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Springer et al.

[11] **3,820,729**

[45] **June 28, 1974**

[54] **METHOD AND APPARATUS FOR CONTROLLING BEVEL WRAPPING MECHANISM**

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[73] Assignee: **Price Brothers Company,** Dayton, Ohio

[22] Filed: **Oct. 30, 1972**

[21] Appl. No.: **294,516**

[52] **U.S. Cl.** ..... **242/7.21,** 242/158 R, 318/172

[51] **Int. Cl.** **B21f 17/00,** B65h 81/06

[58] **Field of Search** ..... 242/7.22, 7.21, 7.23, 7.02, 242/7.16, 158 R, 158.2; 138/176, 172

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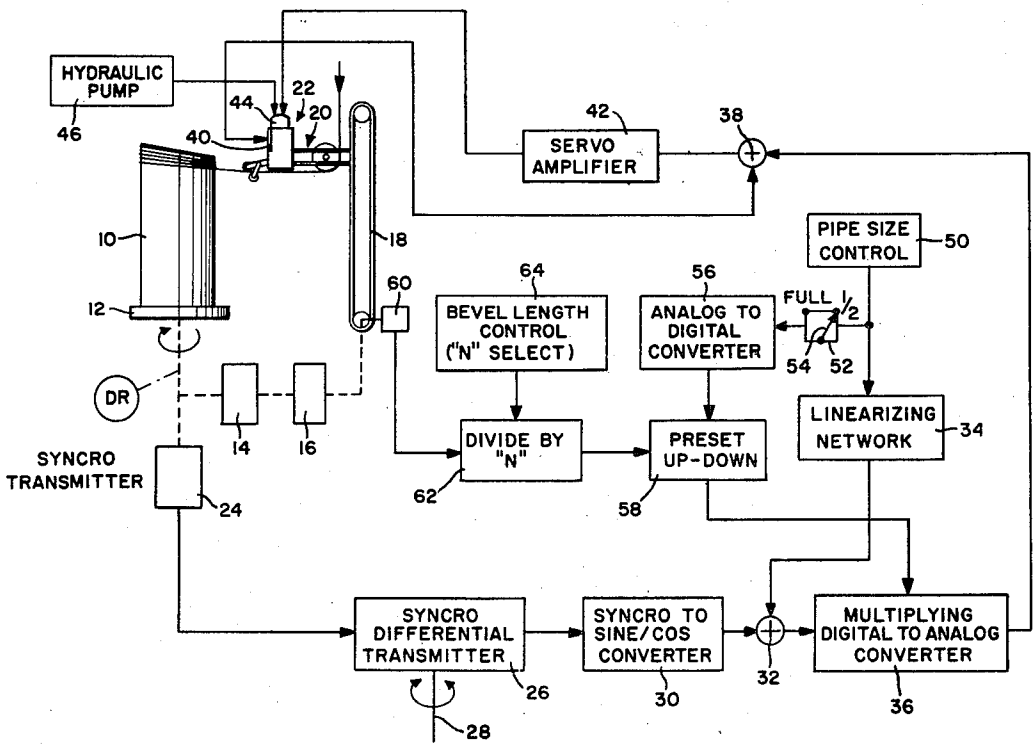
Primary Examiner—Billy S. Taylor

Attorney, Agent, or Firm—Biebel, French & Bugg

[57] **ABSTRACT**

Apparatus for electronically monitoring the rotational position of a concrete core as it is rotated about its axis during a prestressing wire wrapping operation and simultaneous monitoring the position of a wire feed carriage moving axially of the pipe to provide signals for controlling the movement of a pantograph type wire guide which oscillates the wire guide with a straight line movement parallel to the axis of the core as the wire feed carriage moves along the bevel end of the core.

