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APPARATUS FOR WINDING HEAT EXCHANGERS

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3 Sheets-Sheet 2

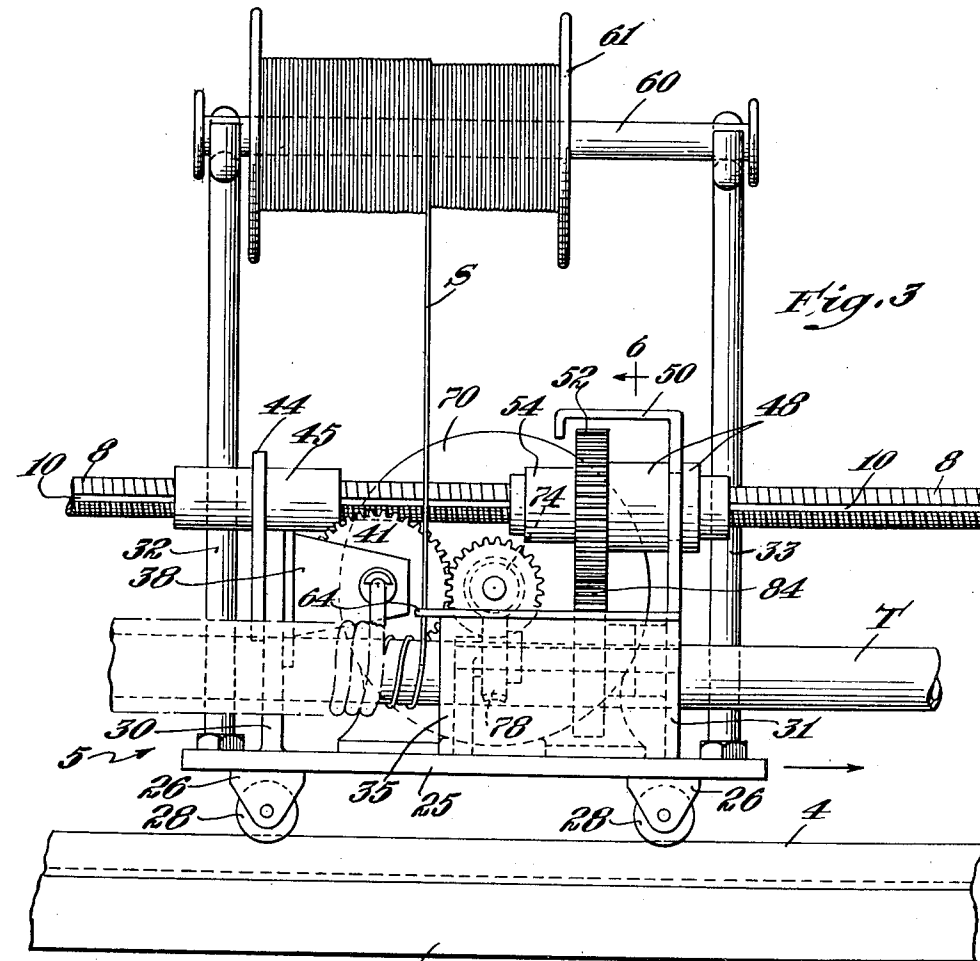


Fig. 3

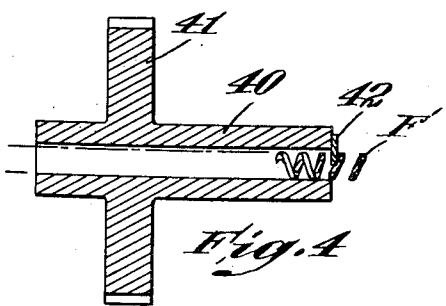


Fig. 4

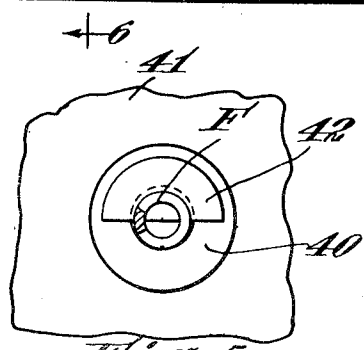


Fig. 5

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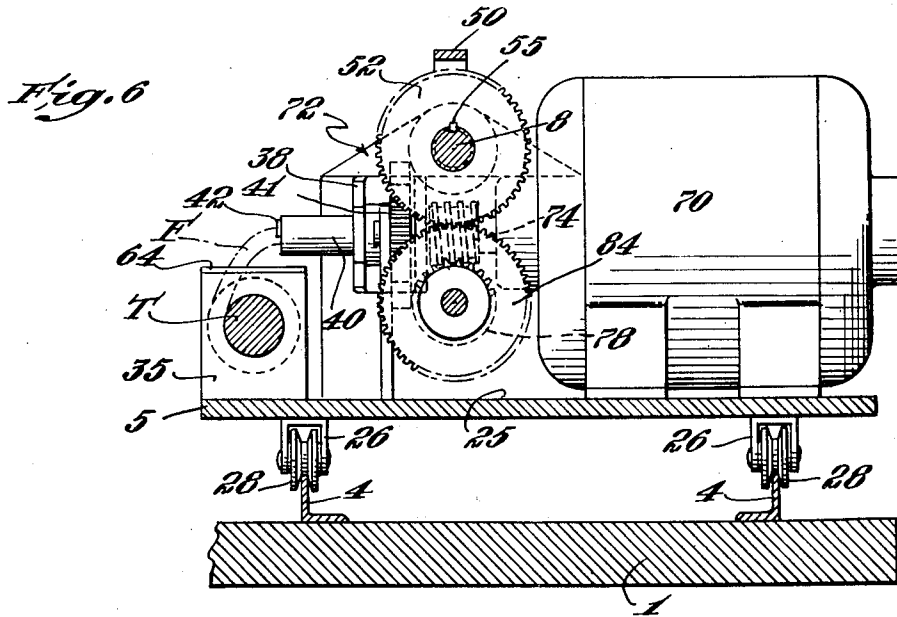
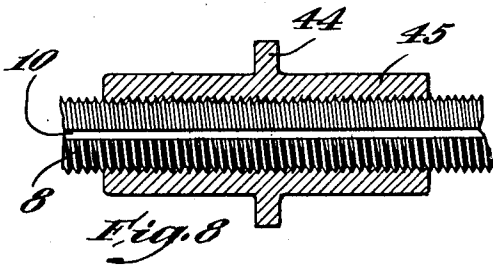
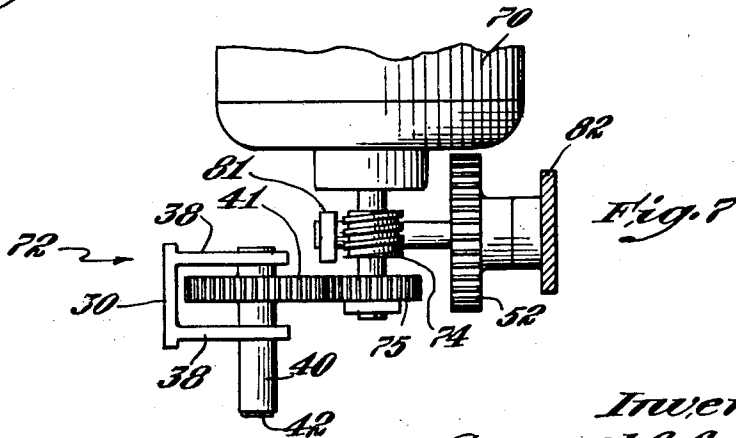
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# APPARATUS FOR WINDING HEAT EXCHANGERS

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3 Sheets-Sheet 3



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## UNITED STATES PATENT OFFICE

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## APPARATUS FOR WINDING HEAT EXCHANGERS

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2 Claims. (Cl. 113—1)

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This invention relates to apparatus for winding a heat exchanger of the type having a central core or tube with helically wound fins integrally joined thereto so as to insure a high degree of thermo-conductivity.

