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Marcum, Jr.

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[54] **APPARATUS FOR STRAIGHT LINE OSCILLATION OF A WIRE GUIDE**

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

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

[58] **Field of Search** ..... 242/7.21, 7.22, 7.23, 7.01, 242/158 R, 158 F, 158 B, 158.2, 158.4 R; 138/172, 176

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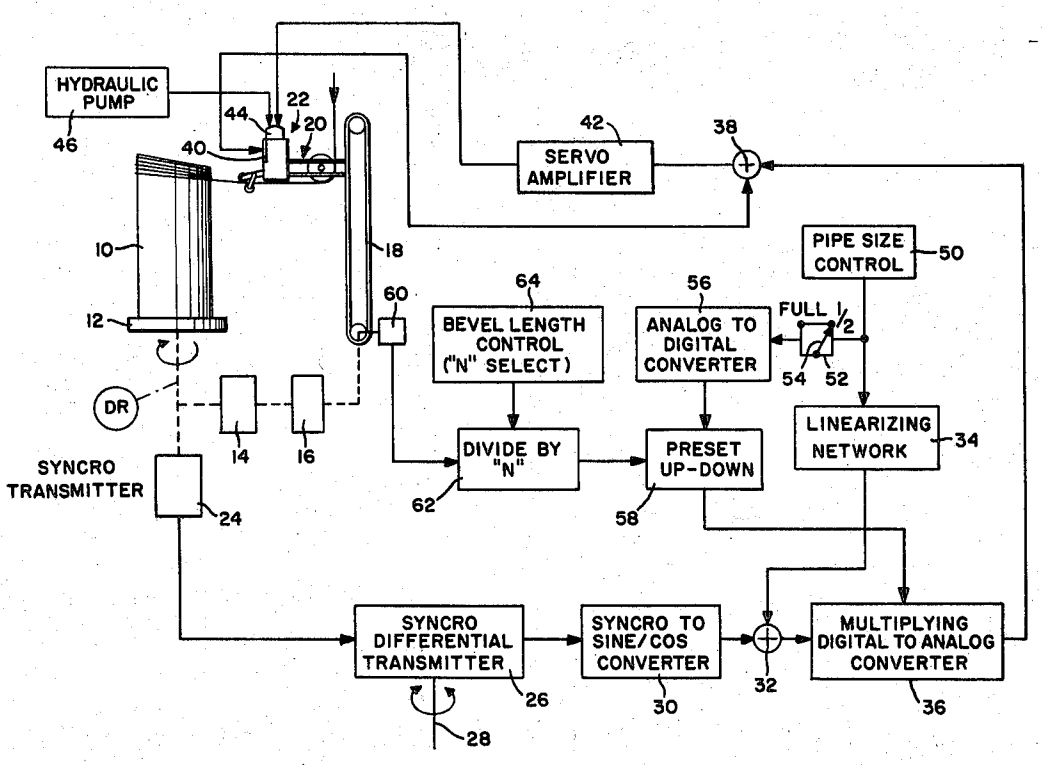
Primary Examiner—Stanley N. Gilreath

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

[57] **ABSTRACT**

Apparatus for oscillating a wire guide carried by a wire feed carriage which moves axially of a rotating concrete pipe core to apply prestressing wire to the core. The oscillating mechanism includes a four bar pantograph with the wire guide mounted on one end of one link of the pantograph to provide straight line movement of the wire guide parallel to the axis of the core being wrapped as the wire guide is oscillated.

