April 17, 1945. R. M. STIKELEATHER 2,374,144

METHOD OF AND MACHINE FOR WINDING RIBBONS ON HEAT EXCHANGE TUBES

Filed June 29, 1943 6 Sheets-Sheet 1

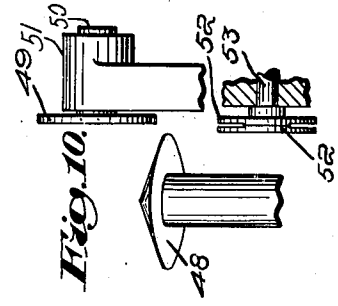

Fig. 10.

Fig. 1.

Fig. 9.

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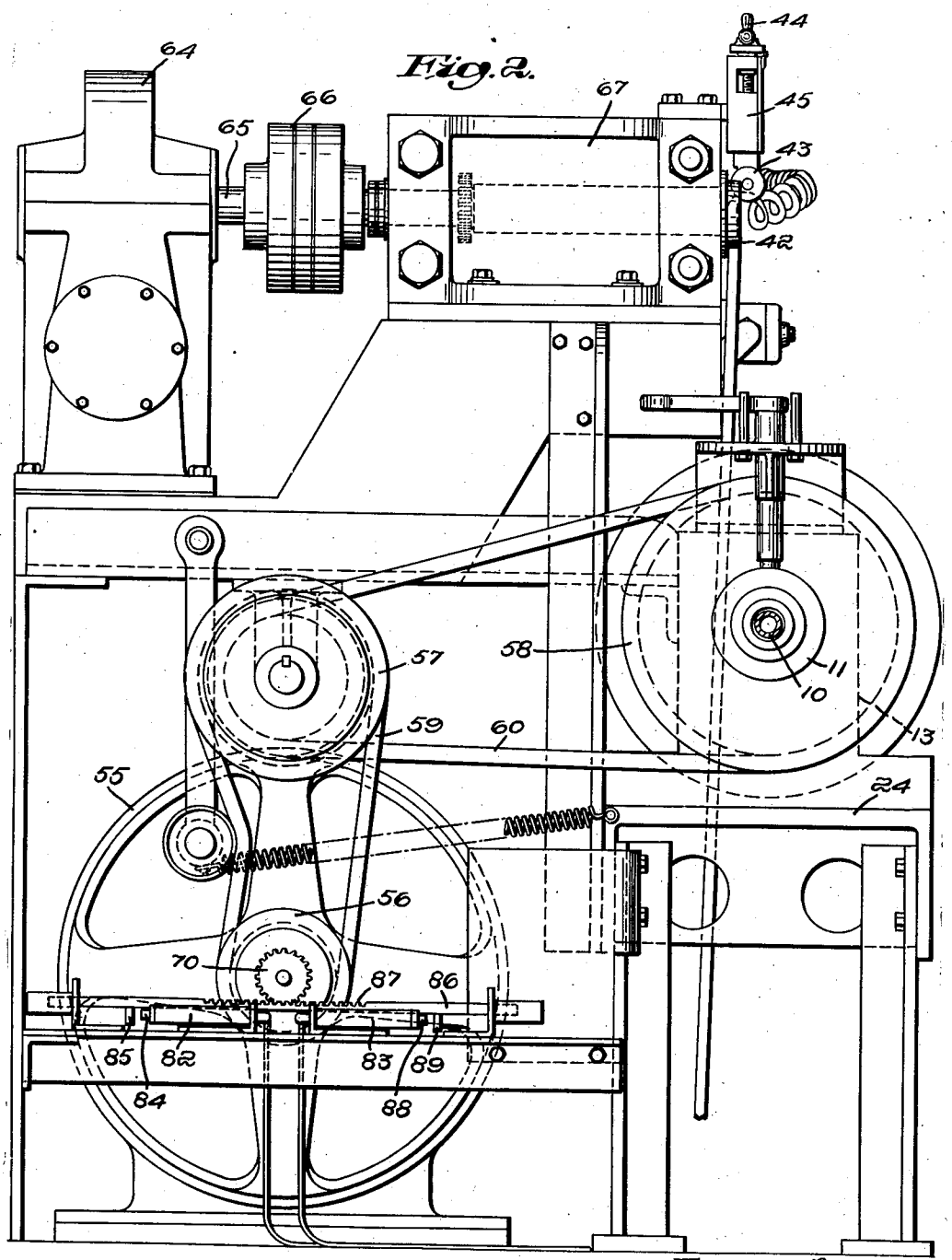
Fig. 2.



