

March 6, 1945.

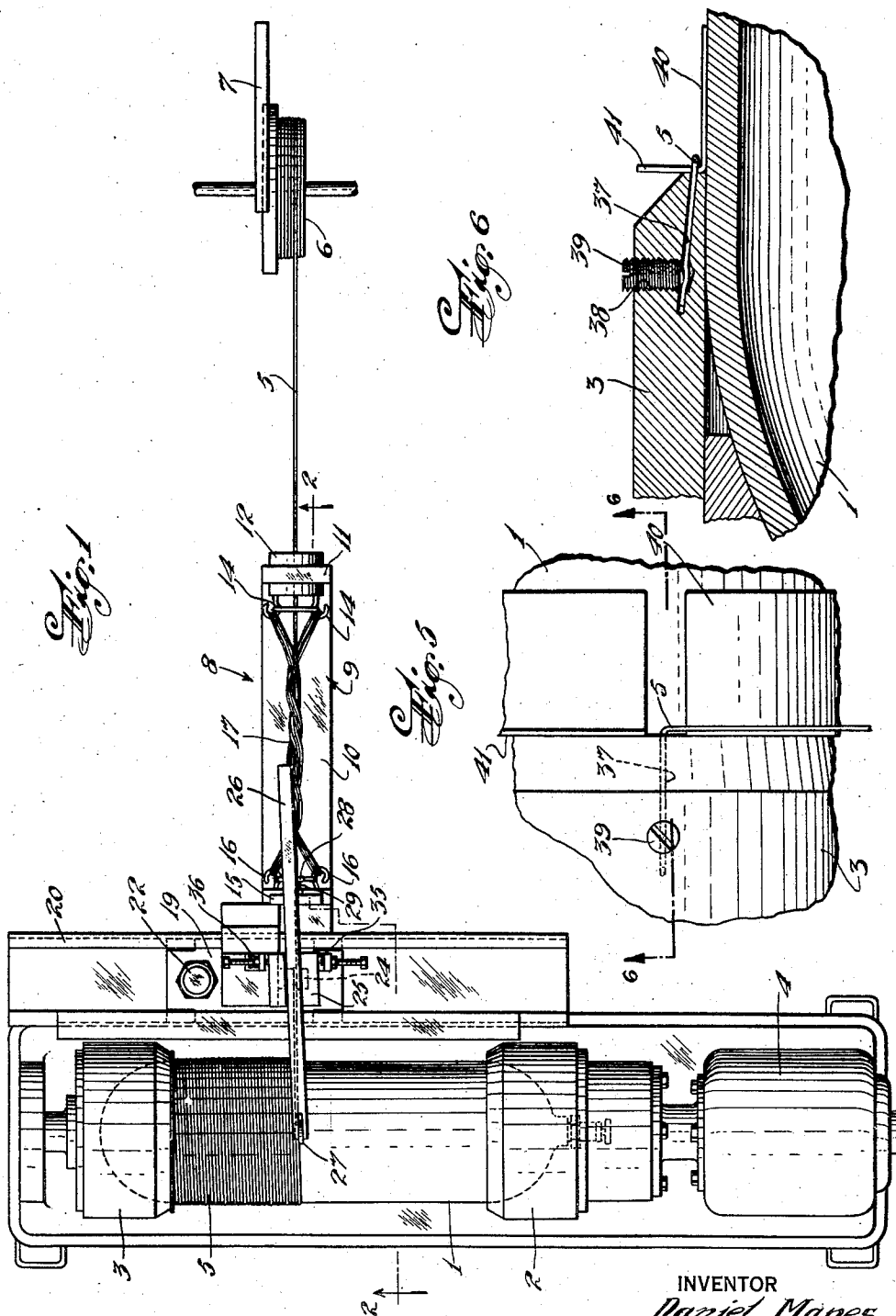
D. MAPES

2,371,107

METHOD OF AND APPARATUS FOR WINDING WIRE ON A BODY OF REVOLUTION

Filed Jan. 8, 1942