8 Claims, 6 Drawing Figures



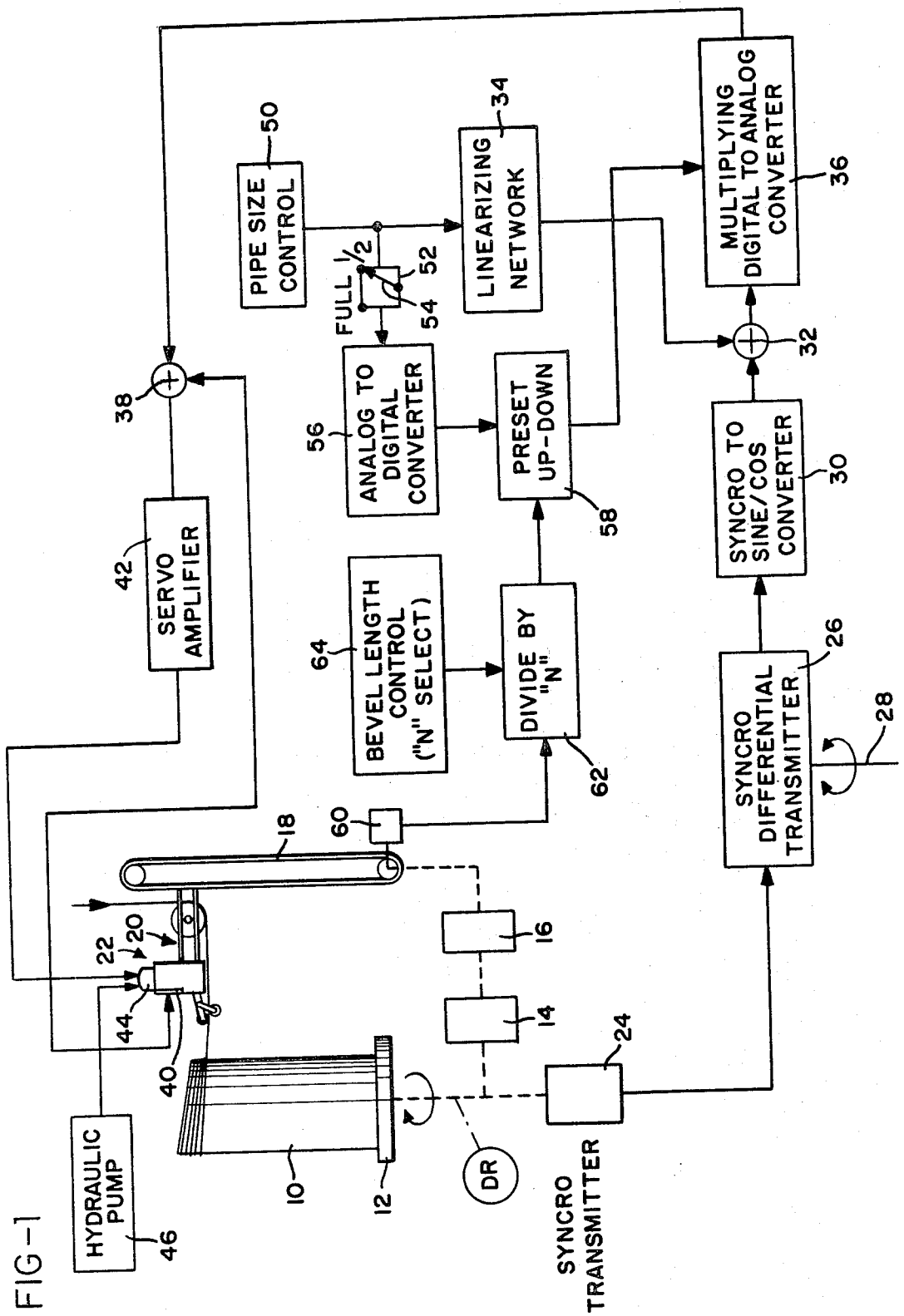

PIPE SIZE CONTROL
50
LINEARIZING NETWORK
34
MULTIPLYING DIGITAL TO ANALOG CONVERTER
36
FULL 1/2
52
54
ANALOG TO DIGITAL CONVERTER
56
PRESET UP-DOWN
58
32
38
SERVO AMPLIFIER
42
SYNCRO TO SINE/COS CONVERTER
30
BEVEL LENGTH CONTROL ("N" SELECT)
64
DIVIDE BY "N"
62
SYNCRO DIFFERENTIAL TRANSMITTER
26
28
60
18
16
14
22
20
44
40
24
HYDRAULIC PUMP
46
10
12
DR
SYNCRO TRANSMITTER

FIG-1

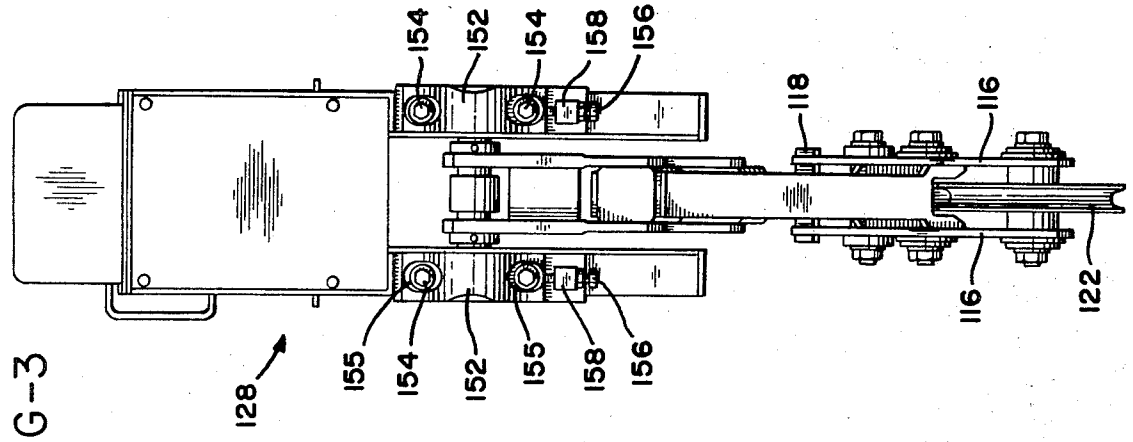

154
152
154
158
156
118
116
116
122
128
155
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156