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METHOD OF AND MACHINE FOR WINDING RIBBONS ON HEAT EXCHANGE TUBES

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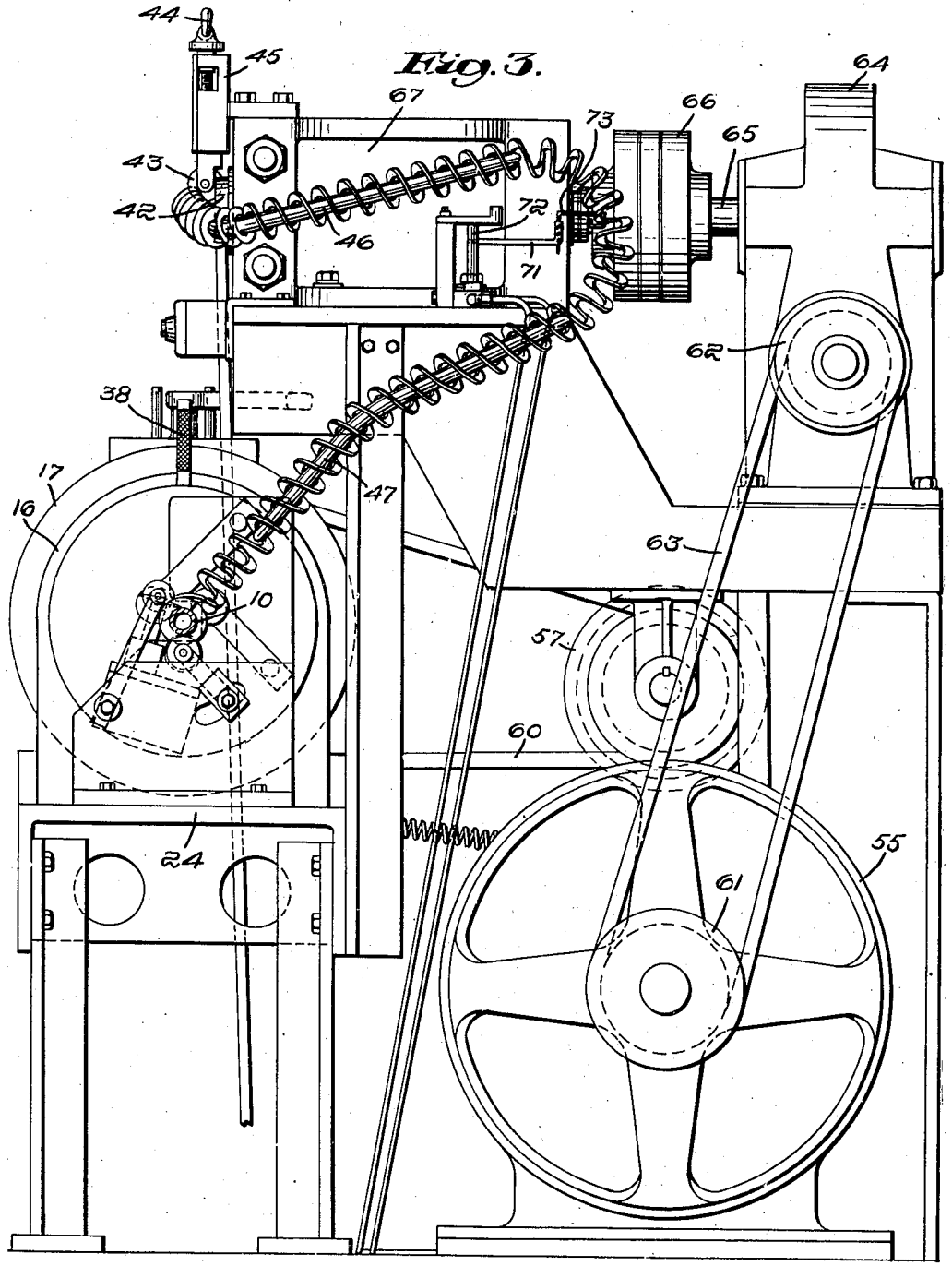
Fig. 3.



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METHOD OF AND MACHINE FOR WINDING RIBBONS ON HEAT EXCHANGE TUBES

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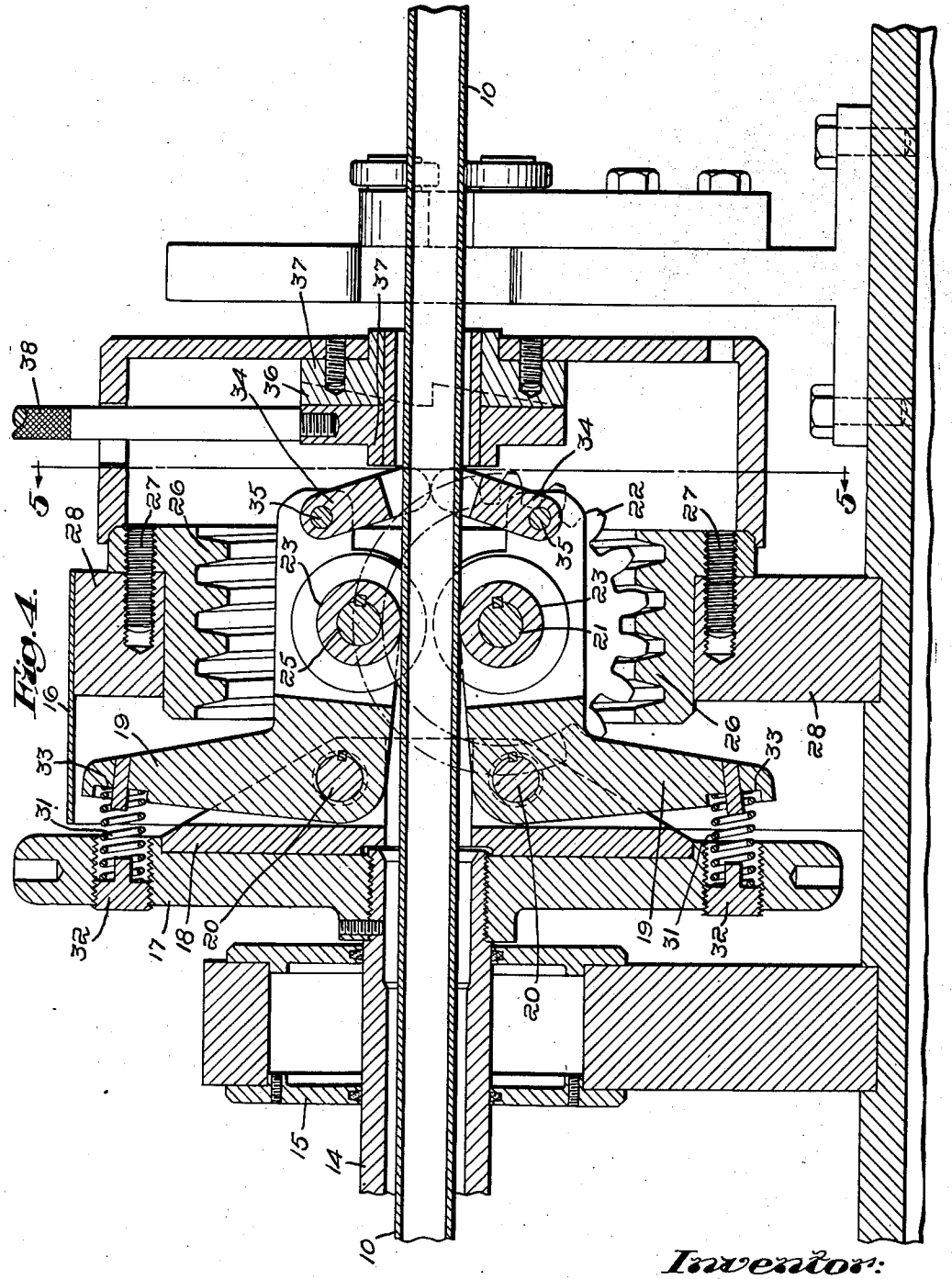