3 Sheets-Sheet 1



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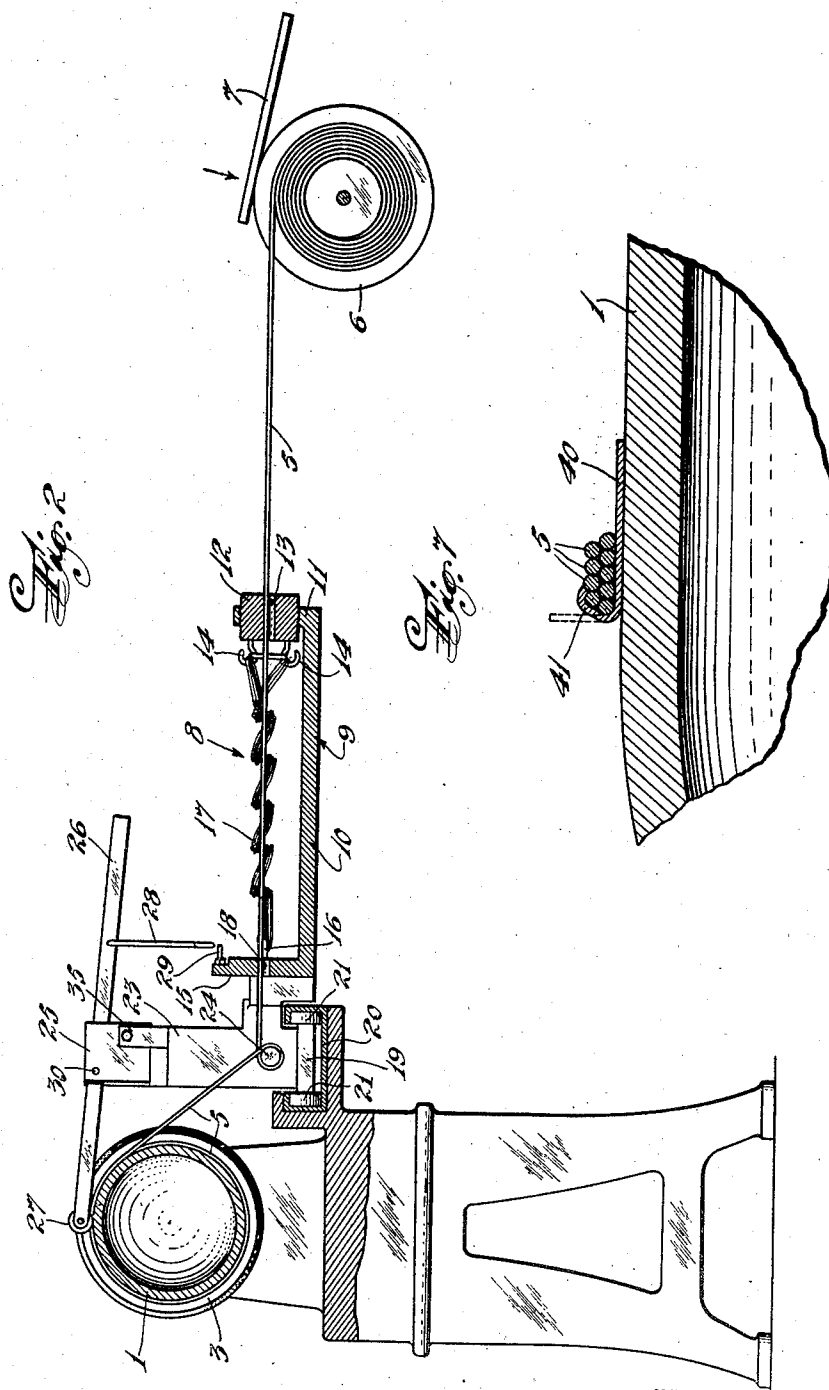
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Fig. 3

