

May 16, 1944.

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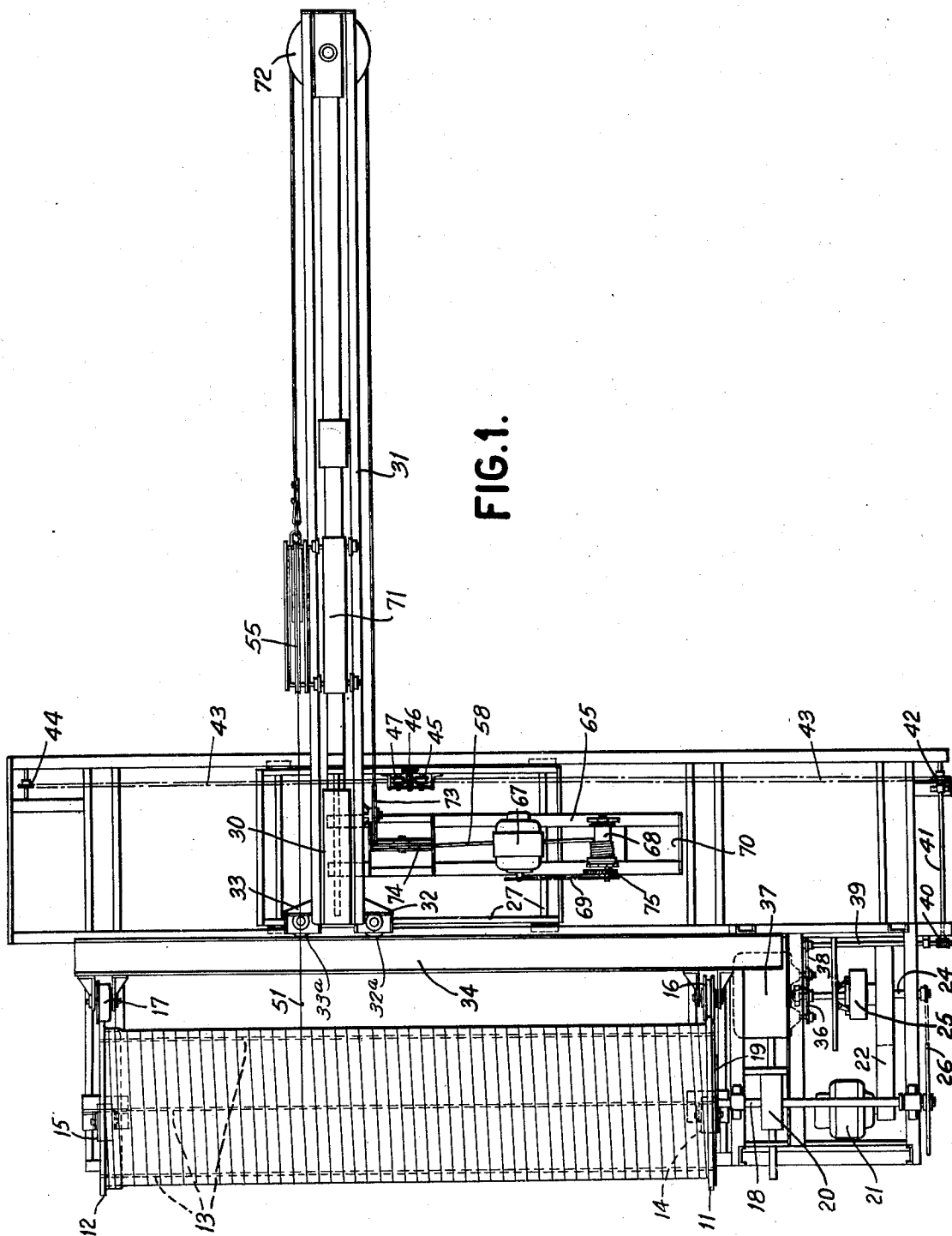
2,348,765

METHOD AND MACHINE FOR WINDING

Filed Sept. 4, 1941

5 Sheets-Sheet 1

FIG. 1.



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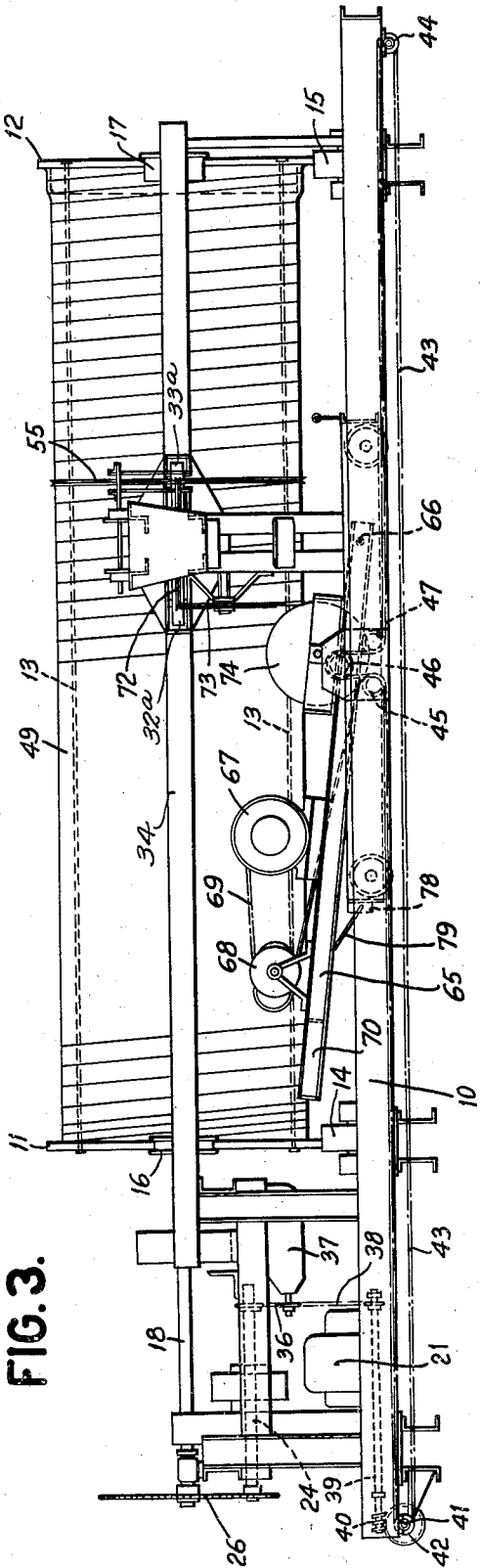
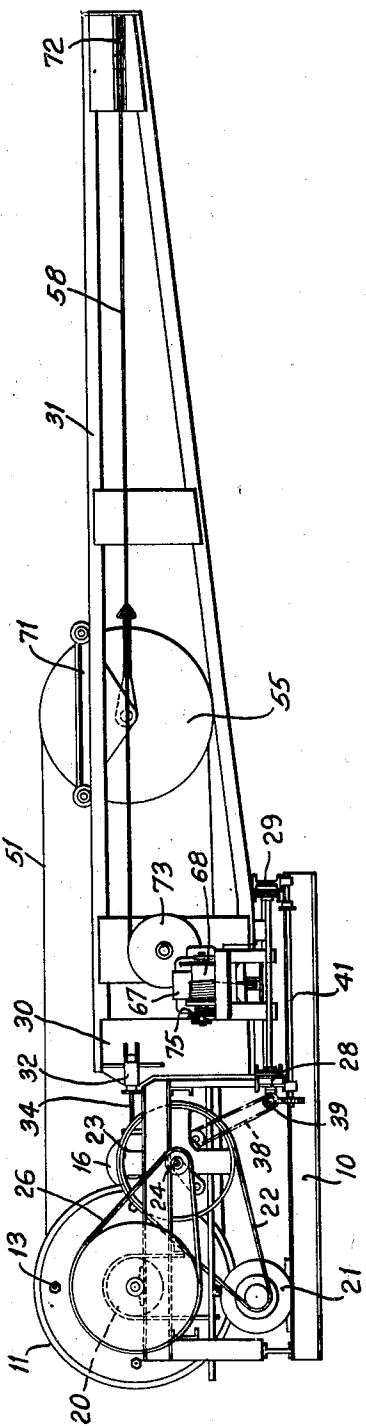