Fig. 4.

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METHOD OF AND MACHINE FOR WINDING RIBBONS ON HEAT EXCHANGE TUBES

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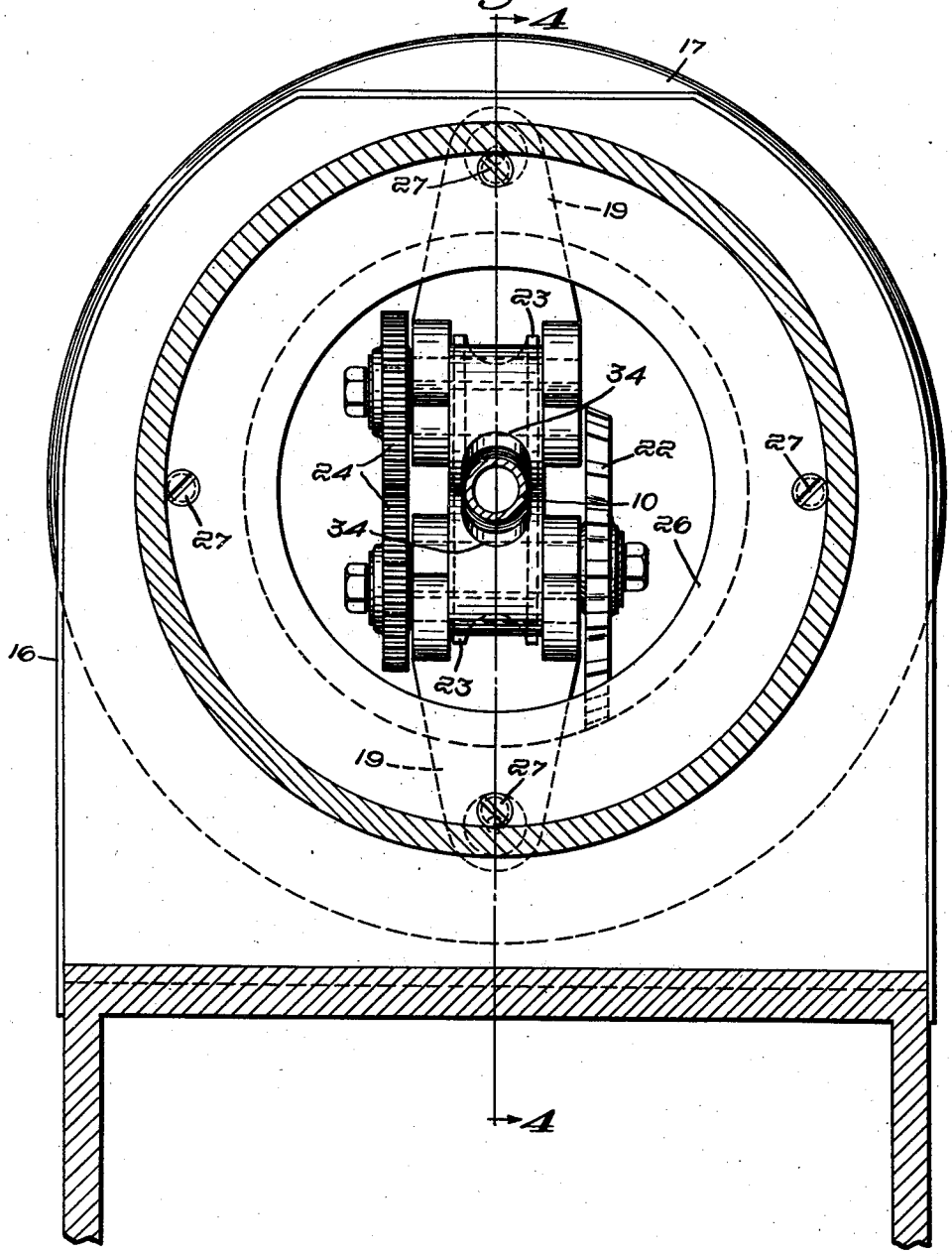
Fig. 5.



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METHOD OF AND MACHINE FOR WINDING RIBBONS ON HEAT EXCHANGE TUBES

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Fig. 7.