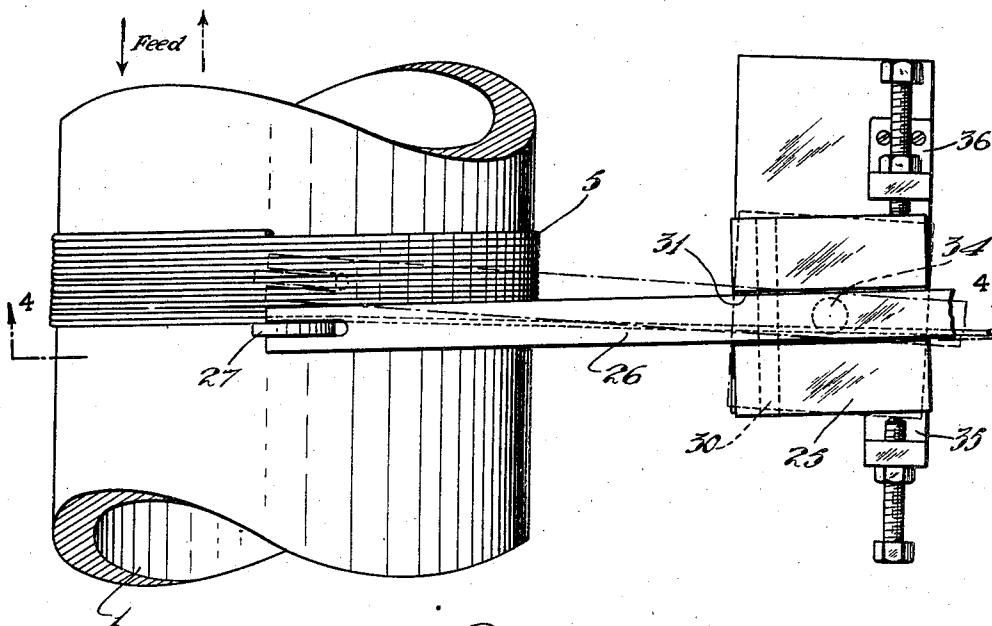
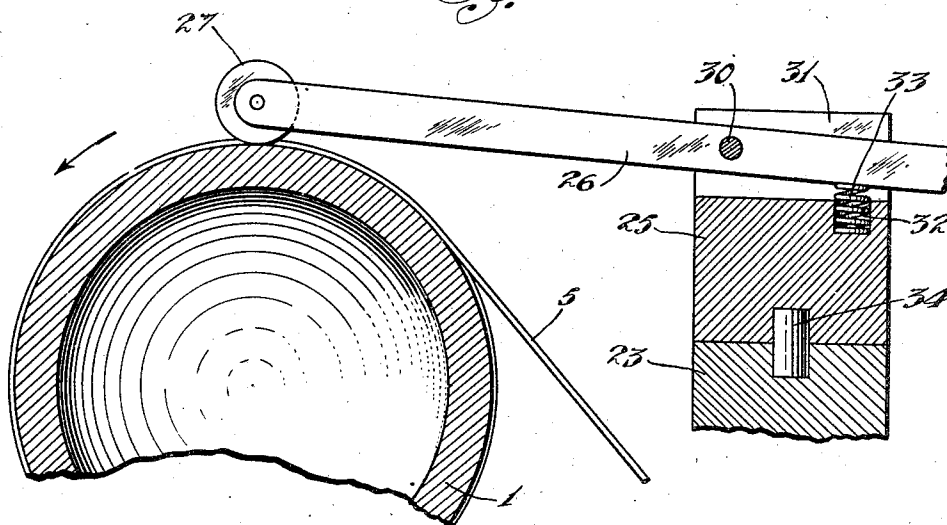


Fig. 4



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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR WINDING
WIRE ON A BODY OF REVOLUTION

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Application January 8, 1942, Serial No. 426,019

12 Claims. (Cl. 153—67)

The present invention relates to new and useful improvements in methods of and apparatus for winding wire, with particular reference to winding wire on bodies of revolution, as, for example, containers of a general cylindrical shape, pipe or tubing, and the like.

The invention is especially adapted to be utilized in connection with winding high tensile strength steel wire, such as that usually known as "piano" wire, on containers or cylinders designed for the storage of high pressure fluid media, to provide a protective jacket for such containers.

The use of protective jackets of high tensile strength steel wire for containers which are otherwise sufficiently strong to withstand the highest operating pressures to which they may be subjected in normal service, is an outgrowth of the widespread use of powerful 0.50 caliber machine guns on modern fighter planes in place of previous less powerful 0.30 caliber machine guns; it having been found that 0.50 caliber machine gun bullets striking a high pressure gas container squarely, will completely pierce the container, leaving entrance and exit openings, and that the container wall is so weakened at the exit opening that under the influence of the high pressure fluid medium issuing from the opening, the container literally tears asunder with explosive force with great danger to the plane and its crew. It has also been discovered that this danger of "explosion" of the container can be overcome by providing the container with a suitable jacket of high tensile strength steel wire, which has no function normally, but which serves to take up the unusual stresses occurring when the container is pierced by a bullet or other high velocity projectile, and to localize the damage to the area immediately adjacent the opening in the container wall.

