MACHINE FOR WRAPPING TENSIONED
ABOUT OBJECTS

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ABSTRACT

A method and machine for winding tensioned wire
material in bands on the external surface of a con-
tainer. A winding unit having self-driving means and a
supply of tensile material is located adjacent a band
position by means of a location means attached to the
said winding unit, and the unit is displaceably sup-
ported by rail means encircling the container. Chain
link means or continuous toothed rack element means
are fixedly mounted on the radially outer portion of
the rail means and provide a form of toothed rack
which helps support guide and intermesh with the
driving means of the winding unit. One end of the sup-
ply of tensile material is secured to the container and
the winding unit is displaced about the container to
continuously draw off the tensile material from the
supply. The force in the tensile material is controlled.
To this end, the winding unit is located adjacent a
band position by first fixedly or removably attaching a
rigid rail track to the wall of the container and there-
after the position of the winding unit relative to the
said rigid rail track is adjusted.

5 Claims, 5 Drawing Figures
MACHINE FOR WRAPPING TENSIONED ABOUT OBJECTS

This application is a continuation of Ser. No. 802,622, filed Aug. 2, 1971, now abandoned, which is a continuation-in-part application of Ser. No. 496,941 filed Oct. 18, 1965 now U.S. Pat. No. 3,452,940.

This invention is concerned with improvements in or relating to pre-stressed containers, and in particular relates to the means and method for wrapping tensioned wire material about the outer surface of concrete pressure vessels.

Trends in the development of pressurized concrete vessels, for use particularly in the field of nuclear power generation, require the pre-tensioning of vessels of pseudo-spherical form in which the final shape of the vessel is determined by a multiple step formation of its outer surface. Such vessels may be of large size with diameters of the order of 100 feet. A further application of such vessels, which may also have smooth outer surfaces, is in the storage of liquids and of liquefied gases under pressure.

It has been found that the pre-tensioning of such vessels is conveniently achieved by winding wire in the grooves formed in the successive steps forming the pressure vessel or onto predetermined places on a smooth outer surface. To wind wire on smooth outer surfaces has not yet been successfully carried out, as there were no suitable means and method available for doing it.

The object of the invention is to provide an improved means and method for winding tensioned wire material in bands on the external surface of a container, or within annular peripheral grooves of a container having an irregular outer surface, or within such peripheral grooves whereby the side walls of the grooves are not suitable for locating the winding means relative to the said grooves.

According to one aspect of the invention, a machine for winding pretensioned wire material in bands on the external surface of a container comprises a wire supply source, a winding means adapted to be located adjacent a band position for winding wire from the supply source, and drive means co-operating in operation of the machine with the winding means to displace the winding means along a fixed path about the container at a speed greater than the speed at which untensioned wire is drawn from the wire supply source, either by controlling the rate at which wire material is drawn from the store on the machine or by directly controlling the tensile force in the wire material, the winding means including a location means to locate the winding means adjacent the band position, and the winding means being adapted to be supported from the container by an endless girdle member extending thereabout, characterized in that the said endless girdle member is a rigid rail track along which the winding means can be driven and from which the said winding means can be located relative to a said band position, the said rigid rail track being fixedly or removably supported from the wall of the container.

According to another aspect of the invention, there is provided a method of winding one or more tensioned elements on the external surface of a container, comprising the steps of locating a winding unit adjacent a band position by means of a location means attached to said winding unit, displaceably supporting the winding unit by rail members encircling the container, securing one end of the supply of tensile material to the container, displacing the winding unit about the container adjacent said band position to continuously draw off the tensile material from the supply, and controlling the force in the tensile element drawn off from the supply and wound about the container, and further comprising the steps of locating the winding unit adjacent a band position by first fixedly or removably attaching a rigid rail track to the wall of the container and thereafter adjusting the position of the said winding unit relative to the said rigid rail track.

In order that the invention may be clearly understood, some embodiments thereof will hereinafter be described by way of example and not of limitation, with reference to the accompanying drawings, in which:

FIG. 1 is an elevation of one embodiment of a winding unit forming part of the machine in accordance with the invention.