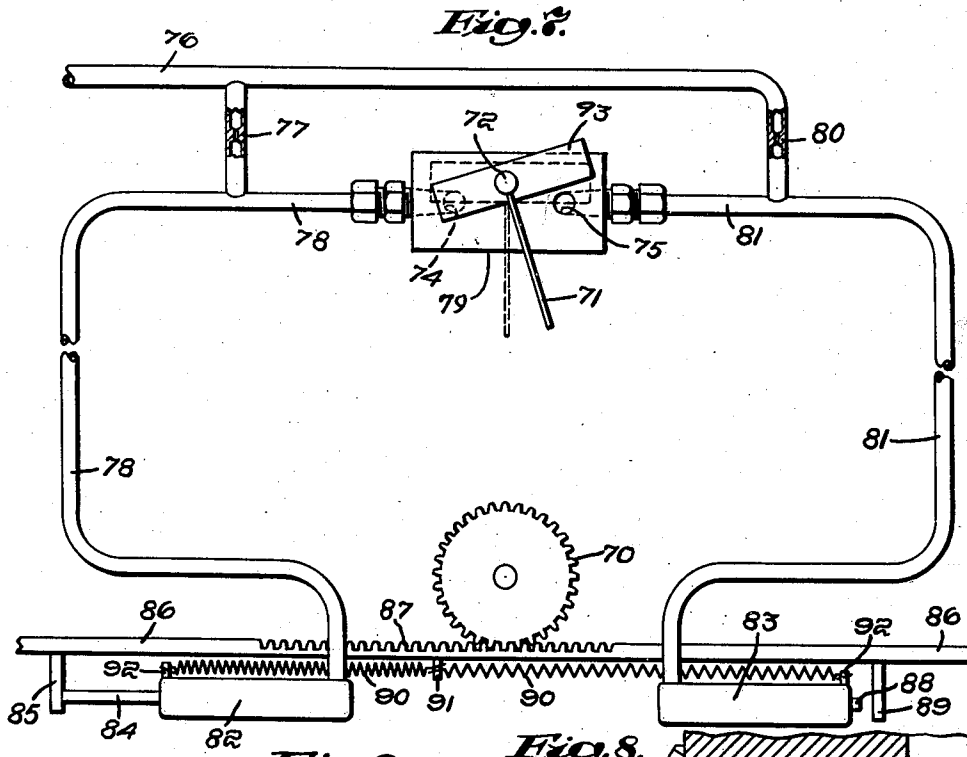


Fig. 6.

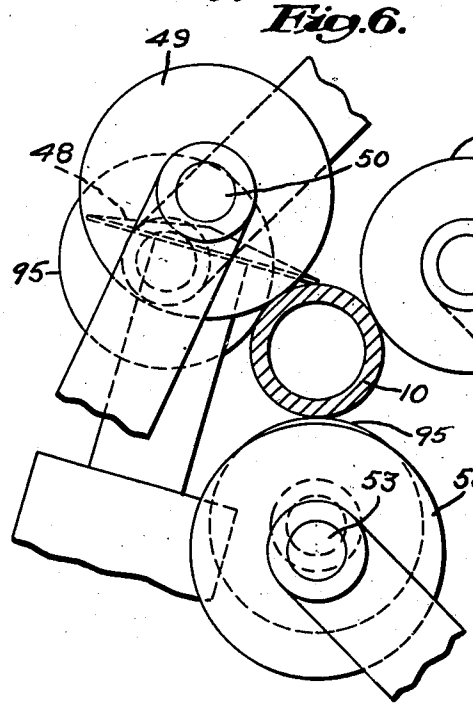
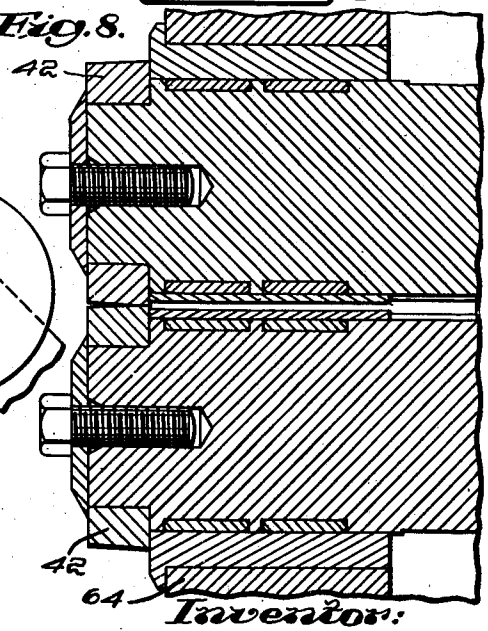


Fig. 8.



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Patented Apr. 17, 1945 2,374,144

UNITED STATES PATENT OFFICE

2,374,144

METHOD OF AND MACHINE FOR WINDING RIBBONS ON HEAT EXCHANGE TUBES

Robert M. Stikeleather, Dedham, Mass., assignor to B. F. Sturtevant Company, Boston, Mass.

Application June 29, 1943, Serial No. 492,706

20 Claims. (Cl. 29—33)

This invention relates to the winding of metal ribbons on tubes, and relates more particularly to methods and machines for winding metal ribbons on heat exchange tubes for forming extended heat exchange surfaces.

It is common practice to use machines for winding copper or aluminum ribbon spirally upon small heat exchange tubes. A typical machine is one in which the ribbon is first crimped by passage between toothed rolls and is then wound on a tube while the crimp in the outer edge is ironed out between pressing rolls for causing the ribbon to fit tightly on the tube. Such machines have not been successful for winding relatively wide ribbons on tubes nor for winding ribbons of metals such as steel which are relatively hard.