FIG-3

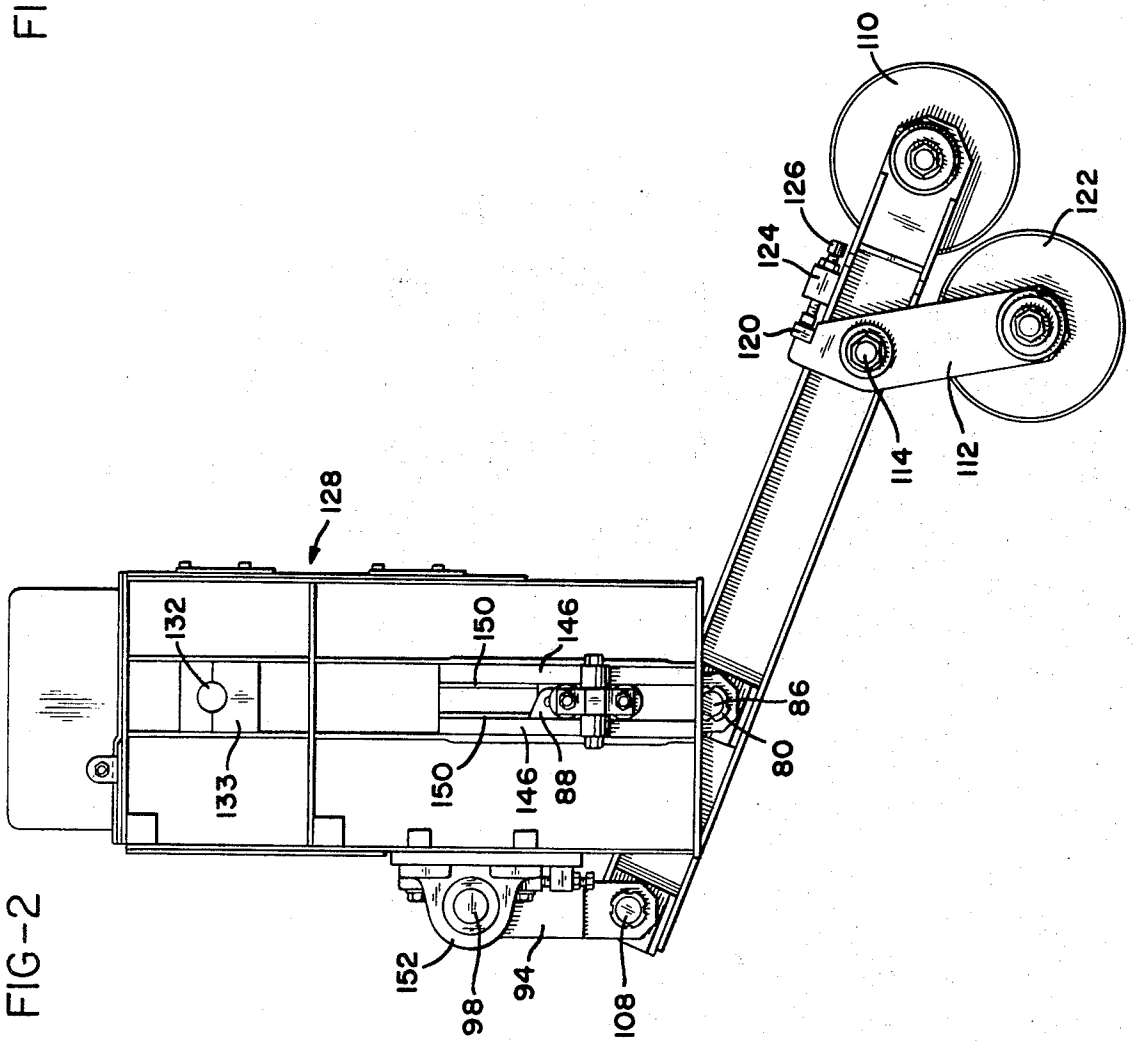

110
126
124
122
120
114
112
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132
150
146
86
80
133
150
146
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152
98
94
108

