METHOD AND APPARATUS FOR WINDING VERTICAL CORES

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ABSTRACT

Installation for winding on a core or cylinder mount, by combining a movement of rotation in relation to the vertical axis of the core or mount with a general movement of translation in a given direction along this same axis, carried out by a set of winders which move relation to a support, which may be mobile, along the same lengthwise axis, the translational and possibly the rotational movement being controlled by a copying device from a template previously prepared on the said core or mount. This copying device comprises a follower or similar device, devices for transmitting its signals to a motor, and devices for driving the said motor in response to these signals.

The motor actuates the movement of a set of winders in both directions between two end positions, an upper one and a lower one, setting off the longitudinal movement of the said support and stopping it, respectively.

14 Claims, 6 Drawing Figures
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METHOD AND APPARATUS FOR WINDING VERTICAL CORES

This invention concerns an improved installation for winding sectional materials on to a core or cylinder mount, and also the method of winding the sectional materials on the core.

It is known that any sectional materials, wires, cables, U-sections, hollow pipes, etc, can be wound on to a core industrially by combining translational and rotational movements; to obtain the necessary pitch, the speed of rotation is made dependent on the speed of translation, or vice versa.

The provision of such control, to ensure a uniform series of spirals, entails major expenditure, particularly if high precision is desired.

The pitch desired must at any moment be posted on an installation provided for the purpose, and a set of mechanical, hydraulic, electrical or electronic devices operated instantaneously, in order to obtain relative rotational and translational speeds in a given ratio, the net speeds having to allow for the high inertias of these devices, the varying decelerating effects of the movements of the mechanisms, the irregularity of the forces involved in the operations to be performed, etc. Consequently, to take each of these factors into account, highly perfected installations must be available, which means very high costs, lengthy adjustments, and inadequate reliability. The drawbacks are even greater when the pitch does not remain uniform over the whole length of the core.

The present invention allows the disadvantages of known processes and installations to be overcome, and in particular it is suitable for use in cases where small or average series are involved. It relates to a simple, more flexible solution, better adapted to manufacturing and tolerance requirements. It offers a solution that is particularly attractive from the point of view of productivity, for the industrial production of wound heat exchangers of very large dimensions as regards length and diameter, going beyond a critical size governed by the winding processes and installations used up till now.

The present invention relates to an installation for winding on a core or cylinder mount, combining a movement of rotation in relation to the vertical axis of the core or mount with a general movement of translation in a given direction along the same axis, carried out by a set of winders which move in relation to a support, which may be mobile, along the same lengthwise axis, the translational and possibly the rotational movement being controlled by a copying process from a template previously prepared on the said core or mount.

According to one embodiment of the invention, the rotational movement takes place at a uniform speed.

According to another embodiment, the support is stationary and the general translational movement is made by the set of winders, in relation to the support.

According to yet another embodiment of the invention, the support undergoes a translational movement in the same direction as the general translational movement, the said general translational movement being the resultant of the movements of the support and the set of winders.

According to yet another embodiment of the invention, the general translational movement is the resultant of the movements in opposite directions of the support and the set of winders, the speed of movement of the support being greater than that of the set of winders.

According to yet one embodiment of the invention, the translational movement of the support takes place at a uniform and adjustable speed.

According to another embodiment of the invention, the aforementioned support is fixed and mobile in turn, and the set of winders moves in both directions between two extreme positions, an upper one and a lower one, starting the longitudinal movement of the said support and stopping it respectively.

According to yet another embodiment of the invention, instruments for copying a template prepared on the said core or mount and forming the theoretical winding curve transmit their signals to instrument controlling the movements of the said set of winders.

More precisely, the object of the present invention is the provision of an installation for winding on a core or vertical mount, the said installation including a set of winders, the movement of which is controlled by instruments designed to copy a template previously prepared on the said core or mount, and forming the theoretical winding curve.

According to one method of constructing the installation involved in the present invention, the copying instruments to guide the movements of the set of winders comprise a follower or other similar device, devices for transmitting its signals to a motor, and devices for driving the said motor in response to these signals.