8 Claims, 6 Drawing Figures



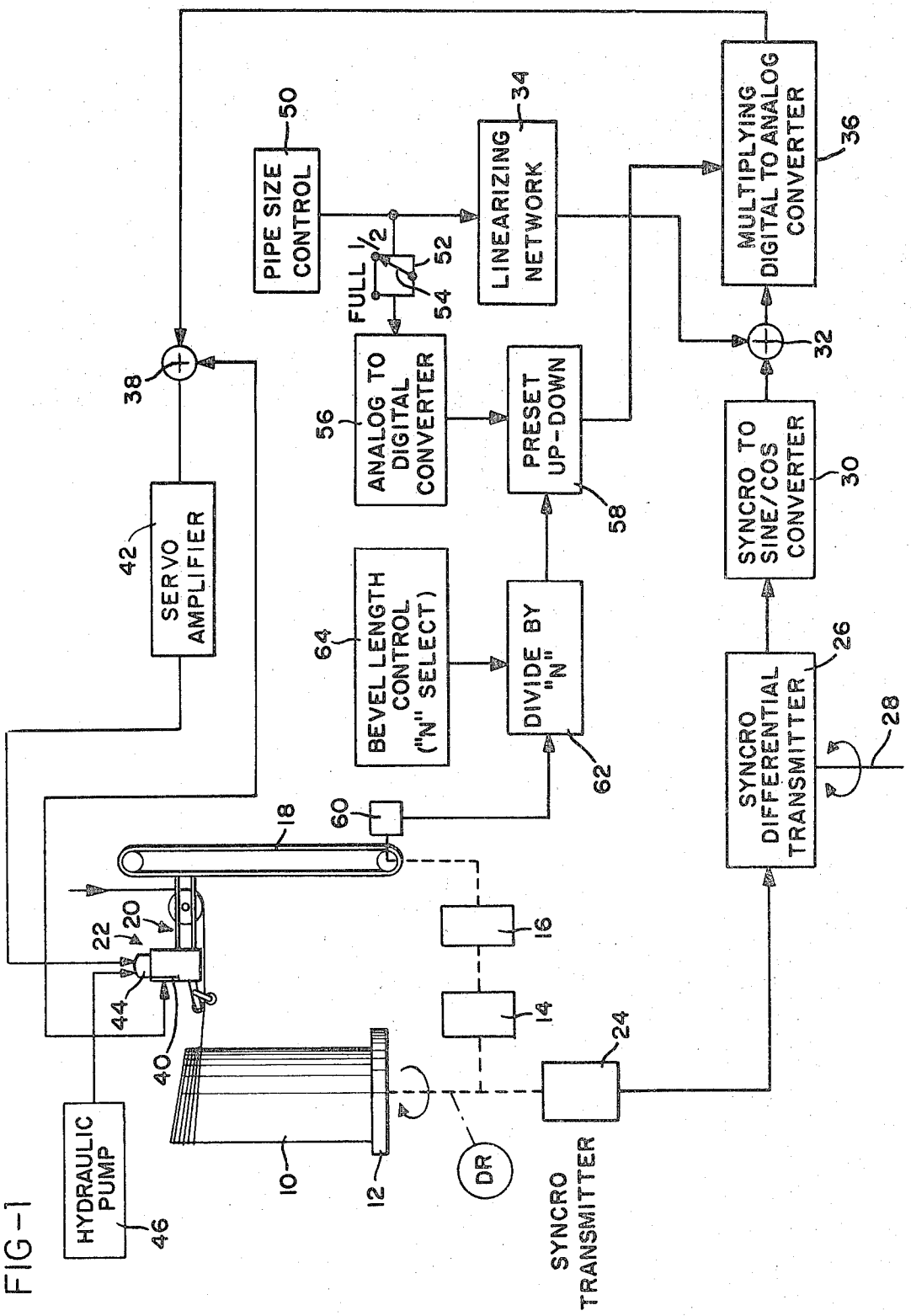

PIPE SIZE CONTROL
50
LINEARIZING NETWORK
34
MULTIPLYING DIGITAL TO ANALOG CONVERTER
36
FULL 1/2
52
54
38
ANALOG TO DIGITAL CONVERTER
56
PRESET UP-DOWN
58
32
SERVO AMPLIFIER
42
SYNCRO TO SINE/COS CONVERTER
30
BEVEL LENGTH CONTROL ("N" SELECT)
64
DIVIDE BY "N"
62
SYNCRO DIFFERENTIAL TRANSMITTER
26
28
18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