FIG-2

FIG-4

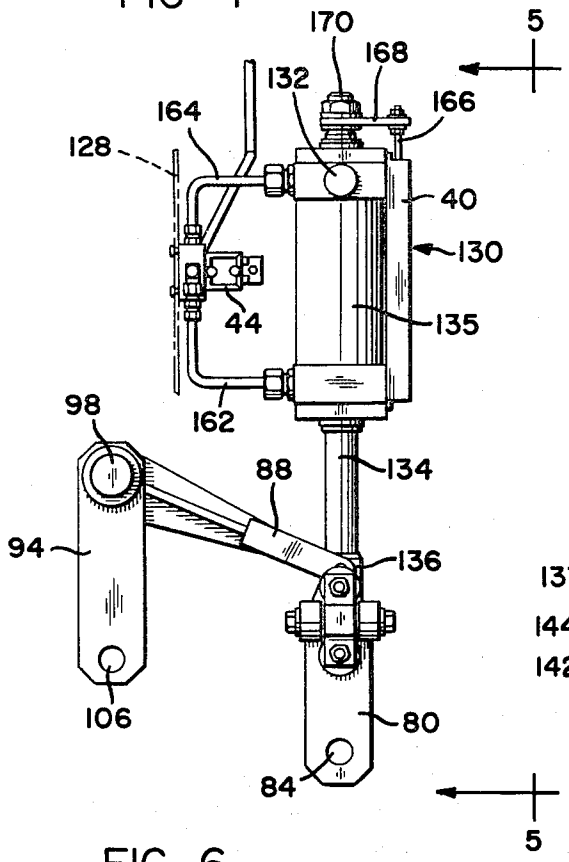


FIG-5

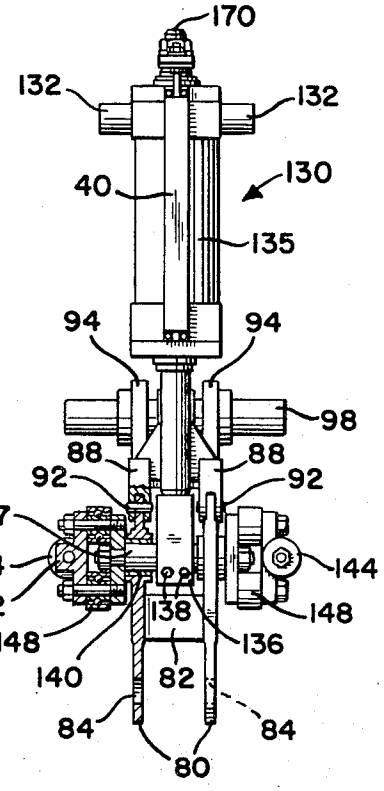
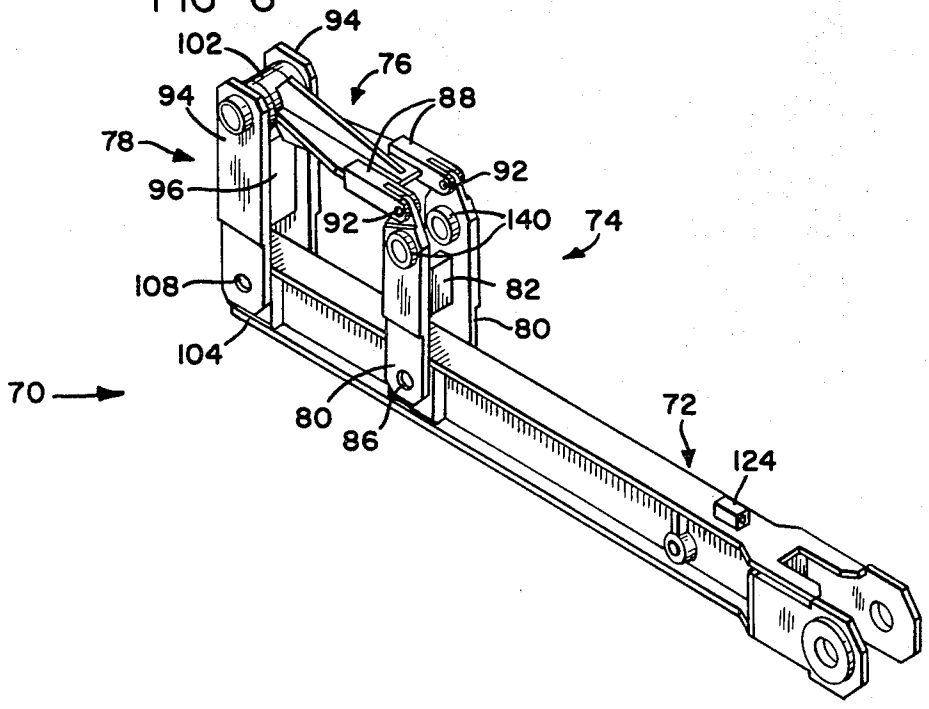