The principal objects of the invention are to provide an efficient and reliable method of and apparatus for uniformly winding the fin material about the core tube so that a predetermined pitch and fin spacing may be secured, and when thus wound, the parts may be integrally joined or united without disturbing the wound fin material; and to provide a simple and reliable apparatus which may be so adjusted as to vary the amount of fin material applied to a predetermined length of core tube so as to secure any desired pitch and fin spacing.

Further objects relate to various features of construction and will be apparent from a consideration of the following description and the accompanying drawings, wherein:

Fig. 1 is a side elevation of a winding machine constructed in accordance with the present invention;

Fig. 2 is a fragmentary end elevation showing the gear train associated with the lead or feed screw and supporting means for the core tube;

Fig. 3 is an enlarged front elevation of the traveling feed mechanism;

Fig. 4 is an enlarged section through the fin-feeding tube;

Fig. 5 is an end elevation of the fin-feeding tube;

Fig. 6 is a section approximately on the line 6—6 of Fig. 3;

Fig. 7 is a top plan view of the transmission mechanism;

Fig. 8 is an enlarged vertical section through the lead screw and associated sleeve;

Fig. 9 is an enlarged fragmentary elevation showing a core tube with fin material and solder wound thereon; and

Fig. 10 is a view, similar to Fig. 9, but showing the parts after having been subjected to a heat treatment effective to unite the fin material to the wound tube.

The embodiment herein shown for the purpose of illustration comprises an elongate bed 1 having adjacent to each end upstanding brackets 2 and 3. Along one side of the bed is a pair of spaced angle irons providing a track 4 on which a carriage 5 runs, as illustrated in Figs. 1 and 6. The brackets 2 and 3 are formed with aligned openings through which project the ends of a lead screw 8 formed with a keyway 10 (Fig. 3)

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which extends from one end to the other, and one end of the lead screw carries a collar 11 and its opposite end carries a gear 12 (Fig. 1).

The bracket 2 is provided with an opening disposed below and in offset relation to the gear 12, and rotatably mounted in this opening is a cylindrical member or chuck 15, the inner end of which projects into a bore of a core tube T so as to provide a means for supporting and rotating the tube. The outer end of the chuck 15 projects beyond the bracket 2 and carries a gear 18. A stub shaft 20, interposed between the gears 12 and 18, carries a gear 21 which meshes with the gear 12 and a second gear 22 which meshes with the gear 18, the construction being such that a given rate of rotation of the lead screw 8 is transmitted through gears 12, 21, 22 and 18 to effect a predetermined rotation of the core tube T.

The carriage 5 (Figs. 3 and 6) comprises a flat body or deck 25 having depending forks 26 which carry rollers 28 that run on the track 4. Mounted at opposite ends of the deck 25 are brackets 30 and 31 and posts 32 and 33 (Figs. 1 and 3). Along the inner side edge of the deck 25 is a small housing 35, the opposite ends of which are provided with openings aligned with the chuck 15 and through which the core tube T extends, as shown in Figs. 1, 3 and 6. The housing 35 provides a support for the core tube adjacent to the section which is being wound and thus cooperates with the chuck 15 in rotatably supporting tube T.

The bracket 30 carries a pair of inwardly projecting ears 38 (Figs. 3 and 7) which rotatably support a feeding tube 40 integrally joined to a gear 41. The bore of the feeding tube 40 is of a size freely to receive the helical fin material F and its delivery end carries a small plate or sector 42 which projects into the bore to provide, in effect, a feeding thread engageable with one or more convolutions of the helical fin material F, as illustrated in Fig. 4, so that upon rotation of the tube 40 the fin material is fed outwardly. The upper end of the bracket 30 is provided with an extension 44 which carries an interiorly threaded sleeve 45 which fits about the lead screw 8 so that rotation of the lead screw causes the carriage 5 to move along the track 4.

The upper end of the bracket 31 carries a pair of collars 48 which loosely fit about the lead-screw 8 and one end of an inverted U-shaped finger 50 is welded or otherwise secured to the top edge of the bracket 31 so that its depending free end is juxtaposed to the outer face of a driving gear 52 circumscribed about the lead screw 8.