FIG. 2.



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FIG. 4.

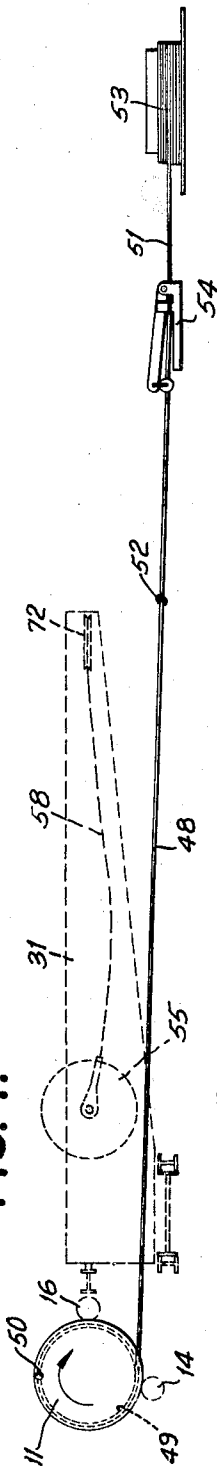


FIG. 5.

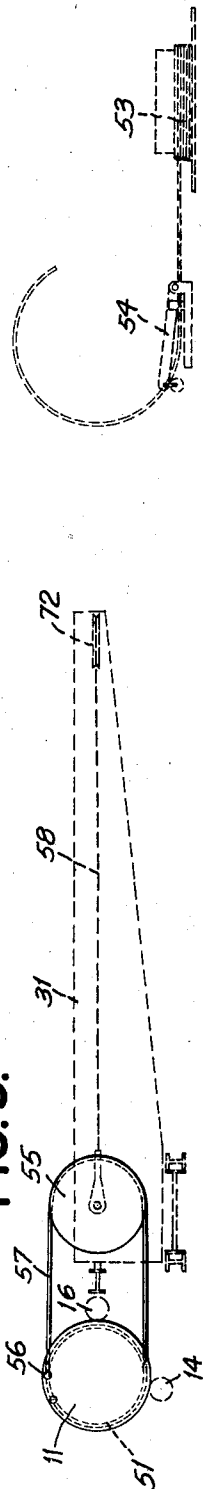


FIG. 6.

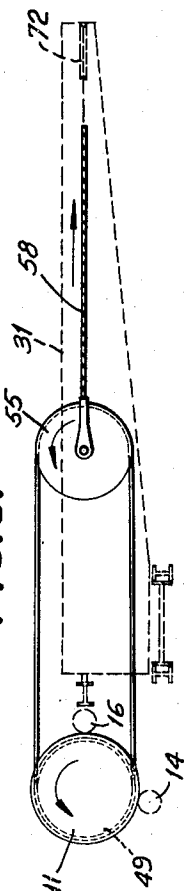
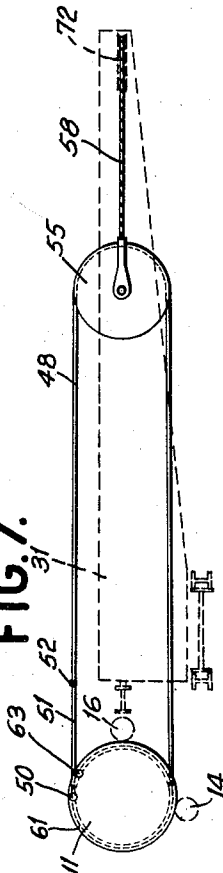


FIG. 7.



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FIG. 9.