FIG-1

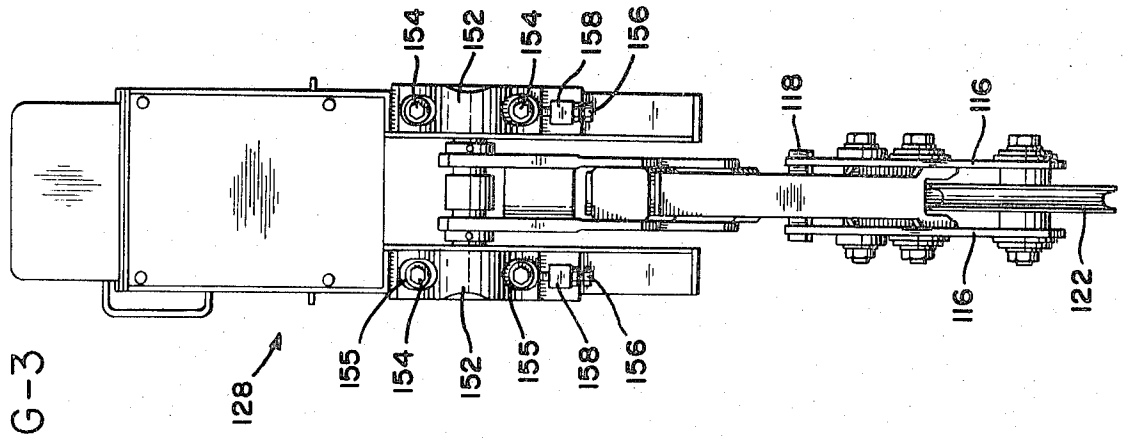

154
152
154
158
156
118
116
116
122
128
155
154
152
155
158
156

FIG-3

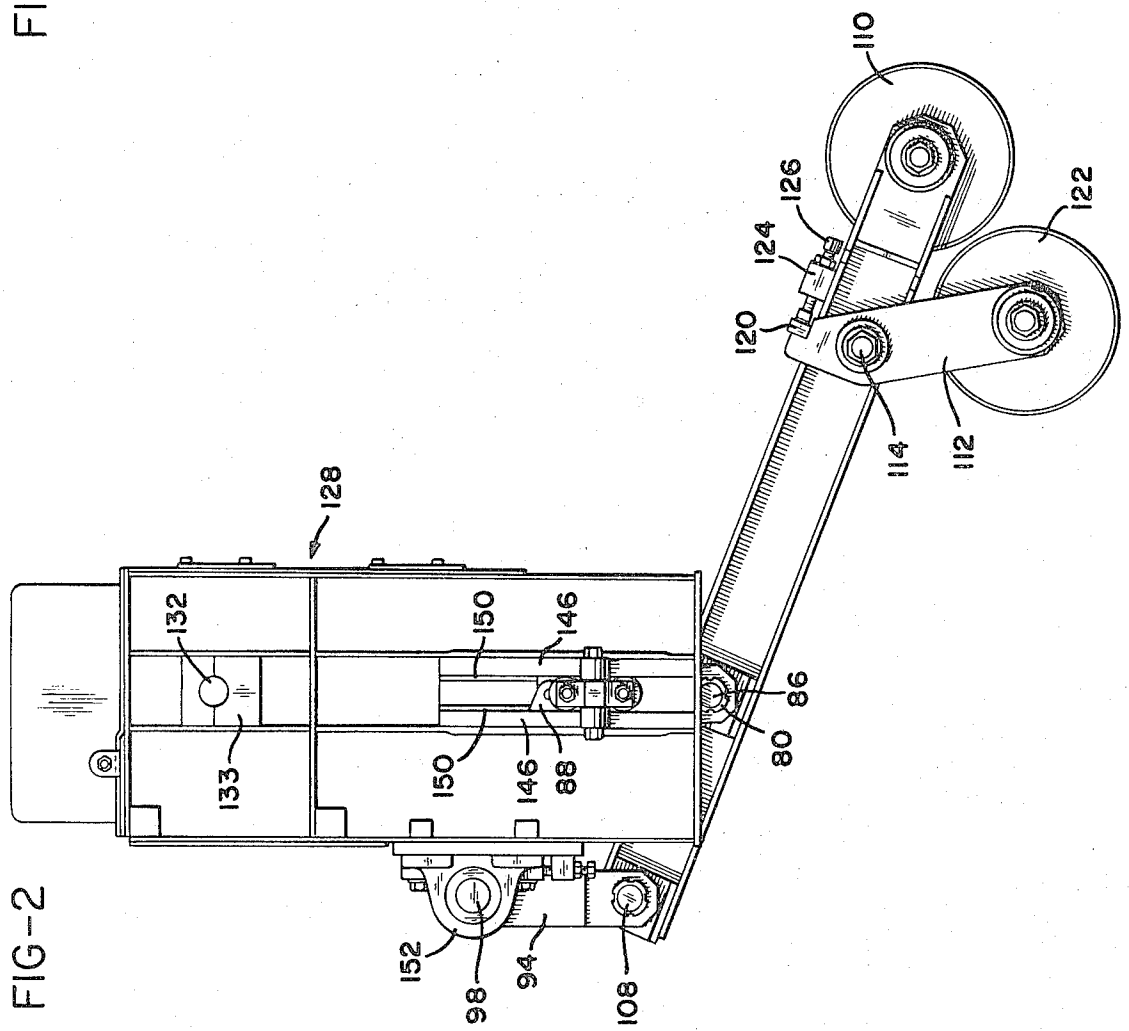

110
126
124
122
120
114
112
128
132
150
146
86
80
133
150
146
88
152
98
94
108

FIG-2

FIG-4

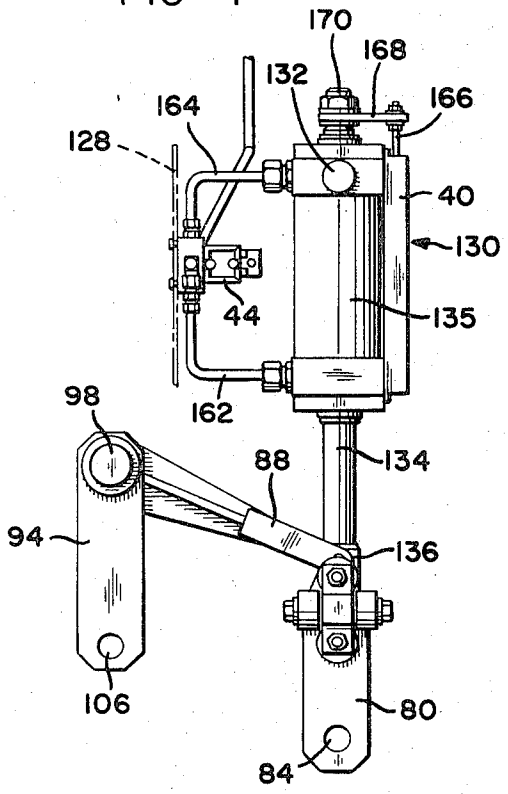


FIG-5

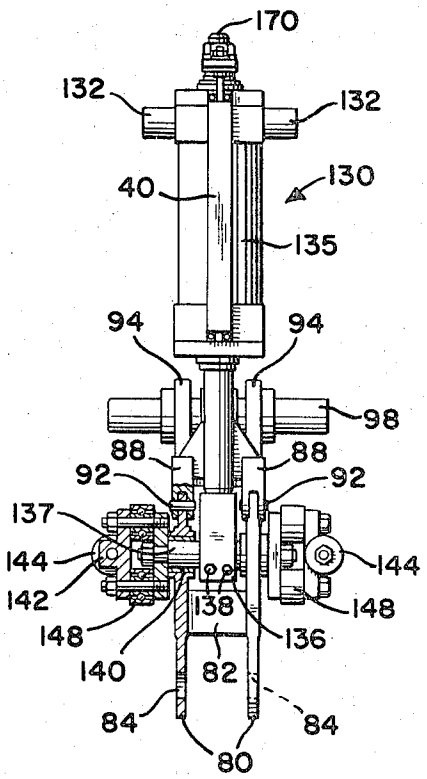
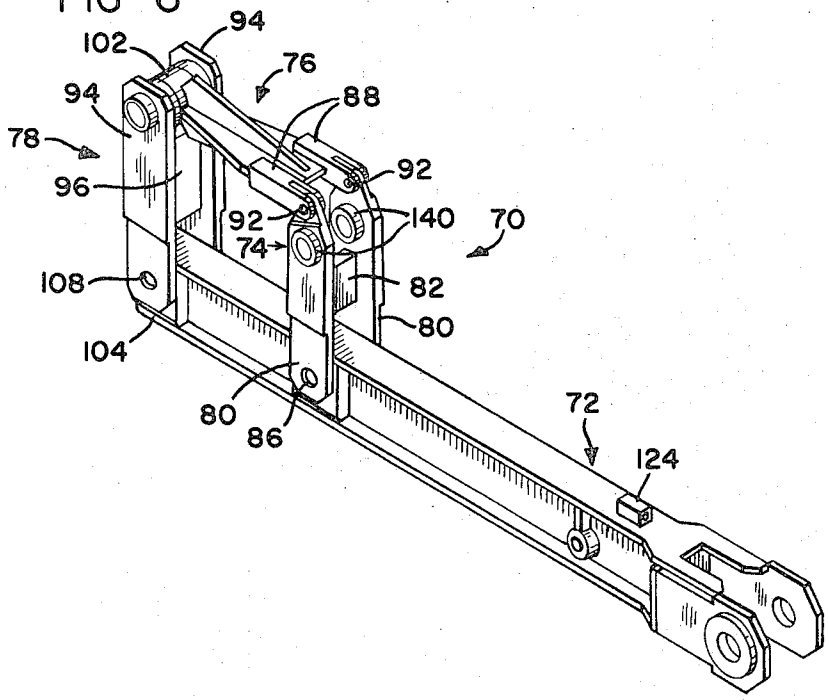


FIG-6



APPARATUS FOR STRAIGHT LINE OSCILLATION OF A WIRE GUIDE

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 case, 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 1 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 4 inches longer than the short side, while in a 36 inch full bevel pipe the longer side is 3 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 a pivotally mounted arm carrying a wire guide at one end is automatically oscillated by control mechanism as the carriage on