FIG. 2 is a section through a wall of an externally grooved container, showing diagrammatic view of one embodiment of a machine with its location means in accordance with the present invention.

FIG. 3 is a section through another container wall having fixed thereto a rigid rail track for supporting the locating means of a machine in accordance with the present invention.

FIG. 3a is a diagrammatic view onto the construction shown in FIG. 3, taken partly in section along line III—III of FIG. 3, and

FIG. 4 is a section through a part of the rail track, taken along line IV—IV of FIG. 3a.

Referring now to FIG. 1 of the drawings it will be seen that a preferred embodiment of the winding unit is formed by a carriage arranged to move on and around a concrete pressure vessel 1 adjacent a groove 2 formed in the outer periphery of the vessel. The carriage 3 is provided with rollers 4 and with rollers 5 which are adapted to ride on a rigid rail track on the outer surface of the vessel 1. Upon these rollers the entire carriage unit can revolve about the periphery of the vessel 1. The rollers 4 act as a location means for the winding unit.

A drive motor 6, which may be any convenient prime mover, for example, petrol or diesel powered, is arranged on the carriage 3, which may also carry a cable guide in the case of an electric drive motor 6. The motor 6 drives a worm and bevel gear 7 through a shaft 8, thereby motivating a pulley 9 via a slipping clutch 10, and also driving a sprocket 11 whose effective diameter is slightly greater than that of the pulley 9. The pulley 9 and sprocket 11 are carried upon a shaft 12 housed in bearings 13.

A similar assembly of pulley 14, slipping clutch 15 and sprocket 16 are mounted upon a non-drive shaft 17 housed in bearings 18. The pulleys 9, 14, which form part of a winding means, have a plurality of separate grooves formed on their periphery, and they are of equal diameter.

Also mounted upon the carriage is a wire supply source formed by a reel 19 mounted upon a bearing 20 having in association therewith a reel brake (not shown) which exerts a weak braking effect to prevent unwanted uncoiling of wire from the reel 19.

Wire 33 uncoiling from the reel 19 passes through a wire guide and brake unit 21 which exerts a further braking action on the wire. The wire passes across pulley 14 in the top groove thereof, then about the top
groove of pulley 9, then about successive lower grooves of the pulleys until the wire leaves the bottom groove of the pulley 9, which is aligned substantially on the centre line of the groove 2 in the vessel 1. The wire then passes through a wire guide unit 22 and a guide 23 forming part of a spooling means 29 before being wound under tension in a groove or another place of the vessel 1.

In order to produce rotational movement of the carriage 3 about the concrete vessel 1, there is provided an endless girdle member formed e.g., by a chain slung about an outer part of the rail track on the concrete vessel 1. The endless chain engages with the drive sprocket 11, the non-driven sprocket 16, and further sprockets which serve to tension the chain e.g., under the action of a spring.

If the container to be pretensioned is a pressure vessel having its outer surface formed in steps of varying diameter, provision is made for additional links of the chain 24 to be inserted when the carriage 3 is moved from a first rail to a second rail of greater diameter.

The spooling means 29 attached to the carriage 3 is operative to move the wire guide 23 in a vertical direction by an increment substantially equal to the width of the wire each time the carriage has made one revolution around the vessel 1. The spooling means 29 comprises a screw-threaded shaft 31 located within a vertical slot 30, and a threaded slider 32 attached to the guide 23 upon the threaded shaft 31.

To the upper end of the shaft 31 is attached a collar carrying four arms 34. Two adjacent links of the endless chain 24 are arranged to carry upstanding actuating pins 35, which strike the arms 34 and so rotate the shaft 31 at each revolution of the carriage 3. The pitch of the screw-thread on the shaft 31 is arranged to be such that the guide 23 is moved vertically a distance equal to the gauge of the wire 33 at each revolution of the carriage, and in this way even and close spooling of the wire within the groove 2 is achieved.

The winding means can be displaced on the carriage in a manner to permit winding of wire material into a number of different band positions, such as different grooves, without changing the position of the rail track of the positioning means 4, 5.

