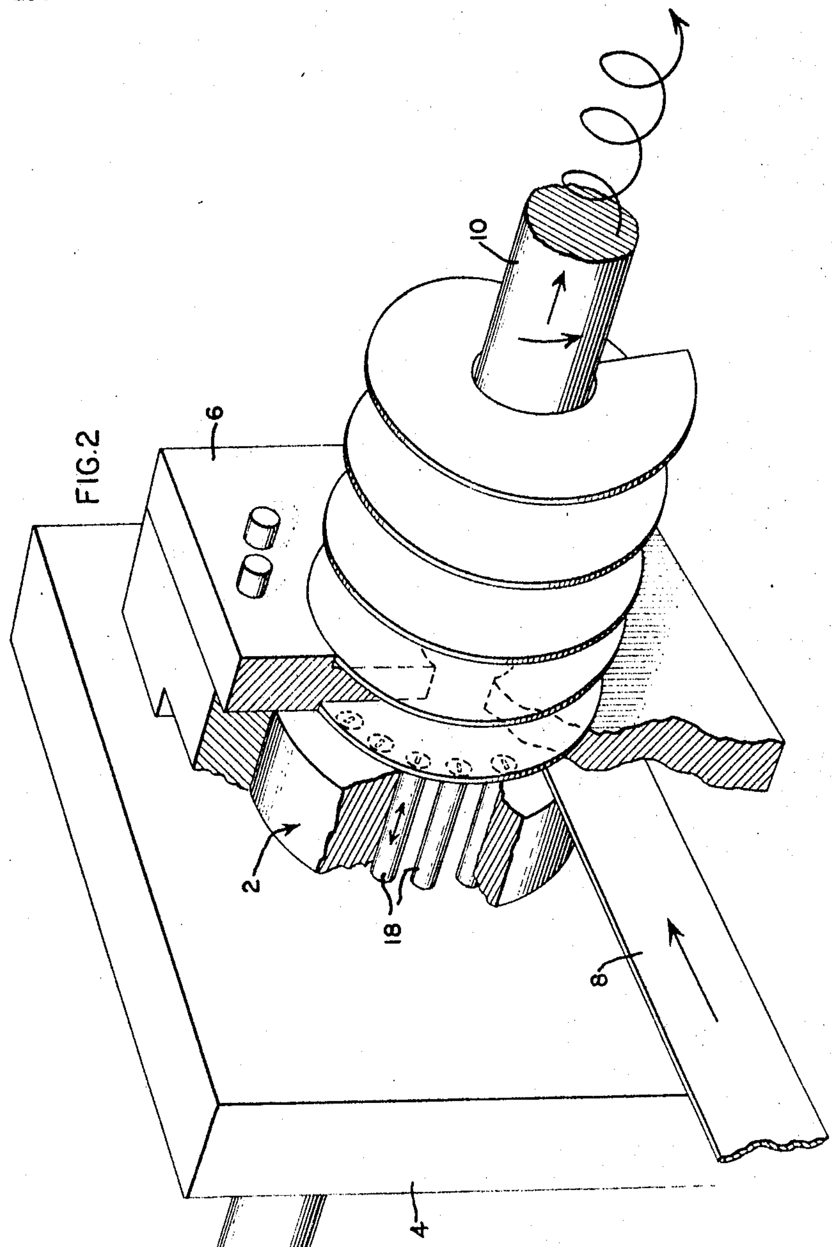
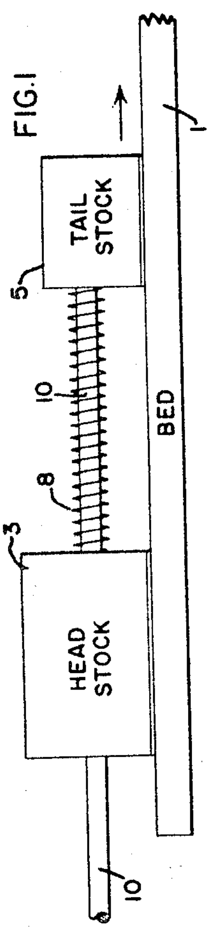


FIG.1



INVENTORS:
ANTHONY ZUBAL,
HARRY F. DAVIS,
BY Robert J. Bird
THEIR ATTORNEY.