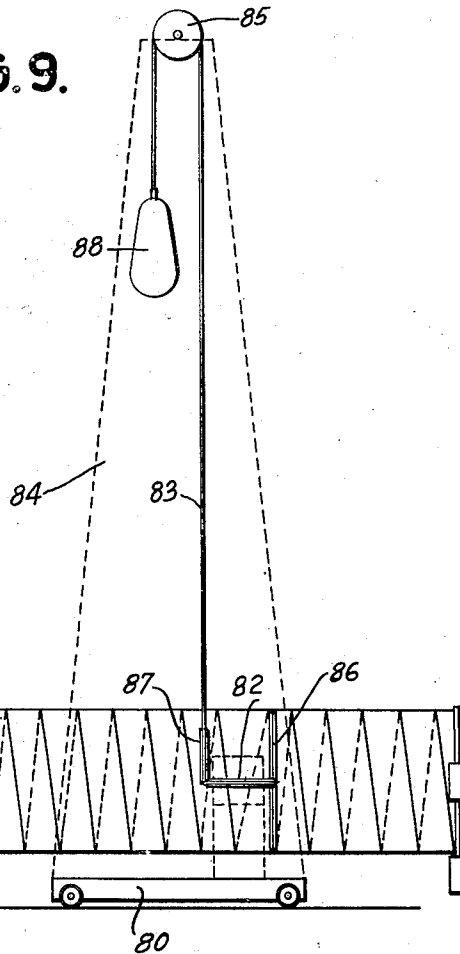
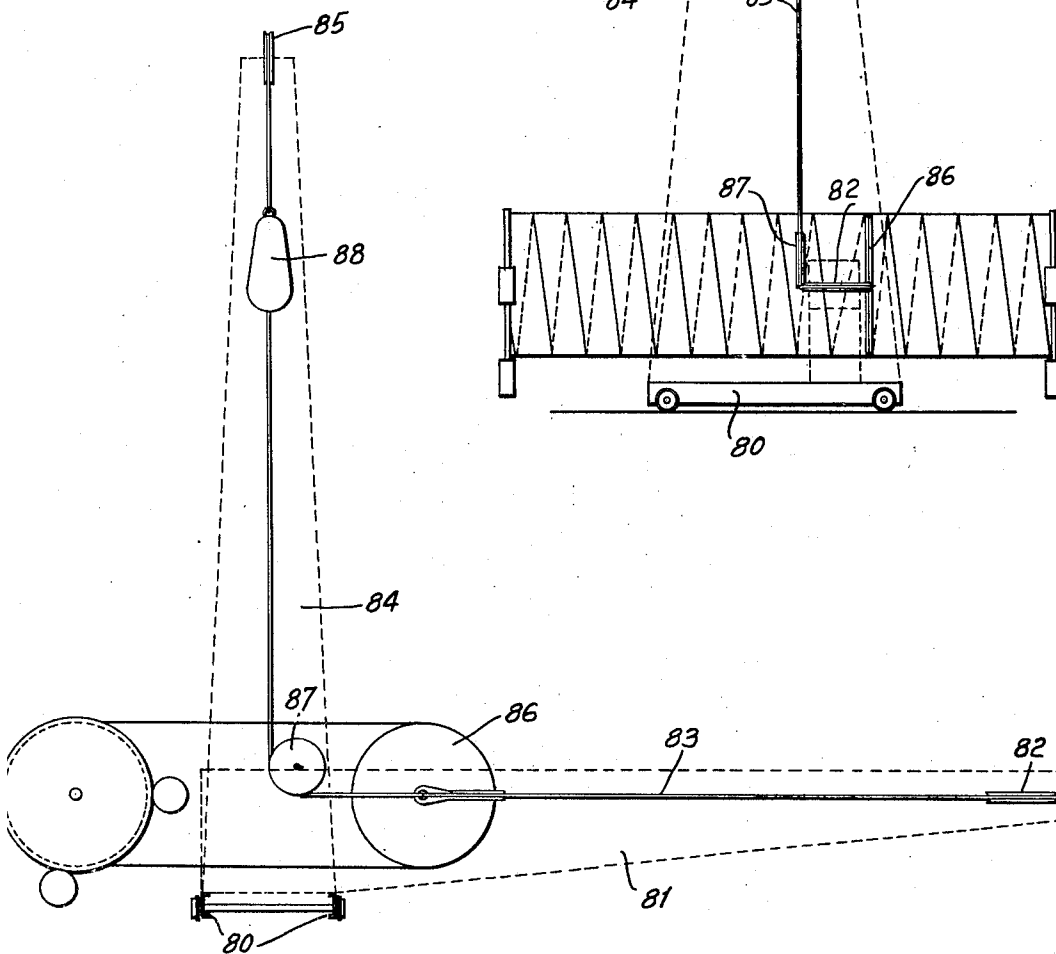


FIG. 8.



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FIG. 11.

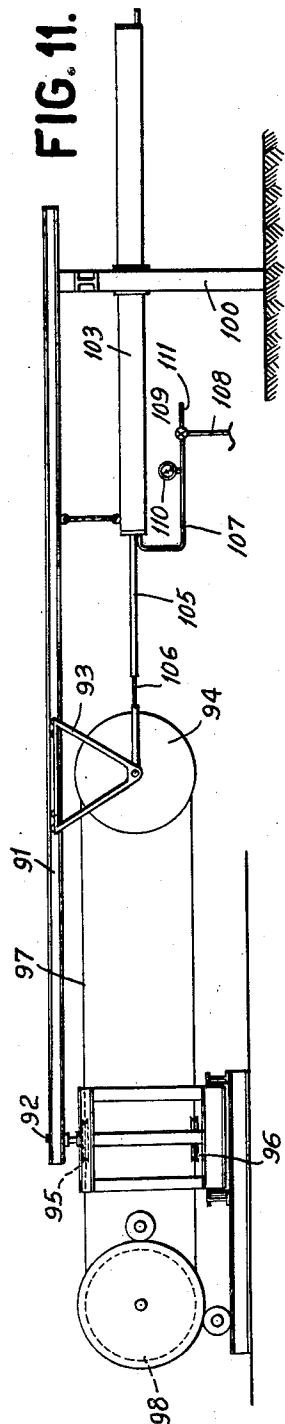


FIG. 12.