which the arm is mounted moves along the bevel end of the pipe core being wrapped. For example, see U.S. Pat. Nos. 3,052,419; 3,052,226; and 3,587,659.

It will be noted, however, that where variation in wrap spacing is obtained by feeding the wire through guide sheaves attached to a pivotally mounted arm, an additional, unwanted variation is introduced, since the guides sheaves are not moving parallel to the pipe core but in an arc. This becomes particularly noticeable where pipe cores of large diameter are being wrapped.

It will be seen, therefore, that with mechanism of this type, either the variation in wrap spacing from that desired which results at the bevel end must be acceptable or, control mechanism must be provided that can compensate for these deviations by controlling other variables of the process.

SUMMARY OF THE INVENTION

Bevel wrapping apparatus in accordance with the present invention provides a system for automatically wrapping bevel pipe wherein the oscillation of a wire guide carried by a wire feed carriage moving parallel to the axis of the pipe core is oscillated with a straight line movement which is also parallel to the core axis. As a result, variations in wrap spacing from the spacing desired, which would occur if the wire guide was merely carried by a pivoted link, are avoided.

The wire guide incorporates a four bar pantograph mechanism in which a feed link carries the wire guide and is actuated by a drive link powered by a double acting hydraulic or pneumatic piston and cylinder. To insure that the outer end of the feed link moves with a straight line motion, pairs of rollers having mutually perpendicular axes are mounted on the drive link and run along trackways extending perpendicular to each other but parallel to the axis being wrapped.