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Filed March 30, 1967 3 Sheets-Sheet 2

FIG.4

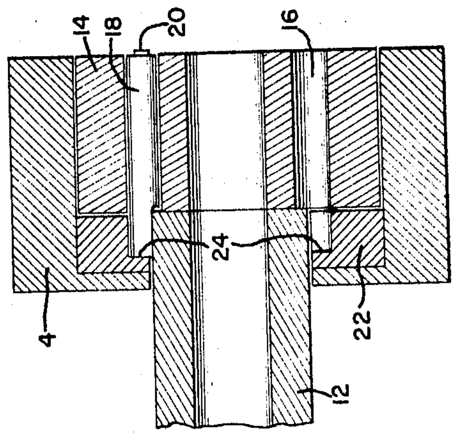
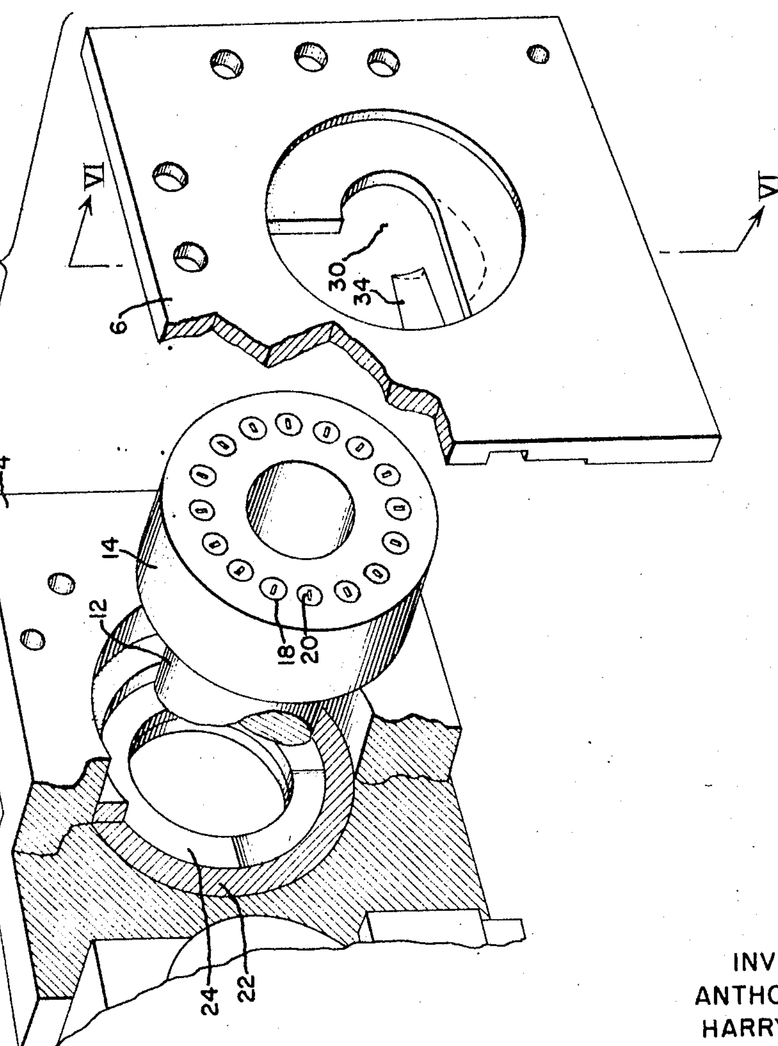


FIG.3



INVENTORS:
ANTHONY ZUBAL,
HARRY F. DAVIS,
BY Robert J Bird
THEIR ATTORNEY.