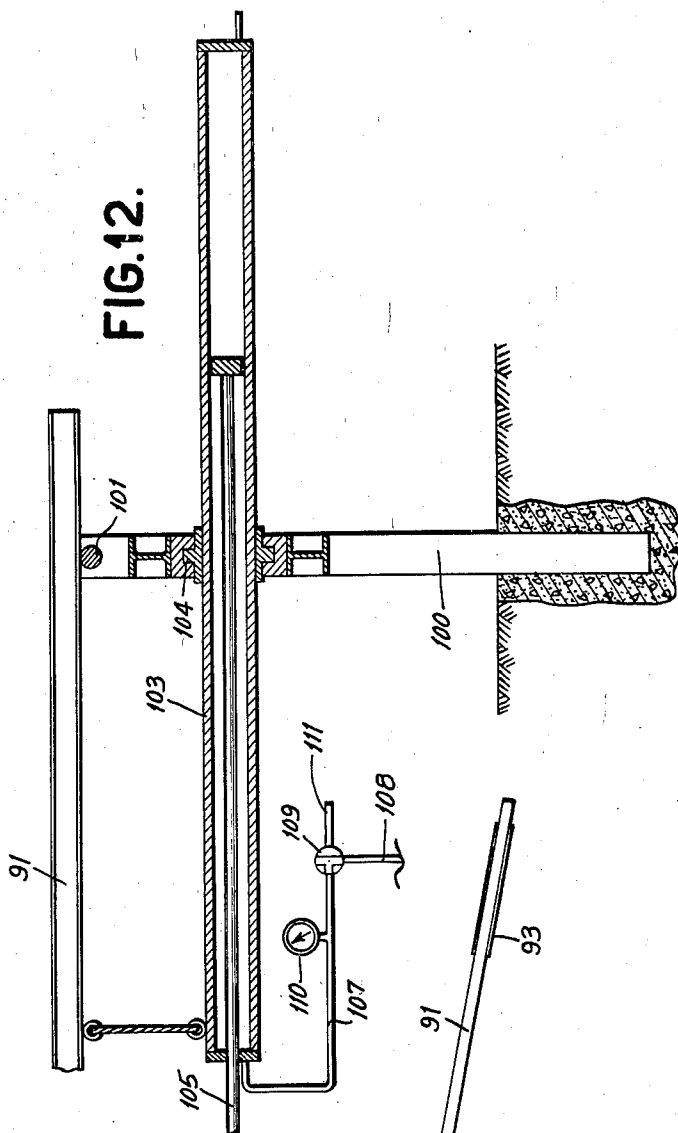
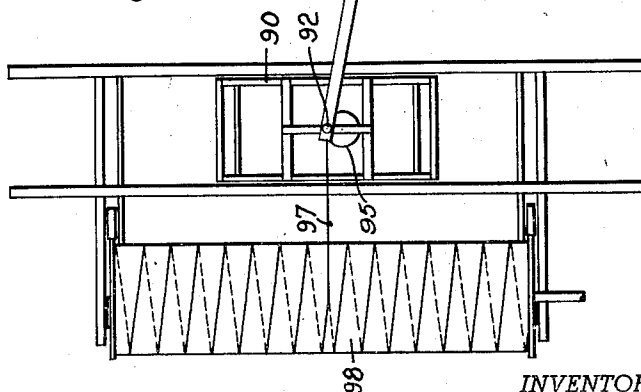


FIG. 10.



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2,348,765

METHOD AND MACHINE FOR WINDING

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Application September 4, 1941, Serial No. 409,450

13 Claims. (Cl. 242—11)

This invention relates to methods and machines for winding a line around objects, and more particularly for wrapping wire on pipe or around other objects designed to withstand fluid pressure from within.

Among the objects of the invention is to effect economy in the construction of pipes or other containers designed to withstand fluid pressure or to carry or hold liquids by providing a method for applying a tensioned wrapping to cause compressive stresses in the wrapped body and thereby enable a saving in the quantity of steel or other reinforcement which otherwise would be required to obtain a construction of commensurate tightness and strength.

Another object of the invention is to provide a method and machine capable of maintaining a wire or other wrapping element under a constant and positively applied tension while the wire is being wound about an object such as a concrete pipe.

Another object of the invention is to provide a method and machine for wrapping wire around a pipe or other object which avoids superimposing upon the torque required to rotate the object idly, a torque for counteracting a moment caused by tension in the wire which is being wrapped around the object, so that the power required to rotate the object during the wrapping operation need not be materially greater than the power which would be necessary to rotate the object idly or when it is not being wrapped with wire. This is of importance in a wire winding operation particularly when the wire being wound is subjected to a high degree of tensile stress.

Another object of the invention is to provide a method and apparatus whereby a wire-reinforced concrete pipe may be constructed which has a wrapping of wire under a tension closely approximating the measured tension that was exerted upon the wire as it was being applied.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims and shown in the drawings, which show by way of illustration a preferred embodiment and the principle thereof and what we now consider to be the best mode in which we have contemplated applying that principle. Other embodiments of the invention employing the same or equivalent principle may be used and structural changes made as desired by those skilled in the art within the spirit of the appended claims and without departing from the present invention.

In the drawings:

Figure 1 is a plan of a machine for wrapping wire around a pipe;

Fig. 2 is an end elevational view of the machine illustrated in Fig. 1;

Fig. 3 is a front elevational view of the machine illustrated in Fig. 1;

Figs. 4, 5, 6 and 7 are diagrammatic sketches respectively illustrating different steps in the operation of applying a wrapping in accordance with the present invention;

Fig. 8 is an end view of a modified form of machine;

Fig. 9 is a front elevational view of the machine shown in Fig. 8;

Fig. 10 is a partial plan of a still further modification;

Fig. 11 is an end view of the modification illustrated in Fig. 10; and

Fig. 12 is a detail of the tension applying mechanism of the machine illustrated in Figs. 10 and 11.

It is generally recognized that if the wall structure of a pipe or other container is placed under compressive stress the failing or bursting capacity of the container can be materially increased. The compressive stress in the wall structure is commonly imparted by a pre-tensioned wire which is wrapped about the pipe or other object.

It will be obvious from the following how the method of the present invention is applicable for applying a wrapping of practically any kind of tension element about a body and because of this the term "line," as used herein, is used in a general sense to define any kind of wire, chain, banding, cable or cordage. The body being wrapped or reinforced may be cylindrical, or have a straight taper, or a varying taper, such, for example, as a bilged barrel, or the object may have a substantially circular cross-section.

The machines illustrated in the drawings apply a helical wrapping which may be applied under low, moderate or high tension. The machines are capable of winding steel wire under high tensile stress about an object and therefore have particular utility in the manufacture of high pressure concrete pipe and wire-wound guns.