Such a jacket consists of a series of turns or coils of wire which are arranged to form a substantially continuous winding on a wall of the container. Of course, when the container wall is pierced by a bullet, a number of turns of the wire are severed; and in order to overcome the tendency of the remaining portion of the coils to unwind or become dislocated, it has been found desirable to wind the wire on the container under a predetermined degree of tension, and to so present the wire as to create a tendency for it to cling to the contour of the container. In order to further aid in holding the winding in place; an adherent coating, such as one of solder, is usu-

ally applied to the jacket; and as the wire itself should preferably have a coating resistant to rust and conducive to the adhesion of the solder, so-called "tinned" wire may be advantageously employed.

Ordinary methods of winding wire and machines for this purpose known heretofore, have not been satisfactory for providing wire-wound jackets of the foregoing character. One of the difficulties of such previously known machines is that the wire tensioning means mechanically damages the wire coating. Another difficulty is that the tensioning means, by the application of friction, heats the wire to such an extent as to cause melting or deterioration of the coating and also to affect the tensile properties of the wire.

Accordingly, it is an object of the invention to provide an improved method of and apparatus for winding wire on bodies of revolution, such as cylindrical containers, and the like.

Another object is to provide a rapid, precise and economical method of and apparatus for winding wire.

Another object is to provide a method of and apparatus for winding wire in such a manner that the individual coils or turns of the jacket tend to cling to the contour of the container upon which they are wound.

Another object is to provide a method of and apparatus for winding wire in such a manner that the coils or turns of the winding remain substantially in place on the vessel, even if a portion of the winding is pierced or ruptured.

A further object is to provide a method of and apparatus for winding wire, wherein the wire may be suitably tensioned without damage to the coating of the wire, either mechanically or due to heat caused by friction.

Other and further objects of the invention will become apparent upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

In the drawings:

Figure 1 is a plan view of an apparatus for winding one or more layers of wire upon a body of revolution;

Figure 2 is a sectional view, partly in elevation, taken on the line 2—2 of Figure 1;

Figure 3 is an enlarged plan view of a portion of the apparatus shown in Figure 1 and illus-

trating means for guiding the wire in place as it is being coiled about a cylinder;

Figure 4 is a transverse sectional view taken on the line 4—4 of Figure 3;

Figure 5 is an enlarged fragmentary plan view, illustrating means of attaching the starting end wire to one of the chucks;

Figure 6 is a fragmentary sectional view taken along line 6—6 of Figure 5; and

Figure 7 is an enlarged fragmentary sectional view, illustrating means for securing the end coils or turns together.

Referring now to the drawings, there is shown in Figure 1 a cylinder 1 rotatably secured between a head chuck 2 and a tail chuck 3 of a conventional lathe powered by motor means 4. The cylinder is seen to be partly wound with wire 5, which is being supplied from a stock reel 6, the reel being retarded by a friction brake 7. On its way from the stock reel 6 to the cylinder 1, the wire 5 passes through tensioning means 8 arranged to move, as a whole, parallel to the main axis of the cylinder 1, as will be hereinafter made apparent. The tensioning means 8 comprises a supporting member 9 having a longitudinal portion 10 provided with a pair of outer and inner uprights 11 and 15 respectively. The upright 15 is centrally apertured as at 18, while the upright 11 has rotatively adjustably mounted therein a bushing 12 formed with a central aperture 13. The bushing 12 and upright 15 are provided with a pair of hooks 14 and 16 respectively, and which are disposed in confronting relation. The wire 5 passes through the apertures 13 and 18 longitudinally of the portion 10 and between the hooks of each pair during the feed of the wire from the reel 6 to the cylinder 1.

The ends of a pair of rope lengths 17 are fastened to the hooks 14 and 16, respectively, and with said lengths being twisted about each other and the wire. By adjustment of the bushing 12 within the upright 11, the tension of the rope lengths is regulated about the wire, thus permitting the wire to be fed to the cylinder under a desired tension for a purpose hereinafter made apparent. The tensioning means 8 is made a part of a carriage means 19, which is designed to be supported by a carriage bed 20 suitably secured to the side of the lathe where, ordinarily, the tool would be. A minimum amount of friction between carriage and bed is obtained by the interposition of rollers 21.