Alternative systems of actuating the spooling means 29 are possible. For instance a worm gear and high ratio reduction drive may be arranged between the shaft 17 and screwed shaft 31.

In the operation of the machine, wire 33 from the supply reel 19 is passed about the two pulleys 9, 14 and through the various wire guides, and its end is attached to an anchoring point on the outer surface of the container.

The motor 6 is set in operation, turning the pulley 9 to draw wire off the supply reel 19, and to rotate the sprocket 11 thereby moving the carriage about the periphery of the vessel 1.

Since the diameter of the sprocket 11 is slightly greater than the diameter of the pulley 9 the speed of the carriage about the container is slightly greater than the peripheral speed of the pulleys 9, 14. Since it is this latter speed which governs the rate at which wire is unwound from the reel 19 in its untensioned state, the wire leaving the pulley 9 and wound within the groove 2 is extended and so placed in tension.

The slipping clutches 10, 15 are effective to limit the above-mentioned tension in the wire to a desired working value, which may be a fixed percentage of the breaking strain of the wire. Adjustment means are provided within said slipping clutches to enable variations to be made in the wire tension.

At each revolution of the carriage 3, the two actuating pins 35 on the chain 24 engage two successive arms 34 on the spooling means, and the guide 23 is moved in an upward direction to permit the next coil of wire to be laid in the groove in side by side relation with the previous coil.

When the carriage has made a number of revolutions about the container corresponding to the number of coils of wire required to cover the width of the groove, the wire is attached to an anchorage in the groove or on the container surface.

Referring now to FIG. 2 of the drawings, there is shown a part of a container wall 101, presenting on its external surface a plurality of grooves 102, 102', 102'' etc. into which layers 103, 103', 103'' etc. of tensioned wire have to be wound.

For winding a tensioned wire in bands within the said grooves 102, or simply onto the external surface of the container wall, a machine is provided which comprises a winding unit 104 adapted to be located adjacent a band position. To this end, the winding unit 104 includes means 105, 105', to locate the winding unit adjacent the band position and the whole machine further comprises an endless rigid rail track 106, 106' fixedly or removably mounted on the outer surface of the container wall 101 to support the winding unit 104.

The location means 105, 105' and the winding unit 104 are mounted on a carriage arranged to move along said rail track 106, 106'. The location means 105, 105' which locates the winding unit 104 adjacent a band position for winding may be a guide roller assembly that transfers the weight of the winding unit and of the said carriage to the rigid rail track, which guide roller assembly 105, 105' may include well known adjustment means, such as screw-threaded shafts, whereby the said winding unit 104 may be moved towards or away from said rail track 106, 106' so as to locate the winding unit in relation to the or each band position served by the said rail track 106, 106'.

A construction of the winding unit, mounted on a carriage and comprising a wire supply source, a winding means adapted to the located adjacent a band position for winding wire from the supply source, and drive means co-operating in operation of the machine with the winding means to displace the winding means along a fixed path about the container at a speed greater than the speed at which untensioned wire is drawn from the wire supply source, either by controlling the rate at which wire is drawn from the source or by directly controlling the tensile force in the wire material, the said winding unit comprising location means in form of a guide roller assembly, has been described hereinafter.

Of course, other constructions are possible. In known devices, the locating means, i.e., the guide roller assembly of the known device were movable only within the grooves of the container wall. This was of course limiting the depth of the grooves available for applying tensioned wire. Also, known devices could not be used for winding a tensioned wire onto a non-grooved container wall.

In the machine of the present invention this drawback has been overcome by providing said rigid rail
track 106, 106' for supporting the guide roller assembly 105, 105' of the winding unit 104.

The rigid rail track 106, 106' may be fixed directly to the wall 101 of the container, or by permanent support elements which are integral with the container wall, or by removable support elements clamped to the container wall surface, and arranged to maintain the winding unit at a substantially constant distance from the bottom of the groove or surface portion being wound.