The method of the present invention enables the application of a very high tensile stress to the wire of the wrapping and also provides for maintaining the high tensile stress throughout the entire wrapping operation. As the result of the high tensile stress imparted to the wire, economies are effected in the design and con-

struction of reinforced concrete pipe. An economical pipe having a high factor of safety under working pressures ensues.

In its general operation the machine is designed to rotate a pipe, initially in one direction while a wrapping of wire is helically applied from one end of the pipe to the other, and then in the opposite direction while the same wire which was previously applied to the pipe is unwound therefrom and reapplied in a helical wrapping extending back to the end of the pipe where the initial wrapping was begun. During the second rotation of the pipe the connecting loop of wire between the initially applied and the secondarily applied wrappings is engaged by a sheave or other guide through which a predetermined and constant pull is exerted upon the wire. The tension thus imparted is a positive tension in that no frictional elements are utilized for producing it. In view of the fact that the reaches of the loop of wire pass to both sides of the pipe where they continue as separate helical wrappings, the effects of the tensile stress in the wire is balanced. Therefore, it is not required that the turning moment ordinarily necessary for rotating the pipe idly be added to compensate for a resisting force due to tension in the wire being applied.

The machine illustrated in Figs. 1, 2 and 3 has a base 10 made up of a number of connected structural members, channel irons and I-beams upon which the entire machine is supported.

In the manufacture of concrete pipe having pre-stressed steel reinforcement and concrete, the most suitable proportions of steel and concrete and the most effective amount of tension in the steel and resultant amount of compression in the concrete are determined by computation. The concrete shell is then cast by any method to give the dimensions and strength desired. It may or may not be reinforced but it is common practice to make the shell without reinforcement. Customarily the concrete is aged and cured before a tension wrapping is applied.

For wrapping with this machine two steel runner rings 11, 12 are applied to the pipe, one at each end. These runner rings are bolted together by bolts 13 which pass through the pipe. The runner rings are so designed as to cause centering of the pipe with respect to themselves.

The pipe is then mounted upon two rollers 14, 15 in such manner that the rings rest upon the rollers and also bear against two other rollers 16, 17. This second pair of rollers are so positioned as to counteract the tendency of the pipe or object being wrapped to move forward in response to the tension in the wire being applied.

The pipe is rotated through a shaft 18 which carries at one end a crank 19 which is bolted to the runner ring 11. Shaft 18 is provided with a braking device 20 for safety purposes. The drive for shaft 18 comprises a motor 21 which is adapted for rotation in opposite directions. This motor drives through a belt 22 and pulley 23 which run idly on shaft 24. A clutch 25 is provided for engaging pulley 23 to shaft 24. Shaft 24 is connected to shaft 18 by a chain and sprocket connection 26, whereby direct drive of the pipe is obtained. In place of a reversible motor suitable gearing can be used to effect reverse rotation of the pipe.

The carriage upon which the wire applying mechanism is mounted is illustrated in Figs. 1, 2 and 3. This carriage 27 is mounted upon a pair of rails 28, 29 which lie parallel to the axis of the pipe. The carriage includes a frame structure

30 to which a cantilever beam 31 is secured. The rear of frame structure 30 carries a pair of brackets 32, 33 in which a pair of rollers 32a and 33a are mounted on vertical axes. These rollers bear upon an I-beam 34 which extends for the full length of travel of the carriage along its rails. The I-beam serves as a thrust receiving member for receiving the end-thrust of the cantilever beam during a wire laying operation, and it also supports rollers 16 and 17.

The supporting rollers for the carriage 27 are mounted to engage between the flanges of rails 28 and 29 and tipping of the carriage is thereby prevented.

Power for advancing carriage 27 along its rails may be provided by a second motor, but it is preferably provided by motor 21. Power is transmitted from motor 21 through belt 22, pulley 23, clutch 25, shaft 24, chain and sprocket drive 36, through variable speed transmission 37, chain and sprocket drive 38, shaft 39, worm and worm gear 40, shaft 41, sprocket 42 and chain 43. Chain 43 extends back and forth for the full length of the carriage rails as shown in Figs. 1 and 3. At one end of the rails the chain is engaged by sprocket 42 and at the other end of the rails it is engaged by sprocket 44. Intermediate the end sprockets the chain is in engagement with three sprockets 45, 46 and 47 which are carried by the carriage. The carriage is locked to the chain by locking sprocket 46 against rotation. Accordingly, when the machine is in operation the carriage will traverse from right to left and from left to right along its tracks, depending upon the direction of rotation of the motor 21. Since the motor also rotates the pipe, the rotation of the pipe and the travel of the carriage will be synchronous and accordingly the speed of rotation of the pipe and the speed of travel of the carriage will determine the pitch of the wire being wrapped about the pipe. A desired pitch may be obtained by making suitable adjustment at the variable speed transmission 37.

Before explaining the mechanism by which tension is applied to the wire, we shall explain the method of wrapping the wire upon the pipe.

In order to avoid wastage of wire, for the first few turns of the initial wrapping we employ a length of cable 48 (Fig. 4) which is subsequently removed from the pipe after the wire wrapping operation is completed. This cable is called a dummy cable. It does not become a component part of the finished pipe. One end of the dummy cable is attached to the right end of the pipe 49 (as view in Fig. 3) as at 50, Fig. 4. The other end of the dummy cable is attached to the end of the wire 51 at 52. The supply of wire 51 is contained in a coil 53 and a light friction brake 54 is preferably employed in order to apply some restraint and slight tension to the wire as the initial wrapping is applied. As a substitute for the brake a similar tensioning means may be employed to effect any desired magnitude of tension in the initial wrapping.

With the carriage at the right end of the machine and with suitable adjustment of the operating mechanism, the motor is started and as the pipe is rotated clockwise (Fig. 4), the carriage travels from right to left (Fig. 3), thereby causing the laying of the wire about the pipe in a helix extending and traveling along the pipe from its right end. Upon reaching the left end of the pipe the operation of the machine is stopped and the wire is then cut between the brake 54 and the pipe (Fig. 5).