FIG-6



METHOD AND APPARATUS FOR CONTROLLING BEVEL WRAPPING MECHANISM

BACKGROUND OF THE INVENTION

Prestressed concrete pipe is made by wrapping prestressing wire under tension about a pipe core. In the majority of pipe sections manufactured, the ends of the pipe extend at right angles to the longitudinal axis of the pipe. In some cases, however, particularly where it is desired to make a slight change in grade or direction of the pipe line as it is installed, one end of the pipe section may be slanted, or bevelled, with respect to the longitudinal axis of the pipe. Pipe sections of this type are referred to as bevel pipe.

Bevel pipe will either be full bevel or half bevel. In a full bevel pipe the longer side is one inch longer for each foot of internal diameter than the shorter side. For example, in a 48 inch, full bevel pipe, the longer side is four inches longer than the short side, while in a 36 inch full bevel pipe the longer side is three inches longer than the shorter side. In a half bevel pipe the long side of the pipe is one half inch longer for each foot of internal diameter than the short side of the pipe.

It will be apparent that in wrapping prestressing wire on bevel pipe, although the spacing between adjacent wraps should be uniform along a major portion of the length of the pipe, some variation in spacing between adjacent wraps on the long and short sides of the pipe must be made at the bevelled end to accommodate the difference in lengths between the opposite sides of the pipe.

In the past this variation in spacing has been accomplished by the machine operator visually checking the spacing between adjacent wire wraps and "jogging" the wire wrap carriage at the bevel end of the pipe to provide unequal spacing of the wire wraps at the long and short sides of the pipe.

More recently, apparatus has been designed for eliminating the necessity of relying on operator judgment for obtaining the desired wire wrap spacing on the pipe. In apparatus of this type the wire feed carriage which moves along the rotating pipe core carries a pivotally mounted arm on the outer end of which the wire guide is mounted. A cam mechanism is contoured such that, as the carriage moves along the bevel end of the pipe, the arm is caused to pivot, thereby varying the spacing between adjacent wraps. See for example, U.S. Pat. No. 3,052,419 and 3,052,266, with U.S. Pat. No. 3,587,659 also of interest.

It will be apparent, however, that in view of the variation of pipe size which will be encountered in normal wrapping operations, and the fact that the pipe may have either a full or have bevel, it is desirable to provide apparatus which is extremely flexible in adjusting to different pipe sizes and bevels. Obviously, where control of the wire wrapping mechanism is dependent upon a cam of fixed size, the flexibility of the apparatus in accommodating pipes of different dimensions and bevel will be limited.

It will also be noted that where variation in wrap spacing is obtained by feeding the wire through guide sheaves attached to a pivotally mounted arm, control of the wrap spacing becomes more difficult because the guide means, during pivotal movement of the arm, is moving on an arc rather than parallel to the axis of the pipe being wrapped. It will be apparent that this deviation from axial movement becomes more apparent where pipe sections of particularly large diameter are being wrapped.

SUMMARY OF THE INVENTION

The present invention provides a system for wrapping bevel pipe core in which a range of pipe sizes and degrees of bevel angles are readily accommodated and in which the wraps at the bevel end, as well as throughout the remainder of the pipe, are applied uniformly without additional control for this purpose.

This is accomplished by placing the operation of a pantograph mechanism under the control of an electronic system which monitors pipe rotation and wire feed carriage position to cause the wire guide carried by the pantograph to oscillate parallel to the core axis in the vicinity of the bevel end of the core in synchronism with the core rotation to thereby apply wraps at the desired varying intervals to the pipe core at its bevel end.

Thus, the combination of a mechanical wire guide which is capable of straight line oscillation parallel to the pipe core axis and a variable electronic control provides automatic wrap spacing at desired intervals but without the necessity of introducing additional control mechanism, possibly at the expense of other, basic control features.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of the system of the present invention;

FIG. **2** is a side view of the bevel wire control mechanism;

FIG. **3** is a rear view of the mechanism of FIG. **2**;

FIG. **4** is a side view of the mechanism with portions removed for clarity;

FIG. **4** is a side view of the mechanism with portions removed for clarity;

FIG. **5** is a view taken on line **5—5** of FIG. **4**; and

FIG. **6** is a perspective view of the pantograph linkage of the bevel wire control mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to the simplified block diagram shown in FIG. **1** of the drawings, it will be seen that, in accordance with the present invention, a pipe **10** is placed on a platform **12** to be rotated by a drive mechanism **14.** The drive mechanism also supplies power through a variable ratio drive **16** to a carriage drive mechanism **18** driving a wire feed carriage **20.** The variable ratio drive therefore controls the pitch of the wire as it is wrapped onto the pipe by controlling the rate at which the carriage **20** moves vertically as the pipe is rotated.