According to another embodiment of the invention, the set of winders contains a train of winders, spool-holders, each carrying one of these winders, vertical uprights on which the said spool-holders slide, these uprights being carried by a circular crown or carrousel, which may rotate on the vertical axis of the core or mount.

According to yet another form of embodiment of the invention, the said circular crown is rotationally mounted on a support that may be able to move along a vertical axis.

According to yet another embodiment of the installation involved in the present invention, the aforementioned support consists of a platform, mobile vertically, at least in part, formed from removable gratings shaped like segments of increasing diameter.

Other objects and advantages of the invention will be apparent by reference to the following detailed description together with the accompanying drawings, in which:

FIG. 1 is a vertical half-section showing the principal parts of an installation for winding tubing on the vertical core of a heat-exchanger;

FIG. 2 is a horizontal cross-section roughly along line II—II on FIG. 1;

FIG. 3 is an exploded view illustrating the principle of the removable grating;

FIG. 4 shows, also in vertical section and on a larger scale, the top part of the installation as seen in FIG. 1;

FIG. 5 illustrates on a larger scale the central portion of FIG. 1.

And FIG. 6 is on a still larger scale, an elevational view of the feeling device illustrated in FIG. 1.

The installation illustrated mainly in FIGS. 1 and 2 is intended for winding sectional material and more especially sections of tubing 1 about a vertical core 2 for the manufacture of a heat-exchanger on the site of future utilization.
The vertical core 2 rests on the ground 3 by means of a support 4. The winding installation comprises principally a plurality of winding devices 6 adapted to be simultaneously rotated and moved up and down about the vertical core 2. The winding devices are suspended from a rotary circular crown 7 (see also FIG. 4), coaxial with the core 2 and supported by a plurality of uprights 8 carried by an annular platform 9, which is adapted to be moved up and down between guide posts 11 which also rest on the ground 3, under the action of hydraulic jacks such as 12, each operated from a pressure fluid source 14 including a motor pump set 15.

The top portions of the vertical posts 11 are connected to the top of the vertical core 2 by means of bracing members such as 13. In the embodiment illustrated, four vertical posts 11 are provided at the angles of a square space on the ground (FIG. 2) and four more posts between the first. As an example, the hydraulic jacks 12 are two in number and any conventional means (not shown) are provided for ensuring perfect level up and down movement of the platform 9.

The annular platform 9 comprises a one-piece peripheral portion 17 and a number of removable annular grating portions 20 (FIGS. 1 and 2) forming together a grating with a central opening of variable diameter according to the number of portions removed from the structure. The aim of this grating is so that an attendant can stand on it to carry out preparations, adjustments, and supervise the process of winding the tubes around the core.

The inner diameter of the smaller grating portion corresponds to the outer diameter of the core 2, leaving a circular opening 21 allowing sufficient space for at least the first layer of tubing 1 being wound on the core 2.

The upper parts of the grating portions 20 are similar to the ring members of increasing diameters that were used on the tops of kitchen ranges (see FIG. 3) except that instead of being made up of a one-piece complete ring, the different sections thereof are formed from separable segment rings 18. Each segment 18 has an inner shoulder 24 facing upwardly and an outer shoulder 25 facing downwardly.

The inner diameter of the peripheral portion 17 of the annular platform 9 is greater than the maximum diameter of the tubing layer to be wound.

The rotary crown 7 is a kind of annular lattice girder made of square section tubes as shown. It is fitted with supporting wheels 31 engaged on a circular rail or race 32 resting on brackets 30 secured to the top portions of the uprights 8 (see also FIG. 4). The rotary movement is imparted to the crown 7 by means of a friction roller 33 engaged on an annular flange 34 secured to the top portion of the crown 7. The friction roller 33 is mounted on the output shaft of a speed variator 36 on the input shaft of which belongs to an electric gear motor 37. The speed variator and motor are carried by a fixture plate 38 mounted for pivotal movement on a horizontal shaft 39 carried by a structure 41 secured to the brackets 30. The weight of the assembly formed by the speed variator 36, motor 37, and fixture 38 provide for the force necessary to urge the friction roller 33 in driving engagement against the flange 34.