The end of the wire 51 which leads from under the pipe is then passed around sheave 55 and is attached to a lug 56, carried by the pipe. This attachment may be made by threading the end of the wire and applying nuts to it and then engaging the lug with the nuts. This procedure provides a loop 57 between the wire 51 which is wrapped about the pipe and its end at 56. Thereafter, and in the manner which will be hereinafter described, tension is applied to the wire 51, through sheave 55, which engages the loop. This is accomplished by placing a predetermined tension in cable 58.

It will be seen at this point that the couples produced by the two reaches of wire extending between sheave 55 and the pipe balance each other, Fig. 5.

For economy in design, it has been found desirable to wind wire with a tension closely approaching the elastic limit of the steel and bearing a somewhat definite relationship to the elastic limit. Because of the balance of couples the method of the present invention is admirably suited for highly stressing the wire although its advantages also attach to moderately stressed windings.

With the desired tension applied, the rotation of motor 21 is started in a reverse direction and pipe 49 is rotated counterclockwise, Fig. 6. This drive also causes the carriage to travel from left to right, Fig. 3. As the result of the rotation of the pipe and the travel of the carriage the initial wrapping of wire is removed from the pipe, and, after passing over the sheave 55, is re-applied to the pipe as a new helical wrapping. An intermediate position of the carriage is illustrated in Fig. 1 in which the wrapping at the left end of the pipe is the re-applied and more highly stressed wrapping and the wrapping at the right end of the pipe is what remains of the initial wrapping. The loop of wire 57 is between the two windings.

A sketch of another intermediate stage is illustrated in Fig. 6 and it will be seen from a comparison of this figure with Fig. 5 that the sheave 55 has moved away from the pipe. This is principally because of the elongation of the wire resulting from the additional stress placed therein during the second wrapping. A still further position of movement away from the pipe is illustrated in Fig. 7 which is intended to illustrate the relationship of the sheave 55 and the pipe when the carriage has reached the limit of its right hand travel. In this position the operation of the machine is stopped.

The carriage has now arrived back to its initial position at the beginning of the operation of the machine. The originally attached dummy cable 48 runs from its point of attachment with the pipe at 50, counterclockwise to the underside of the pipe and around sheave 55 to its point of attachment 52 to the wire 51. On the last re-wrapped turn of the wire at point 61, only a few inches from where the remaining unwrapped length of wire touches the pipe, the wire is clamped to the pipe.

Tension on the unwrapped portion of the wire from point 61 to point 52 and tension on the dummy cable from point 52 over sheave 55 and under the pipe to point 50 is released by the release of tension on cable 58. The dummy cable 48 is then removed by disconnecting it from the pipe at 50 and by disconnecting it from the wire at 52. The free end of the wire 51 is cut to desired length and threaded. Nuts are applied to

the wire and the wire is fastened to the lug 63 upon the pipe. By tightening the nuts against the lug the previously free end of the wire is tensioned and then clamp 61 may be released. With the removal of clamp 61 the wrapping of the wire is completed.

The only advantage derived in the use of dummy cable 48 is to save a length of wire which would otherwise be wasted. It is clear that the use of this cable can be avoided and when no cable is employed the end of the wire at the beginning of the initial wrapping would be attached to the pipe at point 50, Fig. 4.

In describing the method of wrapping wire about a pipe we have referred to an initial wrapping of relatively light or moderate tension and to a second wrapping of relatively high tension. An important advantage of the method may be gained by stressing the wire of the initial wrapping somewhat more. When this is done the tension in the wire forming the second wrapping will more nearly approximate the stress exerted upon the wire as the second wrapping is being applied.

In placing a tensioned helical wrapping about a concrete pipe the pipe is compressed and the circumference of the pipe is diminished as each turn of wrapping is applied. The progress of the wrapping extends the state of compression along the pipe with the result that the pipe yields beneath previously applied turns and consequently relieves or causes some loss of tension in those turns. By converting an initial pre-stressed wrapping into a second wrapping there is less loss of tension in the second wrapping on account of diminution of circumference of the wrapped pipe, because most of yield in the wrapped pipe was occasioned by the initial wrapping and but relatively minor diminution of circumference is accomplished during the second wrapping. Accordingly, the wrapping and re-wrapping operations are productive of a final wrapping having a tension more closely approximating the tension applied by the machine than could be accomplished with a machine by which the entire wrapping operation is completed with only one application of wrapping.

It follows also, that when using the method of the present invention for applying a permanent pre-stressed wire about a body which yields considerably under compression, or when it may be desirable to apply high compression gradually, more than two winding operations may be employed. In such cases, instead of finishing the wrapping operation at the end of the second wrapping and cutting and fastening the wire in the manner described, a higher stress is applied to the wire through sheave 55, and the machine is operated to cause unwinding of the second wrapping and accompanying rewinding of the wire of the second wrapping into a third wrapping. At the end of the third wrapping the wire may be further stressed to impart a still higher tension and then unwound and simultaneously rewound as a fourth wrapping. The third and fourth wrapping operation (and any further odd and even numbered wrapping operations) will correspond and be similar to the previously described initial and second wrapping operations, respectively, except for the higher tension to which the wire is subjected during subsequent operations. A series of rewindings will minimize loss of tension and practically eliminate any difference in tension between the

final and initial turns in the final or permanent wrapping.

The mechanism for placing tension in the wire during the rewinding operation is designed to apply a constant pull on cable 58 while also taking up extended length of the stressed wire. This mechanism includes a pivoted beam in the form of a cable beam 65, Fig. 3, which is pivoted at one end at 66. This beam carries a frame upon which a motor 67 is mounted. The motor is arranged to drive a winch 68 through a sprocket and chain connection 69. The motor and the winch are so mounted upon the beam as to cause the beam to drop unless restrained from doing so by cable 58 which is wound about the winch. The beam may be additionally weighted by weights 70 at its free end. Adjustment of these weights provides a means for varying the amount of tension which is maintained in cable 58.

Cable 58 is secured at one end to sheave 55. As illustrated in Figs. 1, 2 and 3, the sheave is provided with a trolley 71. The trolley has rollers which fit track elements on the top side of cantilever beam 31. This trolley forms a frame for supporting sheave 55, especially when the machine is idle.

The cable 58 runs from the trolley and sheave 55 over sheave 72, at the unsupported end of the beam, sheaves 73 and 74 and to winch 68 about which it is wrapped. Operation of the motor causes the winch to take up on the cable and draw the trolley and sheave 55 toward the unsupported end of the beam. The ratchet connection 75 prevents retrograde rotation of the winch.