If desired, an adjustable friction brake for the carriage 19 may be provided as at 22.

The carriage 19 is formed with a block 23 or the like, which is adapted to carry on one side a roller or pulley-like member 24 having a relatively small diameter, and on its top a secondary block 25. The block 25 is seen to support a wire guide, which may take the form of an arm 26 normally adapted to make contact through its end 27 with the cylinder 1, as will be shown and explained with respect to Figures 3 and 4. The guide arm 26 may be held, if desired, in an "out-of-contact" position with respect to the cylinder 1 by means of a "hook and eye" arrangement, which is shown to comprise an eyed member 28 suspended from the arm 26, and a pin-like member 29 projecting horizontally from the upright 15, and adapted to cooperate with the eye of the member 28. The wire 5, after passing through the upright 15, is looped once around the roller 24, and is then coiled about the cylinder 1. Initially, the free or starting end of the wire is secured to the tail chuck

3 by means of a set-screw 39, as will be explained in detail.

Referring now to Figures 3 and 4, the guide arm 26 is shown pivotally supported at 30 on the secondary block 25. The block 25 is formed with a slot 31 across its top which accommodates the arm 26 and permits it to rotate vertically through a small angle. The block 25 is also formed with a vertical recess 32 communicating with the slot 31 and wherein is positioned an expansion spring 33, serving to exert an upward thrust on the arm 26, and thereby maintaining the end 27 thereof in close contact with the cylinder 1. The end 27 is provided with a rotatably mounted wheel, or other suitable means adapted to move over the cylinder surface with a minimum amount of friction. The block 25 on which the arm 26 is mounted is arranged to rotate about a pin member 34 secured to the top of the block 23. The rotation of the block 25 is limited to a small arc, the size of which is determined by adjustable screw stops 35 and 36 disposed on top of the block 23. The wheel on the end 27 of the arm 26 is intended to bear on the cylinder just ahead of the respective coil being wound so that the wire, as it is being coiled about the cylinder, exerts a lateral thrust on the end 27 of the arm 26. The action of the wire coils, in thus dragging along the carriage 19, causes the block 25 to bear on one stop when the feed is in one direction, and against the other when feeding in the reverse direction. The relation between the direction of feed (shown by arrows) and the position of the arm 26 and the block 25 is indicated in full and in broken lines, respectively. The adjustment of the stops 35 and 36 makes it possible to determine the best position of the carriage 19 with respect to the arm 26 so that the ultimate in close winding is attained. The foregoing described form of wire guide 26 is an illustration of a preferred embodiment, and alternative possibilities will suggest themselves to one skilled in the art.

Figures 5 and 6 illustrate how the wire 5, before the winding operation proper is begun, is threaded into a passage 37 in the wall of the chuck 3. The passage 37 terminates in a threaded recess 38 for the accommodation of a set-screw 39 which secures in place the free end of the wire 5. At 40 is indicated a split end-ring preferably constructed of sheet metal, for instance, brass, which is positioned on the cylinder 1 before the wire is applied thereto, serving as an anchor for the wire when the winding is completed. A flange 41 on the ring 40 is bent inwardly and over the end coils to securely hold the coils, as is evident from Figure 7. Another similar end-ring (not shown) is employed for the other end of the winding.

The foregoing description makes it evident that when a new cylinder is to be wound, the tail chuck 3 is retracted sufficiently for the cylinder to be fitted between the tail chuck 3 and the head chuck 2, whereupon the tail chuck is brought up again to a snug fit over the bottom of the cylinder, shown in broken lines in Figure 1, and is locked in position by conventional chuck locking means, not shown. One of the end-rings 40 is then fitted over the cylinder adjacent the chuck 3 as illustrated in Figures 5 and 6. The wire 5, having been threaded through the apertures 13 and 18 and between the rope lengths 17, is looped once around the preset roller 24, and finally the free end thereof is inserted into the passage 37 of the chuck 3 and there secured by means of the set-screw 39. The lathe may now

be started up on slow speed until enough coils of wire have been put on to cover the brass end-ring entirely. After the wire has begun to wind on the cylindrical surface of the cylinder itself, the speed of winding may be increased to between 200 to 300 feet per minute. At this high speed, the lateral inertia of the carriage 19 and the arm 26 is used to force each wire coil into close contact with the previous one, the vertical pressure exerted by the arm on the cylinder being determined by the strength of the spring 33.