Each winding device 6 carries a spool holder 52 in which a spool 51 of tubing is mounted for rotation on a vertical axis; in the example shown, four winding devices 6 are provided in order to wind four portions of tubing 1 simultaneously around the core 2. Each winding device 6 has a frame 53 mounted for vertical sliding movement along two upright guides 45 (FIGS. 1, 2 and 5) supported from horizontal beams 46 secured to the underface of the circular crown 7 through intermediate sectional members such as 48.

The lower end portions of each pair of upright guides 45 are connected together by a horizontal bracing member 47 in order to keep the distance between the equal to the distance between the top end portions of the upright guides.

The frame 53 of each winding device 6 consists of a horizontal member, to each of which is secured a pair of side plates 50 embracing an upright guide 45 on which are engaged a pair of upper rolls 54 and a pair of lower rolls 55 freely rotatably mounted between the side plates on spindles supported by the plates.

Each winding device 6 is suspended from one end of a chain or cable 57 passing over two pulleys 58, 59 and the other end of the chain or cable carries a balancing counterweight 61. The pulley 59 is an idle one carried by a bracket 60 secured to an upright guide 45 and to the beam 46, while the pulley 58 is mounted on the output shaft 63 of an electric gear motor 64 secured to the beam 46.

A lower limit-switch 71 is secured to the lower end of the upright guide 45 and an upper limit-switch 72 secured to the upper end of said upright guide are selectively operable by the lower and upper face, respectively of the side plates 50 and are connected to the motor pump set 15 through wires 73, 74. (FIG. 1) a connection box 75 containing a suitable electrical appliance with an amplifier carried by the rotary crown 7, a set of stationary terminals 76 and two wires 78, 79. The connection box 75 and set of stationary terminal 76 are seen in more detail in FIG. 4. The terminals 76 are carried by an angle support 81 which is secured to the top portion of a vertical post 11. The various wires in the connection box 75 are connected to circular contact rails 83 secured to the top of the rotary crown 7, while the corresponding terminals carried by the support 81 consist of brushes 76 respectively in frictional engagement with the corresponding contact rails 83.

Each electric motor 64 to move a winding device vertically is supplied with current from any suitable sources through wires 85 (FIG. 1), the connection box 75, and corresponding contact rails 83 and terminals 76 (FIG. 4), under the control of a feeder or tracer device 88 (FIGS. 1 and 6) which is also connected to the connection box 75 through wires 89.

The feeder device 88 is shown in more detail in FIG. 6. It consists mainly of a feeder or tracer finger 91, adapted to engage a prior tube winding 1 or any suitable initial helical template, and secured to a roller 92 rotatably mounted on a shaft 93 which is secured to the outer end of a tubular arm 94 the other end of which is pivotally mounted on a horizontal shaft 95 mounted in a carriage 96 adapted to slide in horizontal guide ways 97 carried by the frame 53 of the winding device 6 and biased towards the central core 2 by a spring device, diagrammatically represented at 99.

The feeder 91 is made of a low-friction material such as Teflon. In the example contemplated, this feeder consists of a cylindrical member with a transverse end groove 102 adapted to engage the helical tube or template. The shaft 95 also carries the arm 104 of a poten-
The installation above described may be operated in different ways.

In one version, the platform 9 is initially located in its lowermost position, that is to say the hydraulic jacks 12 are retracted and the winding devices 6 also assume their lowermost position with respect to the platform 9. The core 2. In order to control the vertical movement of the winding devices it is therefore necessary to form an initial helical template on the core 2, for instance by helically winding a rope 1A on the core 2, as indicated in broken lines at the top of Fig. 1. The pitch of this template is equal to the pitch of the tubing to be wound on the core.

The feeler 91 (Fig. 6) is brought into engagement with the template 1A and the motor 37 is energized causing the circular crown 7 to rotate about the core together with the four winding devices 6 supported thereby, while the four motors 64 cause the corresponding winding devices 6 to be moved upwards in response to the control action of the respective feeler devices 88.