The winding unit 104 is driven along the rigid rail track 106, 106' by one or two endless link-chains 107, 107' mounted on a radially outer leg of at least the upper rail, co-operating with sprockets 108, 108' driven by the winding means. The driving could also be performed (as shown in FIG. 4) by a continuous toothed rack element 106a rigidly attached to the rail track in any conventional manner such as welding and arranged in intermeshing relationship with a pinion 108b driven by the winding means in the same manner as sprocket 108, or by a threaded or intended rod or member, or by a driving surface of any other suitable form against which the winding unit can operate.

FIGS. 3 and 3a of the drawings show another arrangement of a rail track 109, 109' supported from a non-grooved container wall 110. The rail track comprises two U-shaped rails 109 and 109' vertically spaced at a distance h (h may be e.g., 160 in.). These Figures are also showing, diagrammatically, the guide roller assembly 111, 112, 113, 114 of a winding unit 115.

At least the upper rail 109 is supported, adjustably in height, by a plurality of supporting members 116. The supporting members 116 are slidably fixed in vertical rail means 117 anchored in the container wall 110.

FIG. 4 shows a detail of the fixation of rail 109. The rail 109 comprises a plurality of L-shaped elements 118, 119 which are fixed by suitable means to a number of support elements 116 circumferentially spaced around the container wall 110. Each support element 116 is fixed in so-called Jardal-rails 117 anchored in the container wall 110. This construction enables a good levelling of the rail track before locating the winding unit in the rail track.

The machine and method described provide, for example, for the winding of a band of pretensioned wire on the external surface of a container, or for the winding of a band of pretensioned wire within a peripheral groove of a container wherein the groove sides are inadequate for the support of the winding unit, or for the winding of a band of pretensioned wire within a groove of a container wherein the outer surface is not substantially parallel with the bottom of the groove, as for example, containers wherein the exterior of the boundary wall is polygonal in cross-section.

What is claimed is:

1. A machine and system for winding pretensioned wire material in bands on the external surface of a generally cylindrical container, comprising:
   a. a carriage having drive means including drive pinion gear means;
   b. a wire supply source and winding means on said carriage adapted to be located adjacent a band position for winding wire from said supply source;
   c. said drive means cooperating in operation of said machine with said winding means to displace said carriage with winding means along a fixed path about the periphery of the container at a speed greater than the speed at which untensioned wire is drawn from the wire supply source;
   d. said winding means including location means to locate said winding means adjacent the band position;
   e. said carriage with winding means being supported upon said container by means of a pair of container embracing, horizontally disposed endless girdle members disposed in a vertically spaced-apart manner, and each comprising a rigid rail member along which the carriage-supported winding means is driveable and from which the same is located relative to said band position;
   f. said rail members having means therewith for supporting said rail members from the wall of the container;
   and
   g. said rail members having continuous, toothed rack means fixedly attached on a radially outer peripheral portion thereof for driving engagement by said pinion gear means of said drive means.

2. A machine and system as defined in claim 1 wherein said means of paragraph (f) for supporting said rail members comprises support elements removably mounted on said container.

3. A machine and system as defined in claim 1 wherein said container includes a peripheral outer wall and said rigid rail members are fixed to said wall by permanent support elements which are made integral with the container wall.

4. A machine and system as defined in claim 1 wherein said container includes a peripheral outer wall and said rigid rail members are fixed to said wall by composite support elements of which at least certain elements are made integral with the container wall and constitute part of adjustment means embodied therewith to provide for at least vertical adjustment of said rail members, said elements having vertical adjustment slot means; and said adjustment means further including removable support elements adjustable clamped within said slot means to the container wall and arranged to maintain the winding means at a substantially constant distance from the external container surface portion to be wound.

5. A machine and system as defined in claim 1 wherein the cylindrical container is provided with a plurality of vertically spaced, horizontally disposed annular peripheral grooves in which the windings are disposed, and means supporting said endless girdle rail members upon said container in the vertically spaced apart manner so as to span and have a plurality of said peripheral grooves disposed adjacent one another between said rail members so as to provide winding of the wire material around said container and within said interposed plurality of grooves without the necessity of changing the mounting position of the winding machine on and between the rails and without the need to provide such rail members for supply source;

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