The rollers are mounted on the drive at the point of intersection of the drive link with a line passing through a fixed pivot connection of two other links of the system and the wire guide sheaves. As a result, the linkage system provides a true axial movement of the wire guide sheaves, eliminating both inaccuracy in wrap spacing at the bevel end of the pipe and the necessity of providing additional control mechanism to compensate for nonlinear movement of the wire guide sheaves.

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 view taken on line **4—4** of FIG. **3**;

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 at 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 snycro 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 a wire wrap operation.

Each pipe is initially mounted for wrapping 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 431-3B-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 hydraulic 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 10-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 10 bit digital or binary word. This 10 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 link **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 bevel control mechanism also includes a sup-

porting 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**. Ourwardly 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. A pair of adjusting bolts **156** are threaded through blocks **158** and bear on a lower surfaces of the bearing blocks **152** to provide a limited amount of vertical adjustment. As best seen in FIG. **2** of the drawings, outer ends of the shaft **98** are journalled in bearing blocks **152** to pivotally attach the linkage **70** to the supporting framework **128**.

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**. Since the intersection of the links **76** and **78** is fixed and since the guide end of the feed link **72** and the axes of shafts **137** and **98** lay on a straight line, 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.

Additionally, since the shaft **137** is restrained by the rollers **144**, **148** and cooperating trackways on the supporting framework **128** and can only move in a vertical direction, the guide end of the feed link 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 bevel pipe core with the spacing between adjacent wire wraps at the bevel end of said core varying from a maximum at the long side of said core to a minimum at the short side thereof, including means for rotating said core about the longitudinal axis thereof, a wire feed carriage, means for moving said carriage along a path parallel to the axis of rotation of said core at a speed proportional to the rotational speed of said core about said axis, wire guide means mounted on said carriage, and means for oscillating the wire guide means relative to said carriage as said carriage moves along said core adjacent said bevel end thereof to vary the spacing between adjacent wire wraps, the improvement wherein the means for oscillating said wire guide means comprises:

a. a linkage system including a feed link carried by said wire feed carriage,

b. means mounting said wire guide means on said feed link, and

c. means for oscillating said feed link with said guide means moving parallel to said rotational axis of said core.

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

a. said linkage system is a pantograph and said wire feed link is one link thereof.

3. The apparatus of claim **2** wherein said pantograph further 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 means.

4. The apparatus of claim **3** 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.

5. The apparatus of claim **4** further comprising:

a. means for restraining said point on said drive link against movement in directions other than parallel to said core axis.

6. The apparatus of claim **5** wherein:

a. said point on said drive link lies substantially on a straight line connecting said pivot point fixed with respect to said carriage and said guide means.

7. The apparatus of claim **4** wherein said means engaging said drive link comprises:

a. a double acting piston and cylinder,

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

c. means interconnecting said piston rod and said drive link at said point thereon.

8. In apparatus for wrapping prestressing wire about a bevel pipe core including means for rotating a core about its axis and a carriage movable along a path parallel to said axis the improvement comprising:

a. a supporting framework mounted on said carriage,

b. a double acting piston and cylinder including a piston rod attached to said piston and projecting outwardly of said cylinder mounted on said framework,

c. a source of fluid under pressure,

d. means for directing said fluid into said cylinder on opposite sides of said piston,

e. means for controlling said fluid directing means in response to the desired spacing of wire wraps on said core,

f. a drive link pivotally attached intermediate its ends to an outwardly projecting end of said piston rod,

g. track means mounted on said framework and extending parallel to said axis of rotation of said core,

h. means attached to said drive link at said point of attachment thereof to said piston rod and movable along said track means only in a direction parallel to the axis of rotation of said core,

i. a spacer link pivotally attached at one end to said supporting framework and at an opposite end thereof to one end of said drive link,

j. a guide link pivotally attached at one end thereof to said supporting framework at the point of attachment of said spacer link to said framework,

k. a feed link pivotally attached at one end to an end of said guide link opposite said one end thereof,

l. means pivotally attaching said feed link intermediate its ends to an end of said drive link opposite said one end thereof, and

m. guide means mounted on an end of said feed link opposite said one end thereof.

* * * * *