This invention provides a machine which will satisfactorily wind relatively wide ribbon on relatively large diameter tubes and which will satisfactorily wind steel ribbon on tubes. The ribbon is not crimped as formerly. Its outer edge is first rolled and stretched, causing the ribbon to form a spiral, the inner diameter of which is slightly less than that of the tube so that when the ribbon is placed on the tube it fits tightly on same.

Objects of the invention are to wind relatively wide ribbons on tubes and to wind relatively hard ribbons on tubes.

The invention will now be described with reference to the drawings, of which:

Fig. 1 is a side elevation of a machine embodying this invention, for winding ribbon on a tube;

Fig. 2 is an elevation view of one end of the machine of Fig. 1;

Fig. 3 is an elevation view of the other end of the machine of Figs. 1 and 2;

Fig. 4 is a sectional view of the mechanism used in the machine of Figs. 1–3 for advancing the tube on which the ribbon is being wound, and is taken along the lines 4—4 of Fig. 5;

Fig. 5 is a sectional view along the lines 5—5 of Fig. 4;

Fig. 6 is an enlarged sectional view along the lines 6—6 of Fig. 1;

Fig. 7 is a diagrammatic view of mechanism for automatically controlling the speed of the tube advancing mechanism;

Fig. 8 is an enlarged sectional view of the tapered rolls for rolling and stretching the outer edge of the ribbon;

Fig. 9 is an enlarged view illustrating the ribbon rolling mechanism of Fig. 1, with ribbon removed, and

Fig. 10 is an enlarged view illustrating the ribbon winding mechanism of Fig. 1, with ribbon and the tube on which it is wound, removed.

The tube 10 is rotated and advanced through the machine at rates coordinated with the feed of the ribbon thereon as will be described. With reference to Fig. 1, the tube 10 is advanced through bores in the coupling 11, the pulley 12, the bearing 13, the shaft 14, and the bearing 15 by the tube rotating and advancing mechanism indicated generally by 16.

With reference to Figs. 4 and 5, the mechanism 16 includes the back plate 17 which is screwed onto the threaded end of the hollow drive shaft 14 and to which the mounting bracket 18 is attached. The feed roll supports 19 are mounted to the bracket 18 by the pivot pins 20. The lower feed roll shaft 21 is journaled in the lower support 19 and the upper feed roll shaft 25 is journaled in the upper support 19. The feed rolls 23 are mounted on the shafts 21 and 25. The gear 22 is mounted on one end of the shaft 21. A lower gear 24 is mounted on the other end of the shaft 21 and meshes with a similar gear 24 mounted on the shaft 25 whereby upon rotation of the gear 22, the gears 24 and the feed rolls 23 are rotated.

The gear 22 meshes with the outer gear 26 which is attached by the screw 27 to the support 28 which in turn is attached to the bed of the machine. The gear 26 is thus held against rotation and since the assembly including the back plate 17, the bracket 18, the feed roll supports 19, the feed rolls 23 and the gear 22 is rotated bodily around the axis of the tube 10 by the drive shaft 14, the gear 22 meshing with the gear 26 is caused to rotate and to rotate the feed rolls 23.

The feed rolls 23 grip the tube 10 and rotate it as they are rotated as described, bodily about the axis of the tube and at the same time due to the rotation about the feed roll shafts 21 and 25, they rotate in opposite directions with respect to each other and advance the tube 10 through the machine.

The springs 31 contacting the cap screws 32 in threaded bores in the end plate 17 and the outer portions 33 of the feed roll supports 19 cause the feed rolls 23 to grip the tube 10 with the proper pressure. This pressure may be regulated by adjustment of the cap screws 32.

The tube release lugs 34 are pivoted in the outer ends of the feed roll supports 19 by the pivot pins 35. The cam 36 cooperating with the fixed cam 37 is rotatable by the hand lever 38 to press against the inner ends of the lugs 34 causing them to move inwardly against each other and to push the outer ends of the feed roll supports

19 apart and move the feed rolls 23 away from the tube 10 for releasing the tube 10 from rotation and advancement.

The rolls 95 are mounted for free rotation on shafts journaled in a frame of the machine and contact the tube 10 as it passes from the tube rotating and feeding mechanism 16 and act as guide rolls.

Referring now to Fig. 1, the ribbon 40 is fed from a conveniently located spool through a guide slot formed between the guides 41 and which guides it in between the driven tapered rolls 42, the details of which are shown by Fig. 8. The rolls 42 are rotated in opposite directions and are so tapered as to roll out and to stretch and thin the outer edge of the ribbon as it passes therebetween but to have no effect upon the inner portion of the ribbon. This rolling causes the ribbon to spiral as it issues from the rolls 42, as illustrated. The freely rotatable roll 43 has a groove formed therein into which the ribbon fits as it passes from the rolls 42. The roll 43 is raised and lowered by the lever 44 which actuates a common screw feed 45. The contact of the roll 43 with the ribbon as it passes from the rolls 42, guides the ribbon from the rolls 42 and aids in determining the diameter of the spiral assumed by the rolled ribbon. By raising the roll 43, the diameter of the spiral is increased and by lowering it, the diameter of the spiral is decreased. When the roll 43 is not used, the diameter of the spiral varies somewhat.

With reference now to Figs. 1 and 3, the ribbon spiral after leaving the rolls, is first passed around and along the curved rod 46 and then around and along the curved rod 47 which guide the spiral against the tapered, angle changing roll 48. For accomplishing this movement, the free end of a newly formed spiral is attached to the tube 10 as by soldering or brazing and the tube pulls the ribbon over and through the apparatus now to be described.