Constant tension is maintained in cable 58 by the operation of the motor 67 which is so controlled as to closely limit the hunting movement of the scale beam 65. The control is obtained by switch 78 which is operated by arm 79 depending from the scale beam. The switch is so arranged that as the scale beam is lifted and pivots about pivot 66, the switch will cause discontinuance of the operation of motor 67. As the scale beam drops the switch is operated to close the motor contact and put the motor into operation. This causes the winch to take up on the cable until the cable beam is again lifted sufficiently for it to cause the switch to shut off the motor. The switch keeps the scale beam 65 "floating" and consequently since the fixed weights and applied forces of the scale beam are constant, a constant predetermined tensile stress is applied continually to cable 58 and also to the wire 51 engaged by sheave 55. With this mechanism the load on the cable is positive whether the machine is operated fast or slow, forward or backward, or standing still.

In Figs. 8 and 9 we have illustrated a modified form of apparatus employing the same method for applying a wire wrapping but utilizing a different mechanism for applying tension to the wire. This machine employs the same mechanism for operating the pipe and carriage.

The carriage 80 carries a beam 81 which has a sheave 82 at its outer end. However, instead of a weighting beam for imparting tension to cable 83 the force of gravity is relied upon. Upon the carriage is mounted a tower 84 having a sheave 85 at its top. Cable 83 has one end attached to sheave 86 and is trained over sheave 82, sheave 87 and sheave 85. The end of the cable beyond sheave 85 is attached to a weight 88. This weight is selected to impart the desired

tension in the cable 83 and the wire which is being wrapped about the pipe.

In Figs. 10, 11 and 12 there is illustrated still another modification. In this modification the pipe and the carriage are operated in the manner previously described and the method of applying the winding of the wire wrapping to the pipe is also the same. In this modification carriage 90 is mounted to travel parallel to the pipe as previously described. This carriage supports one end of a beam 91 which is pivotally secured to the carriage at 92. This beam may be in the form of an I-beam and is designed to support the trolley 93 upon which sheave 94 is mounted. The carriage also carries a pair of guide pulleys 95, 96 which are so arranged as to guide the upper and lower reaches of the loop of wire 97 which extend between sheave 94 and the pipe 98.

The end of the beam 91 which is remote from the carriage is supported upon a frame or post 100 which is preferably so located that the beam 91 will always be angularly disposed with respect to the path of travel of the carriage, Fig. 10. With this arrangement the component of force acting upon the carriage during both winding operations will always be in the same direction. As the carriage travels along its tracks the beam will slide over roller 101 and will also oscillate with respect to the post 100.

The means for applying tension to the wire includes a fluid controlled cylinder and piston, Fig. 12. The cylinder 103 is mounted in a vertical trunnion 104 which is supported by the post 100. This trunnion permits oscillation of the cylinder 103 in a horizontal plane with accompanying movements of the beam 91 and also transmits thrust of the cylinder to the supporting post. The piston rod 105 is connected with cable 106 which has its other end connected to sheave 94.

Pressure upon the interior of the cylinder and upon the piston may be maintained by pneumatic pressure in flexible conduit 107. A source of pressure is attached to conduit 108 and a three-way valve 109 is arranged for connecting conduits 107 and 108 to apply pressure to the interior of the cylinder. This pressure can be determined and regulation made by watching gauge 110.

At the end of the wire wrapping operation pressure upon the piston can be released by adjusting the three-way valve to connect the interior of the cylinder and conduit 107 to the exhaust conduit 111. It will be understood that available mechanisms for automatically maintaining the pressure required to obtain a given tension in the cable 106 may be used in conjunction with this particular apparatus.

If desired, the carriage, beam and post arrangement illustrated in Figs. 10, 11 and 12 can be used in conjunction with either the weighing beam described herein or a weight by which the force of gravity is utilized to provide a constant pull on cable 106 and the wrapping wire 97. In both cases the weighing beam or the fixed weight would be supported by a frame anchored upon the ground and fulfilling the function of post 100.

While the machines described herein provide for rotating the pipe and for guiding the wire in a path of travel parallel to the axis of the pipe, it is to be understood that in the general application of the method, it is contemplated that the means for guiding the wire in a helical path could be made stationary and the pipe could be

mounted for translation in a path parallel to its axis.

In the foregoing description of the manner of forming the initial wrapping we have explained that the wire at the beginning of the initial wrapping operation may be secured to the pipe or other object being wrapped either indirectly as by an intervening dummy cable which is ultimately removed and can be re-used in another operation, or directly by attaching the beginning end of the wire to the pipe. It is intended therefore that the word "line" as used herein be understood to mean either a one piece line, or a compound line such, for example, as joined wires, or a dummy cable joined to a wire. This explanation is given in the interest of convenience only and is not to be construed as a restriction upon the material and herein defined meaning of the word line.

What is claimed is:

1. In apparatus for wrapping a line, the combination comprising means for mounting a pipe for rotation, a carriage mounted for travel in a path substantially parallel to the axis of the pipe, a beam having one end secured to said carriage and its other end extending away from said pipe, a sheave for engagement with a loop of line having its ends secured to said pipe, means co-operating between said beam and sheave for guiding the sheave lengthwise of the beam, a cable attached to said sheave, guide means for said cable and over which said cable is trained for drawing taut the loop of line, said cable guide means being carried by said beam and located towards the end of said beam distant from said carriage, and means having connection with said cable for maintaining a substantially constant tension in said cable and in said line.

2. In apparatus for wrapping a line, the combination comprising means for mounting a pipe for rotation, a carriage mounted for travel in a path substantially parallel to the axis of the pipe, a sheave for engagement with a loop of line having its ends secured to said pipe, means controlled by the position of said carriage along the axis of the pipe for determining the position of leads of said loop of line which have connections with the ends of line secured to the pipe, means for guiding said sheave in its travel away from the pipe, a cable attached to said sheave, and means having connection with said cable for maintaining a predetermined tension in said cable and in said loop of line.