The gear 52 is integral with a hub 54 (Fig. 3) which is splined to the lead screw 8 by a key 55 (Fig. 6) loosely fitting the keyway 10 so as to permit a free sliding movement of the gear and hub along the lead screw. When the gear 52 is rotated, as hereinafter described, the lead screw is rotated and not only operates through sleeve 45 to move the carriage along track 4, but also operates as a drive shaft acting through the gear train 12, 21, 22 and 18 to rotate the core tube T.

The upper end of the posts 32 and 33 are bent forwardly and support a rod 60 (Figs. 1 and 3) which is parallel to and in approximate vertical alignment with the core tube T. The rod 60 rotatably supports a supply spool 61 of solder S or the like fusible metallic strand material which is effective when fluxed to solder, weld or otherwise secure the fin material FM to the core tube T. Where the core tube and fin material are of copper or a copper alloy, the solder S may be of the conventional type. The upper end of the housing 35 carries a guiding member 64 (Fig. 3) which overhangs the core tube T in advance of the feeding tube 40 so as to permit the strand of solder to be wound about the tube T ahead of the fin material, as illustrated in Figs. 1 and 3.

The fin-feeding gear 41 and the driving gear 52 are preferably driven from the same source and accordingly an electric motor 70 is mounted on the deck 25 rearwardly of the lead screw 8. The motor 70 is coupled with a transmission mechanism 72 (Figs. 6 and 7) which is connected through suitable gear trains to the gears 41 and 52. As shown in Figs. 6 and 7, the transmission mechanism 72 comprises a worm 74 and gear 75 both mounted on the shaft of the motor 70, the gear 75 meshing directly with the feed gear 41. The worm 74 meshes with a small worm gear 78 fast to a shaft 80, the opposite ends of which are mounted in brackets 81 and 82 projecting upwardly from the deck 25. The shaft 80 carries a gear 84 (Fig. 6) which meshes directly with the gear 52. With this construction and arrangement of parts the motor 70 operates through gear 75 to rotate the fin-feeding tube 40 and through worm 74, gears 78, 84 and 52 to rotate the lead screw 8. By selecting suitable gears the rates of feeder speed and carriage travel may be adjusted to the desired value, and since the core tube T is driven by lead screw 8, selection of suitable gears 12, 18, 21 and 22, the desired pitch of the helix defined by the fin material F may be secured. Thus, the rate of feed of the fin material F, the rate of rotation of the core tube T and the rate of travel of the carriage 5 may be varied so as to obtain any desired pitch and spacing of the fin material on the core tube.

For the purpose of illustration the particular apparatus herein shown is set up to wind fin material on a copper tubing having an O. D. of 0.802" x 0.025" wall and a length up to about 10 feet. The fin material F consists of rectangular copper wire, 0.01" x 0.04" cross section, wound on a 0.058" mandrel to provide a helix having an O. D. of about 0.133". Assuming that the proper selection of gears has been made to produce a winding having the desired fin spacing and pitch, the carriage 5 is first moved to a position adjacent to the bracket 2 (left-hand end as viewed in Fig. 1) and a length of tube T to be wound is inserted through the openings in the housing 35 and its end fastened about chuck 15. A spool 61 of 50-50 solder S (0.032") is mounted on the rod 60 and the end of the solder is threaded through guide 64 and soldered to or otherwise held against the

tube T. The motor 70 is then started so as to apply about 4 convolutions of solder about the tube T and is then stopped. The fin material F is then threaded through the feeding tube 40, as shown in Fig. 4, and its end is spot soldered to or otherwise held against the tube T in contiguous relation to the solder S. The apparatus is now ready for operation and the motor may be turned on, thereby simultaneously effecting rotation of the tube T, feeding and application of the fin material F and solder S and travel of the carriage 5 toward the opposite end of the bed.