A bevel wire control mechanism, shown generally at **22,** is mounted on carriage **20,** and, as described below in detail, applies the wire wraps to the pipe **10.** For present purposes it will be noted that the bevel wire control mechanism is so designed that the point at which the wire is fed from the mechanism to the pipe moves parallel to the axis of the pipe. This is especially important when wrapping wire on large diameter pipe (e.g. 196 inch pipe).

The rotational position of the pipe is sensed by a syncro transmitter **24** (Vernitron Corp., type VCX 23/36–6C). the rotor of which makes one revolution for each revolution of the pipe. The syncro transmitter

24 is electrically connected to a syncro differential transmitter 26 (Vernitron Corp. type VCDX 23/38–6C). The rotor 28 of the syncro differential transmitter does not rotate with the rotor of syncro transmitter 24 but is a fixed rotor which may be adjusted initially by the operator to align the syncro transmitter 24 electrically with the orientation of the pipe so that the pipe and the syncro signals are properly aligned at the beginning of the wire wrap operation.

Each pipe is initially mounted for wapping with its wire anchor, located on the long side of the pipe, at the point of tangency of the wire from the bevel wire control 22. Due to the large size of the pipe and the consequent difficulty in placing the pipes on the platform 12 precisely, an electrical correlation between the pipe position and the syncro transmitter is provided by the manual positioning of the rotor 28.

The electrical output of the syncro differential transmitter 26 is a representation of the angle of the pipe with respect to its starting position. This output is connected to a sine/cosine converter 30 (Natel Engineering, type 431–3–B–60–115), the outputs of which are electrical signals representing the sine and cosine of the angle of the pipe with respect to its starting position, these signals being of a predetermined amplitude and of a frequency equal to the rotational frequency of the pipe.

One output of the sine/cosine converter 30 (e.g., the cosine output) is applied to a summing amplifier 32 where it is combined with a signal from a linearizing network 34. The output of the linearizing network 34 is a signal which is a function of pipe diameter and is used to provide an offset voltage to allow this invention to accommodate an extremely large range of sizes. The output of the summing amplifier 32 is applied as an input to a multiplying digital to analogue converter 36 (Data Device Corp., type UDAC–11–3). The output waveform of converter 36 is identical to its input from amplifier 30 except that the output waveform is reduced in amplitude by a ratio which is initially determined by pipe size and thereafter reduced progressively as wire is wrapped onto the pipe.

The output waveform from converter 36 is applied as one input to a second summing amplifier 38. The other input to the amplifier 38 is a signal generated by a linear variable differential transformer (LVDT) 40 (mfg. by Schaevitz), the output of which represents the position of a hydraulic piston in a bevel wrap control 22. The difference between the control signal from converter 36 and the actual position signal from LVDT 40 is an input signal to servo amplifier 42 (Analog Devices, Inc., type 408). The output of the servo amplifier 42 controls a servo valve 44 which in turn controls hydraulic fluid from a hydrulic pump 46 to the bevel wrap control 22. This, as will presently be explained in detail, causes a feed link of the control 22 to follow or track the control signal output of the digital to analogue converter 36 and therefore will position the wire relative to the carriage mechanism under the control of that signal.

A pipe size control 50 is provided to permit the invention to accommodate pipe of various sizes. The pipe size control 50 is a ten turn potentiometer which provides means for presetting the initial amplitude of the output signal from the digital to analogue converter 36. The potentiometer is connected to an amplifier 52 which is selectable in the embodiment of the invention shown herein to have a gain either of one tenth or one twentieth. A gain of one tenth corresponds to a "full bevel" position of switch 54 while a gain of one twentieth corresponds to a "half bevel" position of the switch. Amplifier 52 is connected to an analogue to digital converter 56 (Datel, type ADC–E12B) which continuously converts the analogue input from amplifier 52 into a ten bit digital or binary word. This ten bit word is used as a preset input to up-down counter 58.

The position of the wire feed carriage 20 is monitored by an output shaft encoder 60 which produces a predetermined number of pulses for each increment of movement of the carriage. These pulses are applied to a divide by N counter 62. The value of N is determined by the length of the bevel to be applied to the pipe 10 and may be selected by a selector switch 64. In the embodiment shown in FIG. 1, the number N may be any integer from one to 63.