The tapered angle changing roll 48 serves to change the direction of the ribbon contacting it, through an angle of 90° for directing the ribbon perpendicular to the surface of the tube 10 as it first contacts same. The backing up roll 49 rotates freely on its shaft 50 in the bearing 51 on the frame of the machine and extends perpendicular to the axis of the tube 10, and closely approaches its surface as illustrated by Fig. 6.

The two rolls 52 have their inner surfaces spaced apart a distance slightly greater than the thickness of the ribbon and are freely rotatable on the shaft 53 which is journaled in the frame of the machine. The ribbon contacting surface of the roll 49 is substantially in alignment with the ribbon contacting surface of the outer roll 52. The roll 49 contacts one side of the ribbon as it is wound on the tube 10 and the inner surfaces of the rolls contact both sides of the ribbon shortly after the winding starts.

The rolls 49 and 52 act to support and straighten the ribbon as it is wound on the tube, keeping it substantially perpendicular to the surface of the tube when this is desired. Since the ribbon is formed by the rolls 42 in a spiral which has a smaller diameter than that of the tube 10, when the ribbon is forced by the rolls 49 and 52 to extend substantially perpendicular to the surface of the tube, it is apparent that the ribbon is pressed on and against the tube with considerable force, causing it to tightly grip the tube. The rolls 52 also aid somewhat in regulating the spacing of the ribbon as it is wound spirally upon the tube. Fixed ribbon contacting tools could be used in place of the rolls 49 and 52 but the rolls are preferred since less friction is involved.

In some cases, it may be desirable not to have the ribbon perpendicular to the tube and in such cases the rolls 52 may be omitted.

The electric motor 55 as illustrated by Fig. 2, rotates through the pulleys 56, 57, and 58 and the belts 59 and 60, the drive shaft 14 which rotates the mechanism described in the foregoing for rotating and advancing the tube 10 on which the ribbon is wound.

The motor 55 also rotates as illustrated by Fig. 3, through the pulleys 61 and 62, the belt 63, the gear box 64, the shaft 65, the coupling 66 and the gear box 67, the rolls 42 which roll the outer edge of the ribbon for forming the spiral.

The spiral forming rolls and the mechanism for rotating and advancing the tube on which the ribbon is wound are thus driven in step by coordinated mechanism but it has been found that due to slight variations in the structure of the ribbon and to variations in the feed of the ribbon or of the tube on which it is wound, there occasionally occurs too much slack or too much tension in the ribbon. To compensate for this, the mechanism to be described, varies the speed of rotation and advancement of the tube 10 for maintaining at all times the proper relation between the feed of the ribbon and of the tube on which it is wound.

The pulley 56 illustrated by Fig. 2, and which has been described as a component in the rotation of, and the feed of, the tube 10 is part of a variable speed drive manufactured by the Allis-Chalmers Company and known as their "Vari-Pitch Sheave." This sheave is attached to the drive shaft of the motor 55. The gear 70 when rotated in a clockwise direction (facing Fig. 2 of the drawings increases the speed of the pulley 57 and when rotated in the opposite direction, decreases the speed of the pulley 57. For adjusting the gear 70, the mechanism now to be described is used.

Referring now to Figs. 1, 3, and 7, the lever 71 is pivoted on the pivot shaft 72 to the frame of the machine and has a wire extension 73 which is looped around the ribbon spiral at a point substantially midway between where it leaves the outer end of the curved guide rod 46 and enters the inner end of the curved guide rod 47.

The lower end of the pivot rod 72 is attached as best illustrated by Fig. 7, to the valve 93 which when the ribbon is out of step with the tube upon which it is wound, uncovers either the port 74 or the port 75 in the pressure chamber 79. Air under pressure from a suitable source is supplied through the tube 76 and an orifice in the tube 77 and through the tube 78 into one side of the pressure chamber 79, and through the tube 76 and an orifice in the tube 80 and through the tube 81 into the other side of the pressure chamber 79.

The tube 78 connects with the cylinder 82 and the tube 81 connects with the cylinder 83. The piston rod 84 of the cylinder 82 when air pressure is applied to the cylinder 82, moves outwardly as illustrated by Fig. 7 to strike the extension 85 on the lever 86, causing it to move to the left with reference to Fig. 7 of the drawings. The lever 86 has a toothed rack 87 in its central portion, in mesh with the gear 70.

The cylinder 83 has a similar piston rod 88 which contacts the extension 89 on the lever

86 when air pressure is applied to the cylinder 83.

When the valve 93 is rotated by the lever 71 to uncover the port 75 and to cover the port 74 as illustrated by Fig. 7, the air which would go into the cylinder 83 through the tube 81, leaks into the atmosphere. Due to the port 74 being covered by the valve, there is no leakage from the tube 78 and the cylinder 82 is supplied with air and acts to rotate the gear 70 as described. The condition just described is one resulting from the spiral being too slack with the result that the lever 71 has acted to rotate the gear in a clockwise direction for speeding up the feed of the tube 10 as described.

If the tension in the ribbon spiral becomes too great, the lever 71 is adjusted in the opposite direction to that described in the foregoing and moves the valve to close the port 75 and to open the port 74. This causes the cylinder 82 to retract its piston 84 and the cylinder 83 to extend its piston 88 to strike the extension 89 and to move the lever 86 to the right with reference to Fig. 7 of the drawings, causing the rack 87 to rotate the gear 70 in a counterclockwise direction for slowing up the feed of the tube 10.

When the tension of the ribbon spiral is just right, the lever 71 assumes mid-position as illustrated in dotted outline by Fig. 7 with the result that both ports 74 and 75 are partially uncovered so that both leak air and neither of the cylinders 82 and 83 receive air and the gear 70 is not rotated in either direction.