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Filed March 30, 1967 3 Sheets-Sheet 3

FIG.6

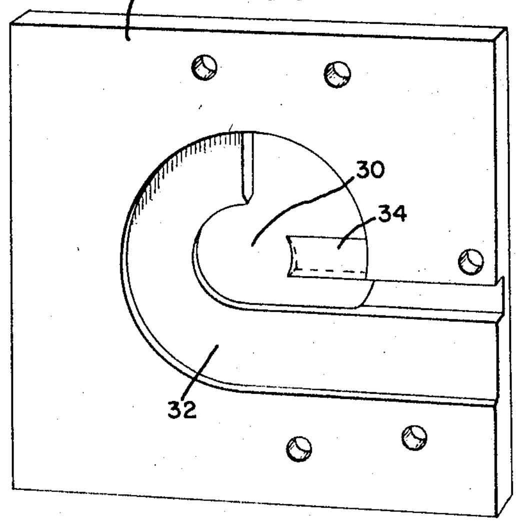


FIG.5

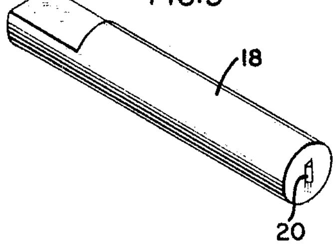


FIG.7

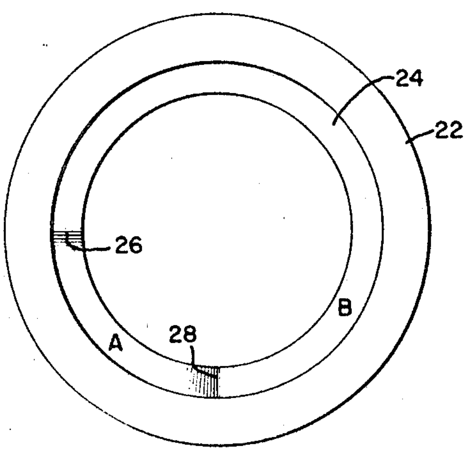
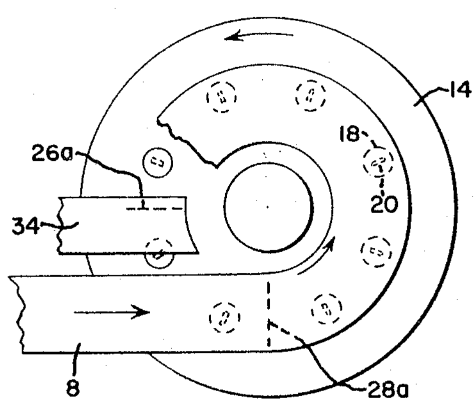


FIG.8



INVENTORS:
ANTHONY ZUBAL,
HARRY F. DAVIS,

BY Robert J. Beird
THEIR ATTORNEY.

United States Patent Office 3,464,101 Patented Sept. 2, 1969

1

3,464,101
METHOD AND APPARATUS FOR HELICALLY WINDING STRIP MATERIAL

Anthony Zubal, Latham, and Harry F. Davis, Amsterdam, N.Y., assignors to General Electric Company, a corporation of New York

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U.S. Cl. 29—157.3 5 Claims

ABSTRACT OF THE DISCLOSURE

Gripping mechanism to force continuous thin metal strip through an arcuate path defined by a shoe. Resulting spiral of strip is continuously applied to the outer surface of a rotating-translating cylindrical tube.

Background of the invention

This invention relates to a method and apparatus for helically winding a continuous thin metal strip, and more particularly, to a method and apparatus for helically winding a continuous thin metal strip around the outer surface of a tube to form a heat exchanger element.

U.S. Patents 3,062,267 and 3,283,399, issued to Benjamin F. Hart and Roland P. Carlson, disclose a method and apparatus for helically winding strip material. In the apparatus shown in those patents, the strip material is motivated through the winding mechanism by the positive action of clutching members of the mechanism abutting against teeth extending from the strip material. In the patents there shown, the strip material is generally core iron and is wound in the form of a cylinder, the aforementioned teeth ultimately defining armature slots for the stators of dynamoelectric machines.