Switch 64 is actually a six position selector switch which is used to select the integers 2, 4, 8, 16, 32 and 63. The larger the value of N, the greater the number of pulses (representing a greater length of travel of the carriage) which will be required to be applied to the up-down counter 58 to reduce its present value (as determined by the pipe size control 50) to zero. Once the preset counter reaches the value of zero, the output of the digital to analogue converter 36 will also be zero which therefore terminates the bevel wrap operation.

Turning now to FIGS. 2 through 6 of the drawings, the bevel wire control mechanism 22 will be described. As seen in FIG. 6 of the drawings, the bevel wire control mechanism includes a pantograph linkage 70 which consists of a feed link 72, a drive link 74, a spacer link 76 and a guide link 78. The drive 74 is formed as a pair of side plates 80 joined by a cross bar 82 and having openings 84 therethrough for the reception of a shaft 86 which pivotally attaches thereto the feed link 72 intermediate its ends.

The spacer link 76 is bifurcated at one end thereof to provide a pair of arms 88 having openings therethrough to receive pivot shafts 92 which pivotally attach the bifurcated end of the spacer link to the upper ends of the side plates 80 of the drive link 74. At its opposite end the spacer link is pivotally mounted between the spaced side plates 94 of the guide link 78.

The side plates of guide link 78 are joined by a cross bar 96 and a shaft 98 extends through openings in the upper ends of the side plates 94 and an opening in one end 102 of the spacer link 76. The end 104 of the feed link 72 is provided with an opening therethrough and is received between the lower ends of the side plates 94, with the opening in feed link 72 aligned with openings 106 in the side plates 94. A shaft 108 passes through the aligned openings in links 72 and 78 to form a pivotal attachment between them at this point.

The opposite end of the feed link 72, as seen in FIGS. 2 and 3, has a grooved guide sheave 110 rotatably mounted thereon and a guide sheave link 112 pivotally attached thereto, as at 114. The guide sheave link 112 includes a pair of side plates 116 interconnected at their upper ends by cross bar 118 and an abutment member 120. Journalled between the lower ends of the side plates 116 is a second grooved guide sheave 122. Mounted on an upper surface of the feed link 72 is a threaded block 124 receiving an attaching bolt 126

which bears at one end against the abutment **120.** With this construction it will be seen the spacing between the grooved guide sheaves **110** and **122** may be adjusted.

Turning now to FIGS. **2** through **5,** it will be seen that the wire level control mechanism also includes a supporting framework **128,** on which is mounted a hydraulic piston and cylinder **130** by means of the trunion **132** and a pillow block **133.** A piston rod **134** protrudes from the lower end of the cylinder **135** and is attached at its inner end to a piston, not shown. The hydraulic piston and cylinder **130** is of the double acting type, for example, the type manufactured by the Parker Hannifin Company No.

At its lower end the piston rod is threaded and received in an internally threaded knuckle **136.** The lower end of knuckle **136** is of split construction and receives a cross shaft **137** therethrough with the split end of the knuckle being clamped to the shaft **137** by means of bolts or the like **138.** Outwardly of the knuckle **136** the shaft is journalled, as at **140,** in the side plates **80** of the drive link **74.**

At its outer ends the shaft **137** has attached thereto roller brackets **142.** Each bracket **142** rotatably supports a pair of rollers **144** which engage trackways **146** on the supporting framework **128.** Each bracket **142** also journals a second pair of rollers **148** which engage trackways **150** extending parallel to trackways **146** but disposed perpendicularly thereto.

Bearing blocks **152** are mounted on one face of the supporting framework **128** by means of bolts **154** passing through slotted openings **155** in the bearing blocks and, as best seen in FIG. **2,** journal the shaft **98** therein. A pair of adjusting bolts **156** are threaded through blocks **158** and bear on a lower surface of the bearing blocks **152** to provide a limited amount of vertical adjustment.

As noted above, the flow of pressurized fluid to opposite sides of the piston of the hydraulic piston and cylinder **130** is controlled through the servo valve **44,** which, as seen in FIG. **4** of the drawings, directs flow alternatively through pressure lines **162** and **164.** Movement of the piston within the cylinder **135** is sensed by means of the LVDT **40,** since its probe **166** is directly connected through arm **168** to an upwardly projecting rod **170** attached to the piston.

With the above construction, it will be seen that the servo valve **44** may direct pressurized fluid to either side of the piston and cylinder **130** through the lines **162** and **164,** causing the piston to move within the cylinder. This movement is sensed by the LVDT **40** which transmits a signal to the amplifier **38** representing the position of the piston in the cylinder.

Movement of the piston rod **134** in a vertical plane is transmitted to the drive link **74** by means of the knuckle **136** and shaft **137.** The intersection of the links **76** and **78** is fixed by virtue of the shaft **98** being journaled in the fixed bearing blocks **152.** It will also be noted from FIG. **2** that the guide end of the feed link **72** carrying the sheaves **110** and **122** and the axes of shafts **137** and **98** lay on a substantially straight line so that, movement of the outer end of the feed link **72** will be parallel to the movement of the shaft **137** in accordance with well known principles of pantograph operation.