During the winding operation the solder S is tightly wound about the tube T and defines, in effect, a helical groove which receives the fin material F, the individual fins of which are contiguous to the strands of solder which prevent displacement of the fin material axially of the tube, as illustrated in Fig. 9. After substantially the entire length of tube T has been wound, the solder and fin material may be severed and their free ends spot soldered or otherwise secured to the tube, preparatory to the next step of subjecting the wound tube to a heat treatment effective integrally to unit the fin material and tube.

The tube thus wound with fin material and solder or other fusible metal may be sprayed with or dipped into a suitable flux, such as a zinc chloride-hydrochloric acid mixture or the like, after which it is subjected to a temperature sufficient to melt the solder or fusible metal and to this end the wound tube may be placed in a gas furnace or an induction furnace, or it may be subjected to the action of a blow torch or any other suitable procedure. Due to capillary action, the fluxed solder migrates to the area about the points of tangency of the individual fins and the surface of the tube T so that, upon cooling, the solder forms a fillet 90, as illustrated in Fig. 10, which integrally unites the fin material to the tube T and insures a relatively high degree of thermal-conductivity between the fin material and tubing.

If desired, the tube T may be wound with only the fin material, in which case the wound tube is first treated with a suitable flux, after which it may be dipped in a bath of molten solder or other fusible metal, withdrawn, and the tube then shaken, centrifuged or otherwise treated to remove excess solder. Due to capillary action, the molten solder is held about the points of tangency of the individual fins and surface of the tube T and, upon cooling, provides a fillet 90, as illustrated in Fig. 10.

After having built up one heat exchanger tube, as illustrated in Fig. 10, it may be inserted through an outer tube T' of copper or the like material and the assemblage then drawn through a suitable die effective to contract the outer tube T' about the wound-core tube T. The contracted outer tube may then be wound with fin material, solder, etc., as above described, to provide a second heat exchanger element or unit concentrically disposed about the first. This procedure may then be repeated so as to build up a heat exchanger having any desired number of concentric units, each consisting of a core tube wound with fin material and integrally united thereto by a fillet of solder.

While I have shown and described one desirable embodiment of the invention, it is to be understood that this disclosure is for the purpose of illustration and that various changes and modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

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I claim:

1. Apparatus for winding fin material about a core tube, comprising an elongate bed having a track extending from one end to the other, a bracket adjacent to one end of said bed, means carried by said bracket for rotatably supporting the core tube, a rotatable lead screw extending parallel to said track, a carriage mounted on said track and having means engaging said lead screw so that rotation of the latter causes said carriage to move along said track, a feed tube rotatably mounted on said carriage and through which said fin material passes, means carried by said feed tube and engageable with the fin material therein for feeding the fin material outwardly when said feed tube is rotated, guide means mounted on said carriage in advance of said feed tube for applying a fusible metal strand to the core tube, and means for simultaneously rotating said feed tube, said core tube and said lead screw so as to effect a predetermined rate of feed of said fin material relative to the rate of rotation of said core tube and axial travel of said carriage.

2. Apparatus for winding helical fin material about a core tube, comprising an elongate bed having a track extending from one end to the other, upstanding brackets at each end of said bed, a chuck carried by one of said brackets for rotatably supporting the core tube, a lead screw rotatably supported by said brackets in spaced parallel relation to said track, connections between said lead screw and chuck so that rotation of said lead screw effects a rotation of said chuck, a carriage mounted on said track, a motor mounted on said carriage, a rotatable feeding tube mounted on said carriage, means carried by said

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feeding tube and engageable with the convolutions of said fin material for feeding said fin material outwardly at a predetermined rate when said feeding tube is rotated, guide means on said carriage in advance of said rotatable feeding tube for applying a fusible metal strand to the core tube, a threaded member engaging said lead screw and connected with said carriage so as to cause said carriage to move along said track in response to rotation of said lead screw, and connections between said motor, said rotatable feeding tube and lead screw operative simultaneously to rotate said feeding tube and said lead screw at predetermined relative rates and thereby effect a predetermined rate of travel of said carriage along said track.

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