In the present invention, the strip material to be helically wound is continuous and uniform with no teeth extending therefrom. One effect of this is to create a need for a method of motivating the strip through the winding mechanism different from the prior art just discussed.

An additional feature of the present invention is that the helically wound strip is continuously applied around the outer surface of a cylindrical tubing which is continuously fed through the apparatus.

In the art of finned tubing manufacture, the process is typically performed by a rotating tube pulling around itself an edgewise disposed strip material. The strip is usually guided and set in place by one or more grooved rollers. An example of this can be seen in U.S. Patent No. 2,988,628—Hall, particularly in FIGURES 3 and 4. This winding method gives rise to localized stresses in the strip material. These stresses can cause buckling at the inner diameter of the resulting fin and stretching or tearing at the outer diameter if the fin is too high. That is, the strip material must be kept below a certain limiting width if it is to be applied by this prior art method.

By means of the present invention, the strip material is gripped at many points uniformly and urged into a helical configuration around a tube. This method and means greatly reduces the localized stresses aforementioned and permits wider strips of a soft material such as copper to be wound around tubing to form higher and improved fins.

It is an object of the present invention to provide an improved method and apparatus for the edgewise continuous winding of strip material on a tubular workpiece.

Another object is to provide a clutching mechanism to motivate a strip material through a helical winding mechanism.

Other objects, advantages and features of the present invention will become apparent from the following description when taken in connection with the accompanying drawing.

2

Summary of the invention

Briefly, the method of the present invention is practiced by motivating a continuous strip material through an arcuate path about one of its edges and continuously applying the same to a rotating tube which is moving axially through the aperture of the arcuate path of the strip. The result is a continuous spiral application of strip to tubing. The apparatus of the present invention includes a headstock having an axial passage for tubing. A tailstock is operatively connected to the tubing and is movable in an axial direction pulling the rotating tubing through the headstock. A clutch member with drive pins indents and clutches strip material which is introduced transversely to the axis of the tubing. The strip material is forced into an arcuate path and applied edgewise to the rotating-translating tubing to form a helical finned heat exchanger tube.

Drawing

In the drawing:

FIG. 1 is a schematic of the environment of the present invention,

FIG. 2 is a perspective view of the edgewise strip winding mechanism of the present invention,

FIG. 3 is an exploded view of the operating members shown in FIG. 2,

FIG. 4 is a sectional view of the driving head of the present invention,

FIG. 5 is a perspective view of a single drive pin used in the driving head,

FIG. 6 is a view taken along the line VI—VI of FIG. 3,

FIG. 7 is a front view of the cam member, and

FIG. 8 is a front view of the face of driving member in association with a strip-workpiece.

Description

Referring to FIG. 1, the environment of the present invention is shown schematically to include a machine bed **1**, a head stock **3** and a movable tail stock **5**. A tubular workpiece **10** is mounted rotatably and translatably by means such as tail stock **5** operatively mounted on bed **1**.

Referring now to FIG. 2, a driving head, generally indicated at **2**, is shown in operative relationship to a stationary mounting frame **4** which is part of head stock **3**, an anvil or shoe **6**, and a strip or workpiece **8**. A tubular workpiece **10** is fed through frame **4** and driving head **2** with a uniform axial velocity imparted to it as by tail stock **5**. Driving head **2**, which is rotatable relative to frame **4** clutches strip workpiece **8**, which is being fed transversely to tube workpiece **10**, and pulls the strip **8** up around the rotating and translating tube **10** resulting in a continuous spiral of constant pitch of the strip **8** around and abutting the tube **10**. The means by which strip **8** is clutched and motivated around tube **10** is the subject of the present invention and will now be described in greater detail.

Referring now to FIG. 3, an exploded view is shown of the driving head **2**, frame **4**, and anvil or shoe **6**. Driving head **2** includes a shaft portion **12** with an enlarged head portion **14** mounted integral therewith. Both shaft portion and head portion are cylindrical having a cylindrical passage or aperture through their centers for the accommodation of tubular workpiece **10**. Head portion **14** has a plurality of axially directed holes **16** passing therethrough and circumferentially spaced an equal distance from the axis of head **14**. The abutment of shaft portion **12** to head portion **14** of the driving head **2** interferes with the clear passage of holes **16** (see FIG. 4) for a purpose to be described.