The springs 90 are connected to the extension 91 from the lever 86 at the midpoint of the rack 87, and to the extensions 92 on the cylinders 82 and 83 and serve to urge the rack 87 towards midposition.

The tube 10 with the ribbon wound spirally thereon may be fed from the machine described in the foregoing, through the usual cleaning and soldering baths for more securely affixing the ribbon to the tube if that is desired.

While one embodiment of the invention has been described for the purpose of illustration, it should be understood that the invention is not limited to the exact apparatus and arrangement of apparatus illustrated as modifications thereof may be suggested by those skilled in the art without departure from the essence of the invention.

What is claimed is:

1. The method of winding a metal ribbon upon a heat exchange tube which comprises rolling one edge of the ribbon for forming a spiral, rotating and advancing the tube, conveying the ribbon spiral to the tube, winding ribbon from the spiral on the tube, and varying the speed of rotation of, and the speed of advance of, the tube in accordance with variations in the tension of the spiral in its travel to said tube.

2. The method of winding a metal ribbon upon a heat exchange tube which comprises rolling one edge of the ribbon for forming a spiral having an inside diameter less than the outside diameter of the tube, rotating and advancing the tube, conveying the ribbon spiral to the tube, winding ribbon from the spiral on the tube, forcing the ribbon to assume a position substantially perpendicular to the surface of the tube as it is wound on the tube whereby the ribbon tightly grips the tube surface, and varying the speed of rotation of, and the speed of advance of, the tube in accordance with variations in the tension of the spiral in its travel to said tube.

3. The method of winding a metal ribbon upon a heat exchange tube which comprises rolling one edge of the ribbon for forming a spiral having an inside diameter less than the outside diameter of the tube, rotating and advancing the tube, conveying the ribbon spiral to the tube, winding ribbon from the spiral on the tube, applying pressure to both sides of the ribbon for forcing it to assume a position substantially perpendicular to the surface of the tube whereby the ribbon tightly grips the tube surface, and varying the speed of rotation of, and the speed of advance of, the tube in accordance with variations in the tension of the spiral in its travel to said tube.

4. The method of winding a metal ribbon upon a heat exchange tube which comprises rolling one edge of the ribbon for forming a spiral having an inside diameter less than the outside diameter of the tube, rotating and advancing the tube, conveying the ribbon spiral to the tube, winding ribbon from the spiral on the tube, pressing the advancing side of the ribbon rearwardly as it is placed on the tube, and varying the speed of rotation of, and the speed of advance of, the tube in accordance with variations in the tension of the spiral in its travel to said tube.

5. The method of winding a metal ribbon upon a heat exchange tube which comprises rolling one edge of the ribbon for forming a spiral having an inside diameter less than the outside diameter of the tube, rotating and advancing the tube, conveying the ribbon spiral to the tube, winding ribbon from the spiral on the tube, pressing the advancing side of the ribbon rearwardly as it is placed on the tube, and applying pressure to the other side of the ribbon after it has been wound a short distance on the tube, and varying the speed of rotation of, and the speed of advance of, the tube in accordance with variations in the tension of the spiral in its travel to said tube.

6. The method of winding a metal ribbon upon a heat exchange tube which comprises rolling one edge of the ribbon for forming a spiral having an inside diameter less than the outside diameter of the tube, rotating and advancing the tube, conveying the ribbon spiral to the tube, winding ribbon from the spiral on the tube, pressing the advancing side of the ribbon rearwardly as it is placed on the tube, and applying pressure to both sides of the ribbon after it has been wound a short distance on the tube, and varying the speed of rotation of, and the speed of advance of, the tube in accordance with variations in the tension of the spiral in its travel to said tube.

7. A machine for applying metal ribbon on a heat exchange tube, comprising means for rolling one edge of a ribbon for forming a spiral, means including a curved member for receiving said spiral and for guiding same to a heat exchange tube, means for rotating and advancing said tube, and means for winding ribbon from the spiral upon the rotating and advancing tube.

8. A machine for winding metal ribbon on a heat exchange tube, comprising a pair of rolls for rolling one edge of a ribbon for forming a spiral, means for rotating said rolls, means for guiding the spiral to the tube, means for rotating and advancing the tube, means for winding ribbon from the spiral upon the rotating and advancing tube, and means including means responsive to variations in the tension of the spiral in its travel between said rolls and said winding means, for

varying the relative speed of said rolls and of said tube rotating and advancing means.

9. A machine for winding metal ribbon on a heat exchange tube, comprising means for rolling one edge of the ribbon for forming a ribbon spiral, means for rotating and advancing a tube, means for receiving the spiral and for guiding same towards the tube in such a direction that its axis is at substantially a right angle to a plane containing the axis of the tube, and means including means for changing the direction of the spiral through substantially a right angle at the tube for winding ribbon from the spiral upon the tube.

10. A machine for winding metal ribbon on a heat exchange tube, comprising means for rolling one edge of the ribbon for forming a ribbon spiral, means for rotating and advancing a tube, means for receiving the spiral and for guiding same towards the tube in such a direction that its axis is at substantially a right angle to a plane containing the axis of the tube, means including means for changing the direction of the spiral through substantially a right angle at the tube for winding ribbon from the spiral upon the tube, and means for pressing backwardly the advancing edge of the ribbon as it is wound on the tube for causing the wound ribbon to assume a position substantially perpendicular to the surface of the tube.

11. A machine for winding metal ribbon on a heat exchange tube, comprising means for rolling one edge of the ribbon for forming a ribbon spiral, means for rotating and advancing a tube, means for receiving the spiral and for guiding same towards the tube in such a direction that its axis is at substantially a right angle to a plane containing the axis of the tube, means including a dome shaped roll having its axis substantially at a right angle to said plane for changing the direction of the spiral at the tube, and means for winding ribbon from the spiral upon the tube.