The effect of the wire coils on the arm 26 is to drag along the carriage 19, and the reason for the presence on the latter of both the rollers 21 and of the friction brake 22 now becomes evident because of the necessity for the carriage to move smoothly but not too freely.

During the high speed winding, the tension means 8 is adjusted as tightly as possible by the rotating bushing 12 without causing enough friction to result in heating of the wire. It is to be noted that the nature of the twisted rope lengths permits of adequate tensioning of the wire without in any way injuring it. Alternative tensioning means having similar properties are, of course, within the scope of the invention.

The preset roller 24 functions to impart to the wire, when the latter is fed thereabout, a set or established tendency to coil in a manner that each coil or convolution of the winding will have a diameter which is less than that of the cylinder. Thus, any coils cut, for instance, by bullets, would tend to cling to the cylinder instead of straightening out and loosening the whole winding.

The friction brake 7 on the rotating stock reel 6 is necessary to prevent over-ride and consequent tangling of the wire. Preferably, the wire should be supplied in large diameter coils, since, obviously, the rotative speed of the coil support will be lower and the wire feed smoother than with a supply coil of smaller diameter.

When the cylinder has been wound to within $\frac{1}{2}$ " of the head chuck, the machine is stopped and a second brass end piece fitted over the cylinder against the head chuck. Before the machine is again started up, the pressure guide arm 26 is hooked back off the cylinder 1 by means of the hook and eye members 28 and 29, in order to eliminate interference with the head chuck 2. The wire may then be wound at slow speed close up to the vertical edge of the end piece.

A second wire layer, if desired, may be wound immediately over the first by merely continuing the feed in a reverse direction as soon as the first layer has been filled in entirely. When one or several coils of the second layer have been wound the arm is released again, and the speed brought up to the 200 or 300 feet per minute mark. At the end of the winding of the second layer, the wire is cut off, and temporarily fastened to prevent loosening. Both the head and tail chucks are now retracted, and some form of spining tool applied to the vertical section of each of the end-pieces 40 to turn them snugly over the end coils as shown in Figure 7.

As a final step, the wire winding is subjected to a so-called solder-lick by dipping a cylinder into a solder bath and rotating the same until the wire jacket is completely coated. Other adherent coatings, not necessarily metallic, will suggest themselves to those skilled in the art. The primary purpose of a coating of this type over the wire jacket is to render it proof against loosening, in case some of the coils should become broken.

It will be apparent from the above that upon being injured locally, as by a bullet, the winding as a whole will tend to cling to the contour of the cylinder even if a considerable portion of the coils are broken.

From the foregoing description it will be seen that the present invention provides a method and an apparatus for winding wire on bodies of revolution, which, in spite of the high speeds of application and close winding, will not injure the wire, and which will precoil the wire in such a manner that it will tend to cling to the body on which it is being wound.

It is to be understood that while I have chosen a container as a specific example for purposes of illustration, the method and apparatus herein disclosed for the production of wire-wound cylindrical containers of the character described, are usable in connection with the winding of wire on any so-called "body of revolution," as commonly understood in geometrical terminology.

As various changes may be made in the form, construction, arrangement and operation of parts, and in the method disclosed herein, without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter contained in the above description or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention, as a matter of language, which might be said to fall therebetween.

The container produced by the method and apparatus described and claimed herein is the subject matter of my co-pending application Serial No. 379,037, filed February 15, 1941.

The wire tensioning means, per se, illustrated herein are the subject matter of my co-pending application entitled Wire tensioning device, Serial Number 575,215, filed Jan. 30, 1945.

I claim:

1. In an apparatus for winding a wire under tension on a body of revolution, the combination of wire guide means, a rotatably supported roller about which said wire is adapted to be looped to be given a preset thereby, coil guiding means adapted to contact said body of revolution immediately ahead of the wire being applied, and a carriage supporting all the above named elements constructed and arranged to be moved by said last named means parallel to the axis of said body.

2. In an apparatus for winding a wire under tension on a body of revolution, the combination of wire guide means, tensioning means for said wire, wire preset coiling means about which said wire is adapted to be fed to establish a predetermined inherent coiling condition in the wire, coil guiding means including a pressure arm pivoted both horizontally and vertically adapted to contact said body of revolution immediately ahead of the wire being applied, and a carriage supporting all the above named elements constructed and arranged to be moved by said arm parallel to the axis of said body.