Any deviation in the level of each winding device from the reference level in relation to the template is translated by the potentiometer into a corresponding voltage-differential signal which is conveyed to the control device, which supplies the motor 64 with a current, the direction and voltage of which correspond respectively to the sign and voltage of the signal emitted by the potentiometer, making the motor rotate in the corresponding direction and at the speed needed to compensate for the deviation.

The tube from the reel 51 in each winding device 6 is therefore subjected to a circular movement around the core 2 combined with a vertical movement, so that it is wound helically on the core 2 in correspondence with the template 1A.

The side plates 50 in each winding device then reach the corresponding upper end switch 72 thus causing pressure fluid to be supplied to the hydraulic jacks 12 from the corresponding motor pump set 15. The platform 9 is thereby subjected to an upward movement, at a speed previously determined so as to be greater than the absolute vertical speed to be imparted to the winding devices to obtain correct continuation of a winding operation, so that the feeler devices 88 are compelled to control the motors 64 in the reverse direction for a vertical movement of the winding devices downwards with respect to the ascending platform 9. Although the linear speed of the hydraulic jacks 12 may be inaccurate, the absolute upward movement of the winding devices takes place at a very accurate speed, controlled by the feeler devices engaged on the template 1A carried by the stationary core 2.

The side plates 50 of the winding devices then come into engagement with the lower switches 71 which stop the upward movement of the platform 9, now positioned approximately at its uppermost level. The rotary movement of the circular crown 7 is continued and the feeler devices 88 still control the corresponding motors 64 for upward movement of the winding devices with respect to the platform 9, now stationary.

The winding devices 6 now reach approximately their uppermost position, with respect not only to the platform 9 but also to the heat exchanger to be manufactured.

Otherwise stated, a first layer of tubing has been wound on the core 2, that is to say four tubes have been simultaneously wound helically beside one another on the core by the four winding devices 6 respectively.

A second layer of tubing may be laid helically over the first layer, either in the same manner or with a reverse pitch if desired, by means of similar operations carried out in reverse order.

As the outer diameter of the successive layers of tubing ond becomes greater, successive portions of the grating 20 are removed.

Any combination of vertical movements of the hydraulic jacks 12 to move the platform 9 up and down, and of the winding devices 6 relative to the platform, may be adopted as desired, also in combination with the rotational movement of the winding devices around the core, either clockwise or anticlockwise. In any case, whatever the rotational speed of the circular crown 7 and the inaccuracy of the speed of the hydraulic jack 12, the pitch of the helical tubing wound on the core is corresponds strictly to the pitch desired, since the vertical speed of the winding devices 6 with respect to the core is determined with accuracy, under the control of the feeler devices, engaged against a pattern 1A or a previous tube wound helically on the core.

In another version, particularly for heat exchangers of lesser height, the platform 9 may be kept stationary during the whole operation of the installation, the only vertical movement being then assumed by the winding devices 6 moving up and down with respect to the stationary platform 9, while being of course still moved around the core together with the circular crown 7 from which they are suspended.

Obviously, the present invention is not confined to the embodiment described and represented: there are many other possible variations for those skilled in the art, depending on the applications contemplated, and without in any way departing from the spirit of the invention.

For instance, other means than the hydraulic jacks 12 may be used to move the platform 9 up and down such as a cable or chain system, with winches.

Also in simplified installations, the platform 9 might be designed as a stationary member.

What is claimed is:

1. An installation for winding elongated material such as sections of tube about a vertical core, comprising:
   a vertical core,
   a substantially horizontal and annular platform having a central opening of adjustable dimension, surrounding said vertical core with at least a first layer of said sectional material wound thereon,
   at least one winding device carried on said annular platform, comprising a support, means mounting said support for rotation around said central opening, a frame, means mounting said frame on said support for vertical movement with respect thereto, means rotatably supporting a spool of said sectional material on said frame,
   first power means for imparting a rotary movement to said support with respect to said annular platform,
   control means associated with said winding device, for controlling the vertical movement of said frame together with said spool of sectional material, ac-
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According to a contour of said vertical core, said control means comprising:
a feeler device mounted on said frame of the winding device, comprising sensing means for detecting the level of said frame in relation to said contour and for delivering a signal translating any deviation in the level of said frame with respect to the level of said contour,
second power means for imparting a vertical movement to said frame together with said spool of said sectional material, with respect to said support, acting in response to said signal to compensate for said deviation in the level of said frame, said sensing means of the feeler device comprising:
feeling means comprising a finger adapted to engage said contour, a supporting arm on which said finger is secured, a pivot horizontally mounted in said feeler device, on which said supporting arm is perpendicularly secured, said supporting arm being pivotally movable about said pivot, a potentiometer comprising an arm integral with said supporting arm, said potentiometer emitting a voltage-differential signal and translating any deviation in the level of the frame of said winding device with respect to the reference level of said contour and a amplifier for said voltage-differential signal,
said second power means comprising an electrical motor supplied with a current resulting from said voltage-differential signal.

2. An installation according to claim 1, said finger comprising a member having a groove adapted to engage said contour, a shaft secured to said supporting arm, said member being rotatably mounted at the end opposite to said groove on said shaft at the end thereof opposite to said pivot.

3. An installation according to claim 1, guideways carried by the frame of said winding device, said feeler device being mounted in a carriage adapted to slide horizontally in said guide-ways, and a spring device biasing said carriage towards the central opening of said annular platform.

4. An installation for winding elongated material such as sections of tube about a vertical core, comprising:
a vertical core,
a substantially horizontal and annular platform having a central opening of adjustable dimension, surrounding said vertical core with at least a first layer of said sectional material wound thereon, at least one winding device carried on said annular platform, comprising a support, means mounting said support for rotation around said central opening, a frame, means mounting said frame on said support for vertical movement with respect thereto, means rotatably supporting a spool of said sectional material on said frame, first power means for imparting a rotary movement to said support with respect to said annular platform, control means associated with said winding device, for controlling the vertical movement of said frame together with said spool of sectional material, according to a contour of said vertical core, said control means comprising:
a vertical core,
a substantially horizontal and annular platform having a central opening of adjustable dimension, surrounding said vertical core with at least a first layer of said sectional material wound thereon,
at least one winding device carried on said annular platform, comprising a support, means mounting said support for rotation around said central opening, a frame, means mounting said frame on said support for vertical movement with respect thereto, means rotatably supporting a spool of said sectional material on said frame,
first power means for imparting a rotary movement to said support with respect to said annular platform,
control means associated with said winding device, for controlling the vertical movement of said frame.

control means associated with said winding device, for controlling the vertical movement of said frame together with said spool of sectional material, with respect to said support, acting in response to said signal to compensate for said deviation in the level of said frame, said annular platform comprising a one-piece outer portion, and removable annular inner portions having respective different diameters, forming said central opening, each annular inner portion comprising separable segments.

12. A method for winding elongated material such as sections of tube about a vertical core, comprising:
a. initially forming a helical template on said vertical core, having a pitch in correspondence with the pitch of the first layer of said sectional material to be wound,
b. simultaneously rotating and moving vertically winding means provided with said sectional material about and along said vertical core, whereby said first layer is wound around said vertical core, c. controlling the vertical movement of said winding means according to said template, by detecting the level of said winding means in relation to said template, and any deviation of said level with respect to the reference level of said template, and by imparting a vertical movement to said winding means to compensate for said any deviation,
d. repeating operations (c) and (d) for the other subsequent layers of said sectional material to be wound, and using the previous layer of said sectional material as said template for controlling the vertical movement of said winding means.

13. A method according to claim 12, and moving said winding means with a constant rotational speed about said vertical core.

14. A method according to claim 12, and supporting said winding means on an annular platform, vertically movable along said vertical core, further comprising:
e. controlling the vertical movement of said winding means according to operation (c), between a lower limit position and an upper limit position with respect to said platform,
f. vertically moving said annular platform when said winding means reach one of said limit positions, and stopping the vertical movement of said platform when said winding means reach the other limit position, and maintaining the vertical speed of said annular platform greater than the vertical speed of said winding means with respect to said annular platform.