Referring now to FIG. 5, a single drive pin **18** is shown in perspective. Drive pin **18** has a pointed tip **20** on one end thereof, which tip is rectangular or elongated in cross section. On the opposite end of drive pin **18** from tip **20**, a shoulder is formed by the removal of material so that pin **18** extends through hole **16** and outward therefrom over the interfering abutting shaft member **12**. Mounted in this fashion, it will be apparent that drive pin **18**, while revolvable with head member **14**, is nonrotatable relative to head member **14**.

Referring again generally to FIGS. 3 and 4, stationary frame **4** is shown and is fixedly mounted on a machine tool bed **1**. Frame **4** defines a cylindrical hole in which driving head **2** is mounted rotatably. An annular cam member **22** is fixedly mounted relative to frame **4**. Cam **22** has an axially facing cam surface **24**. Cam surface **24** is in direct contact with pin **18**, though the drawing, for the sake of clarity, shows a slight clearance between the two members. In practice, there typically will be a ball thrust bearing between rotatable head member **14** and nonrotatable cam member **22**. This too is left out of the drawing for the sake of clarity.

In FIG. 7, showing a front view of cam member **22**, the cam surface **24** is shown as consisting of segments A and B. Segment A is slightly depressed relative to segment B. At point **26**, the transition from the higher segment B to the lower segment A is shown and is approximately 90° in advance of transition **28** from segment A to segment B. The cam surface **24** at segment B is axially displaced relative to segment A by a dimension of the order of .004 inch.

Referring now to FIG. 6, the anvil or shoe member **6** is shown as it appears looking in the direction of movement of tube **10**. Shoe **6** defines an aperture **30** which is coaxial with the aperture in driving head **2**. Shoe **6** also has a guide or way **32** machined therefrom which extends from the edge of shoe **6** in a direction perpendicular to the axis of aperture **30** and tangential thereto. Guide **32** follows the aperture circumferentially around shoe member **6**, for approximately 180°. Shoe **6** also has a radially extending projection **34** which extends inward toward aperture **30**. Projection **34** is substantially a wedge-shaped member in cross-section having a relatively pointed edge at its upper portion.

FIG. 8 shows a frontal view of the driving head **2** in its relation to the shoe **6** and the strip or workpiece **8** being fed thereto. Lines **26*a*** and **28*a*** are shown as phantom lines to correspond with transition lines **26** and **28** in FIG. 7 which represent the transition portions of cam surface **24**.

The operation of this machine will now be described. Assume as a starting point the presence of a suitable heat exchanger tube **10** passing through the aperture **30** of driving head **2** and shoe **6**, such a tube being operatively connected to a tail stock **5** by which the tube is rotated and translated. Concurrently, a continuous strip material is fed into the guide **32** of shoe **6** in a direction generally perpendicular to the direction of movement of tube **10** and tangential to the tube member itself.

As driving head **2**, with its shaft **12** and head **14**, rotates relative to frame **4** and cam surface **24**, drive pins **18** are actuated by the cam surface. As seen in FIGS. 6 and 8, when the head **14** rotates in a counterclockwise direction as shown, pins **18** are driven forward into the strip material **8** at a point corresponding to point **28** on the cam surface. When the pins **18** are in this forward position, they grip strip material **8** by the positive action of their tips **20**. Rotating head **2** with tips **20** thus grip and pull the strip material **8** around a path defined by the guide **32** of shoe **6**. Approximately 270° following point **28** on the cam surface, transition point **26**, the cam surface recedes so as to permit pins **18** to recede into the holes **16**. The pins **18** are so motivated to recede into their holes by the inclined planar surface of projection **34**. The pins are thus in a retracted position between points **26** and **28** (on the cam surface) during the rotation of the head **14**. As each pin again passes point **28**, it is forced forward to repeat the gripping action on strip material **8**. As pins **18** release the strip material **8** at point **26**, the strip material emerges from shoe **6** on the downstream side of projection **34**.