3. In an apparatus of the class described, a carriage, a supporting structure, wire tensioning means comprising rope strands adjustably secured on said structure, wire preset coiling means comprising a rotatable roller about which said wire is adapted to be fed to be given a preset

thereby, and a coil guiding member, all on said carriage.

4. In apparatus of the class described, wire coil guiding means including a movable carriage, supporting means on said carriage, a pressure arm pivoted both horizontally and vertically on said supporting means, and means on said supporting means to limit the rotation of said arm horizontally in either direction from a given median position.

5. In apparatus of the class described, including a longitudinal carriage bed; wire coil guiding means comprising a carriage movable on said bed in either direction, supporting means on said carriage, a pressure arm pivoted both horizontally and vertically on said supporting means, and means on said supporting means to limit the rotation of said arm horizontally in either direction from a given median position.

6. In an apparatus of the class described, the combination of a carriage bed, a carriage movable longitudinally of said carriage bed in either direction, braking means between said carriage and bed, a longitudinal support carried by said carriage having at least one rotatable member, wire tensioning means comprising a plurality of soft strands on said longitudinal support arranged for twisting by said rotatable member, a second support on said carriage, a pulley-like wire precoil member on said second support, a wire coil guiding arm arranged for horizontal and vertical rotation on said second support, means yieldingly urging said arm into changing its position in the vertical plane, and adjustable means on said second support to limit the rotation of said arm horizontally in either direction from a median position.

7. In apparatus for winding piano wire on a substantially cylindrical high pressure medium container, the combination of means for rotating the container, means for supplying the wire, a rotatably supported roller of smaller diameter than the container about which the wire is adapted to be looped to be given a preset thereby, and tensioning means intermediate said wire supply means and said roller whereby the wire is adapted to be wound on the container and preset by said roller while under tension.

8. In apparatus for winding piano wire on a substantially cylindrical high pressure medium container, the combination of means for rotating the container, means for supplying the wire, means for guiding the wire on the container to effect the winding of contiguous convolutions thereon, a rotatably supported roller of smaller diameter than the container about which the wire is adapted to be looped to be given a preset thereby, and tensioning means intermediate said wire supply means and said roller whereby the wire is adapted to be wound on the container and preset by said roller while under tension.

9. In apparatus for winding piano wire under tension on a metal container to form a part thereof, the container having an outlet valve end and a closed end and adapted to store fluid under high pressure for use in war service and to be prevented by said wire from ripping apart when pierced by a projectile, rotatable means including a chuck adapted to hold the container at its said outlet valve end and a chuck adapted to hold the container at its said closed end, wire guide means, wire tensioning means, means including an element of smaller diameter than the container about which the wire is progressively bent to impart thereto a preset condition tending to prevent unwinding of the wire from the container when the winding is ruptured by a projectile, coil guiding means adapted to engage the container immediately ahead of the wire being applied, and a carriage supporting all of the above named elements constructed and arranged to be moved by said coil guiding means parallel to the winding axis.

10. In apparatus for winding piano wire under tension on a thin walled metal cylinder to form a part thereof, the cylinder having an outlet valve end constituting a reduced neck and a rounded closed end and adapted to store fluid under high pressure for use in war service and to be prevented by said wire from ripping apart when pierced by a projectile, rotatable means including a chuck adapted to hold the cylinder adjacent to its said reduced neck end and a chuck adapted to hold the cylinder adjacent to its said rounded closed end, a support for a supply reel of said wire, means for tensioning the wire relative to the cylinder, means for presetting the wire to a condition tending to prevent unwinding of the wire from the cylinder when the winding is ruptured by a projectile, and means for guiding the wire onto the cylinder to form the winding.

11. The method of conditioning a metal container normally storing fluid under high pressure against ripping when pierced by a projectile, which comprises the steps of presetting piano wire to avoid its unwinding from the container when the winding is ruptured by the projectile, winding the wire under tension about the container to form a part thereof, and applying a metal coating over said winding.

12. The method of conditioning a metal container normally storing fluid under high pressure against ripping when pierced by a projectile, which comprises the steps of presetting piano wire to avoid its unwinding from the container when the winding is ruptured by the projectile, winding the wire under tension about the container to form a part thereof and fixing the ends of the winding in position, and applying a metal coating over said winding.

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