12. A machine for winding metal ribbon on a heat exchange tube, comprising a pair of rolls for rolling one edge of a ribbon for forming a ribbon spiral, a grooved roll placed to receive in its groove, the outer edge of the spiral as it passes from between the rolls of said pair, means for varying the position of said grooved roll relative said pair of rolls for adjusting the diameter of the spiral, means for rotating the rolls of said pair, means for rotating and advancing a tube, and means for winding ribbon from said spiral on said tube as it is adavnced and rotated.

13. A machine for winding metal ribbon on a heat exchange tube, comprising a pair of rolls for rolling one edge of a ribbon for forming a ribbon spiral, a grooved roll placed to receive in its groove, the outer edge of the spiral as it passes from between the rolls of said pair, means for rotating the rolls of said pair, means for rotating and advancing a tube, means for guiding said spiral in such a direction towards said tube that its axis is at an angle to a plane containing the axis of said tube, and means including means for changing the direction of said spiral for winding ribbon from said spiral on said tube as it is advanced and rotated.

14. A machine for winding metal ribbon on a heat exchange tube, comprising a pair of rolls for rolling one edge if a ribbon for forming a ribbon spiral, a grooved roll placed to receive in its groove, the outer edge of the spiral as it passes from between the rolls of said pair, means for varying the position of said grooved roll relative said pair of rolls for adjusting the diameter of the spiral, means for rotating the rolls of said pair, means for rotating and advancing a tube, means for guiding said spiral in such a direction towards said tube that its axis is at an angle to a plane containing the axis of said tube, and means including means for changing the direction of said spiral for winding ribbon from said spiral on said tube as it is advanced and rotated.

15. A machine for winding metal ribbon on a heat exchange tube, comprising a pair of rolls for rolling one edge if a ribbon for forming a ribbon spiral, a grooved roll placed to receive in its groove, the outer edge of the spiral as it passes from between the rolls of said pair, means for rotating the rolls of said pair, means for rotating and advancing a tube, means for guiding said spiral in such a direction towards said tube that its axis is at an angle to a plane containing the axis of said tube, means including means for changing the direction of said spiral for winding ribbon from said spiral on said tube as it is advanced and rotated, and means for pressing the advancing edge of said ribbon backwardly as it is wound on said tube.

16. A machine for winding metal ribbon on a heat exchange tube, comprising a pair of rolls for rolling one edge of a ribbon for forming a ribbon spiral, a grooved roll placed to receive in its groove, the outer edge of the spiral as it passes from between the rolls of said pair, means for varying the position of said grooved roll relative said pair of rolls for adjusting the diameter of the spiral, means for rotating the rolls of said pair, means for rotating and advancing a tube, means for guiding said spiral in such a direction towards said tube that its axis is at an angle to plane containing the axis of said tube, means including means for changing the direction of said spiral for winding ribbon from said spiral on said tube as it is advanced and rotated, and means for pressing the advancing edge of said ribbon backwardly as it is wound on said tube.

17. A machine for winding metal ribbon on a heat exchange tube, comprising a pair of rolls for rolling one edge of a ribbon for forming a ribbon spiral, a grooved roll placed to receive in its groove, the outer edge of the spiral as it passes from between the rolls of said pair, means for rotating the rolls of said pair, means for rotating and advancing a tube, means for guiding said spiral in such a direction towards said tube that its axis is at an angle to a plane containing the axis of said tube, means including means for changing the direction of said spiral for winding ribbon from said spiral on said tube as it is advanced and rotated, means for pressing the advancing edge of said ribbon backwardly as it is wound on said tube, and means for maintaining said ribbon substantially perpendicular to the surface of said tube as it is wound thereon.

18. A machine for winding metal ribbon on a heat exchange tube, comprising a pair of rolls for rolling one edge of a ribbon for forming a ribbon spiral, a grooved roll placed to receive in its groove, the outer edge of the spiral as it passes from between the rolls of said pair, means for varying the position of said grooved roll relative said pair of rolls for adjusting the diameter of the spiral, means for rotating the rolls of said pair, means for rotating and advancing a tube, means for guiding said spiral in such a direction towards said tube that its axis is at an angle to a plane containing the axis of said tube, means including means for changing the

direction of said spiral for winding ribbon from said spiral on said tube as it is advanced and rotated, means for pressing the advancing edge of said ribbon backwardly as it is wound on said tube, and means for maintaining said ribbon substantially perpendicular to the surface of said tube as it is wound thereon.

19. The method of forming extended heat exchange surface on a tube, which comprises rolling one edge of a metal ribbon to form an advancing spiral having a smaller inside diameter than the outside diameter of the tube, receiving the spiral as it is formed and guiding it adjacent the tube in such a direction that its axis is at substantially a right angle to a plane containing the axis of the tube, rotating and advancing the tube, changing the direction of the spiral at the tube through substantially a right angle, and winding ribbon from the spiral on the tube.

20. The method of forming extended heat exchange surface on a tube, which comprises rolling one edge of a metal ribbon to form an advancing spiral having a smaller inside diameter than the outside diameter of the tube, receiving the spiral as it is formed and guiding it adjacent the tube in such a direction that its axis is at substantially a right angle to a plane containing the axis of the tube, rotating and advancing the tube, changing the direction of the spiral at the tube through substantially a right angle, winding ribbon from the spiral on the tube, and forcing the ribbon to assume a position substantially perpendicular to the tube as it is wound thereon whereby it tightly grips the tube surface.

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