The pins **18** move forward only about .004 so as to clutch, but not puncture, strip **8**. Furthermore, pins **8** are nonrotatable relative to head **14** so that the broad side of tips **20** are always doing the clutching. This, of course, provides stronger clutching action.

Since tube member **10** is constantly moving forward and rotating by means of the tail stock **5**, it will be seen that the continuously winding strip **8** is wound edgewise around and abutting the tube in a helical configuration relative thereto. The tail stock motor applying torque to the tube **10** keeps the strip material **8** taut around the tube. The strip material **8** which is thus helically wound edgewise around strip of tube **10** may then be pulled through a straightening fixture to straighten out the material if necessary. The strip is then brazed or welded to the tube. These latter processes are not material to the present invention.

The present invention enables the strip material **8** to be wound around tube **10** on its edge without the benefit or without the necessity of a preformed foot or flange on strip **8**. The effect of this is a greater overall diameter of tube **10** and strip **8** than could be obtained if strip **8** were required to be bent into a flanged configuration.

It will be apparent that the invention herein described provides an improved method and apparatus for the edgewise helical winding of strip material around tubing for the production of heat exchanger tubes.

It may occur to others of ordinary skill in the art to make modifications of the present invention which will remain within the concept and scope thereof and not constitute a departure therefrom. Accordingly, it is intended that the invention be not limited by the details in which it has been described but that it encompass all within the purview of the following claims.

What is claimed is:

1. A mechanism for winding continuous strip material in helical disposition around a tube, said mechanism comprising:

means to impart rotational and translational motions to a tubular workpiece,

means to introduce said strip material in a direction substantially normal to the direction of translation of said tubular workpiece and substantially tangential to said tubular workpiece, and

means external to said tubular workpiece to motivate said strip material around a helical path to continuously surround and edgewise abut said tubular workpiece,

said last named means including a revolvable circumferential array of axially movable drive pins having pointed tops arranged so as to indent and clutch said strip material on one surface thereof and cam means to actuate said drive pins into and out of their gripping position.

2. A mechanism for winding continuous strip material edgewise in helical disposition around a tube, said mechanism comprising:

means to impart rotational and translational motions to a tubular workpiece,

a driving head defining an axial aperture for the passage therethrough of said tubular workpiece,

said driving head rotatably mounted relative to a fixed cam member on one end thereof and to a fixed shoe member on the opposite end thereof,

said shoe member defining a circular helical guide path around said aperture,

said driving head defining circumferentially spaced coaxial holes in which are supported axially slidable drive pins having pointed tips, said pins disposed in abutting relation to said cam member and being longer than said holes,

rotation of said driving head relative to said cam and said shoe imparting a reciprocating motion to said drive pins so that when said strip material is introduced to said guide path, said pointed tips of the drive pins indent and clutch said strip on one surface thereof and continuously motivate the same through said guide path around and in edgewise abutting relation to said tubular workpiece.

3. A winding mechanism as defined in claim 2 in which said drive pins are forced by said cam member into their clutching positions during approximately 270° of their revolution.

4. A winding mechanism as defined in claim 2 in which said reciprocating motion has an amplitude of under .010".

5. A method for helically winding thin strip material of uniform cross-section around the outer surface of a tube, said method comprising the steps of:

concurrently rotating and translating a tubular workpiece through a fin winding mechanism, said fin winding mechanism including a plurality of gripping members having pointed tips,

introducing said strip material to said fin winding mechanism in a direction substantially normal to the direction of translation of said tubular workpiece and substantially tangential to said tubular workpiece,

motivating said strip material around a helical path continuously suurounding and edgewise abutting said tubular workpiece by the positive action of said pointed tips of the gripping members indenting and clutching said strip material concurrently at a plurality of surface locations.

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JOHN F. CAMPBELL, Primary Examiner

D. C. REILEY, Assistant Examiner

U.S. Cl. X.R.

29—202, 605; 72—135; 113—1