Movement of the shaft **137,** however, is restrained by the rollers **144, 148** and cooperating trackways on the supporting framework **128** so that it can only move in a vertical direction. The guide end of the feed link **72,** therefore, also is capable of only vertical movement. As a result, the guide end of the feed link moves axially of the pipe **10** being wrapped rather than in an arc, as would be the case if a pivotally mounted arm were utilized.

From the above construction, it will be seen that the present invention provides wire wrapping mechanism which provides for infinite adjustability with respect to pipe diameter and the amount of bevel of the pipe being wrapped and in which the wire guide mechanism moves substantially parallel to the axis of the pipe.

While the methods and forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods and forms of apparatus, and that changes may be made therein without departing from the scope of the invention.

What is claimed is:

1. In apparatus for wrapping prestressing wire about a pipe core having a bevel portion adjacent one end thereof including means for rotating a bevel pipe core about its longitudinal axis, a wire control carriage, means for moving said carriage along a path parallel to the longitudinal axis of said pipe at a speed proportional to the rotational speed of said pipe, and a wire guide on said carriage to direct wire onto said pipe, the improvement comprising:

a. a wire feed link mounted on said carriage and carrying said wire guide,

b. means for oscillating said feed link with said wire guide moving substantially parallel to said core axis,

c. means for generating an electrical signal of sinusoidal wave form which is correlated with the rotation of said pipe about its axis,

d. means for modifying the amplitude of said sinusoidal signal in accordance with the diameter of the pipe being wrapped,

e. means for generating an electrical signal in accordance with movement of said wire control carriage,

f. means for further modifying said sinusoidal wave form signal to reduce its amplitude as the bevel portion of said pipe is wrapped, and

g. means responsive to said further modified sinusoidal signal for controlling the oscillation of said wire feed link.

2. The apparatus of claim **1** further including:

a. means for adjusting the phase of said sinusoidal wave form signal with respect to the initial position of the bevel pipe core.

3. The apparatus of claim **1** wherein:

a. said means for generating electrical signals representing the movement of said wire control carriage includes means for generating a predetermined number of pulses for each increment of movement of said carriage, and

b. said means for further modifying said sinusoidal signals includes a digital to analogue converter responsive to said pulses to reduce the amplitude of said sinusoidal signal by specific increments in response to predetermined numbers of said pulses.

4. The apparatus of claim **1** wherein:

a. said wire feed link is one link of a pantograph.

5. The apparatus of claim 4 wherein said pantograph comprises:

a. a guide link,

b. a spacer link,

c. means pivotally mounting said guide and spacer links on said carriage for pivotal movement about a pivot point fixed with respect to said carriage,

d. a drive link pivotally attached to said spacer link at a point thereon spaced from the pivotal connection of said spacer link to said carriage,

e. means pivotally attaching said wire feed link to said guide link at a point thereon spaced from the pivotal connection of said guide link to said carriage, and

f. means pivotally attaching said drive link to said feed link at a point intermediate the pivotal attachment of said guide link thereto and said wire guide.

6. The apparatus of claim 5 wherein said oscillating means comprises:

a. means engaging said drive link at a point thereon intermediate the points of pivotal attachment thereof to said spacer link and feed link for movement of said point thereon along a path parallel to the axis of rotation of said core.

7. The apparatus of claim 6 wherein said oscillating means comprises:

a. a double acting piston and cylinder, and

b. a piston rod attached to said piston and projecting from said cylinder,

c. said means engaging said drive link at said point thereon also connecting an outer end of said piston rod to said drive link.

8. The apparatus of claim 7 further comprising:

a. a servo valve for directing pressurized fluid into said cylinder on opposite sides of said piston,

b. means for monitoring the positon of said piston within said cylinder,

c. means for comparing the position of said piston in said cylinder to position of said carriage along said core,

d. said comparing means controlling said servo valve to direct fluid to the appropriate side of said piston to obtain the desired spacing between said wraps.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,820,729 Dated June 28, 1974

Inventor(s) Lamar D. Springer, David L. Mullendore & Alfred L. Marcum, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the title, "Method and" should be omitted.

Column 1, line 53, "have" second occurrence, should be --- half --.

Column 2, lines 36 and 37 should be omitted.

Column 5, line 6, "level" should be --- bevel ---.

Signed and sealed this 3rd day of December 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
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Inventor(s) Lamar D. Springer et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The filing date is given incorrectly as October 30, 1972.

The correct filing date is October 3, 1972.

Signed and sealed this 8th day of April 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

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