3. In apparatus for wrapping a line, the combination comprising means for supporting a pipe for rotation upon its axis, a carriage mounted for travel in a path substantially parallel to the axis of the pipe, a beam mounted upon said carriage, a trolley mounted for travel along said beam, a sheave carried by said trolley and provided for engaging a loop of line extending from the pipe, means associated with said beam and carriage for applying tension in the line of said loop, said means including a cable having connection with said sheave, guide means for said cable including sheaves over which said cable is trained, a pivoted weighing beam, and a winch and motor mounted thereon for taking up said cable and applying tension thereto.

4. In apparatus for wrapping a line, the combination comprising means for supporting a pipe for rotation upon its axis, a carriage mounted for travel in a path substantially parallel to the axis of the pipe, a beam having one end supported

by said carriage, a sheave provided for engaging a loop of line extending from the pipe, means for applying tension in the line of said loop, said means including a cable having connection with said sheave, guide means for said cable over which said cable is trained, said guide means including a sheave carried by said beam and a weighted member carried by said carriage for taking up said cable and applying tension thereto.

5. In apparatus for wrapping a line, comprising means for mounting a pipe for rotation upon its axis, a carriage mounted for travel in a path substantially parallel to the axis of the pipe, means on said carriage for guiding the winding of a line around said pipe as said pipe is rotated, a beam having one end secured to said carriage for travel therewith, a trolley carried by said beam, said trolley having a sheave mounted thereon for engaging a loop of a line which is being unwrapped and wrapped upon the pipe.

6. In the method of wrapping a line around an object, the steps comprising forming a line by joining a measured length of cable to a length of wire, securing the free end of the cable to the object, wrapping the line including the joined lengths of cable and wire about the object, securing the last or unwrapped end of the wire to the object, wrapping the object in reverse to the initial wrapping with the line from the initial wrapping, securing the wire of the line of the last wrapping to the object by clamping the wire to the object, and disconnecting the length of cable from the wire and object and removing same.

7. The combination with apparatus for applying a tensioned winding of a line about a pipe, including means for supporting and rotating a pipe about its axis, a carriage supported for travel alongside of the pipe and means for moving the carriage lengthwise of the pipe during a line winding operation, of a sheave for engaging a loop of line having reaches which extend between the sheave and opposite sides of the pipe and which constitute continuations of separated windings of a line about the pipe, a cable attached to said sheave for exerting a pull thereon and on said loop, and tension applying means wholly supported by said carriage and attached to said cable for applying a substantially constant pull on said cable, sheave and loop of line.

8. The combination with apparatus for applying a tensioned winding of a line about a pipe, including means for supporting and rotating a pipe about its axis, a carriage supported for travel alongside of the pipe and means for moving the carriage lengthwise of the pipe during a line winding operation, of a sheave for engaging a loop of line with reaches which extend between the sheave and opposite sides of the pipe and which constitute continuations of separated windings of line about the pipe, guide means on said carriage for guiding said sheave for travel in a line transverse to the pipe, a cable attached to said sheave, and means having connection with said cable for maintaining substantially constant tension in said cable and in said loop of line during a line winding operation.

9. The combination with apparatus for applying a tensioned winding of a line about a pipe,

including means for supporting and rotating a pipe about its axis, a carriage supported for travel alongside of the pipe and means for moving the carriage lengthwise of the pipe during a line winding operation, of a sheave for exerting tension in a loop of line having reaches which extend between the sheave and opposite sides of the pipe and which constitute continuations of two windings of line about the pipe, a cable attached to said sheave, guide means for said cable and over which said cable is trained, said cable guide means being mounted for travel with said carriage alongside the pipe during a line winding operation, and means having connection with said cable for maintaining substantially constant tension in said cable and in said loop of line.

10. The combination with apparatus for applying a tensioned winding of a line about a pipe, including means for supporting and rotating a pipe about its axis, a carriage supported for travel alongside of the pipe and means for moving the carriage lengthwise of the pipe during a line winding operation, of a sheave engaging a loop of line having reaches which extend between the sheave and opposite sides of the pipe and which constitute continuations of separated windings of line about the pipe, a cable attached to the said sheave for imparting tension in the loop of line engaged by the sheave, force applying means carried by said carriage and having connection with said cable to exert a pull on said cable, sheave and loop of line during the travel of said carriage and sheave alongside of the pipe.

11. The combination with apparatus for applying a tensioned winding of a line about a pipe, including means for supporting and rotating a pipe about its axis, a carriage supported for travel alongside of the pipe and means for moving the carriage lengthwise of the pipe during a line winding operation, of a sheave engaging a loop of line having reaches which extend between the sheave and opposite sides of the pipe and which constitute continuations of separated windings of line about the pipe, means attached to said sheave for retracting the same away from said pipe while imparting a substantially constant tension in said line during winding of the line about the pipe, said means including a cable

and a device supported by said cable, said device comprising a weighing beam and an automatically operated winch thereon for taking-up on said cable while a substantially non-varying tension is maintained in said cable and in the line looped about the sheave.

12. The combination with apparatus for applying a tensioned winding of a line about a pipe, including means for supporting and rotating a pipe about its axis, a carriage supported for travel alongside of the pipe and means for moving the carriage lengthwise of the pipe during a line winding operation, of a beam having one end supported by said carriage and its other end extending away from the pipe, a trolley mounted for travel along said beam, a sheave carried by said trolley and engaging a loop of line having reaches which extend between the sheave and opposite sides of the pipe and which constitute continuations of separated windings of line about the pipe, means mounted on said carriage for guiding the reaches of said loop between the sheave and the pipe during travel of the carriage alongside the pipe, and means attached to said sheave for imparting tension in the line of said loop during a line winding operation.

13. The combination with apparatus for applying a tensioned winding of a line about a pipe, including means for supporting and rotating a pipe about its axis, a carriage supported for travel alongside of the pipe and means for moving the carriage lengthwise of the pipe during a line winding operation, of a sheave for exerting tension in a loop of line having reaches which extend between the sheave and opposite sides of the pipe and which constitute continuations of separated windings of line about the pipe, means mounted on said carriage for guiding the reaches of said loop between the sheave and the pipe during travel of the carriage alongside the pipe, and means attached to said sheave for imparting tension in the line of said loop during a line winding operation, said means including a pressure operated cylinder and piston and a cable having connection with said sheave and with said piston.

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