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(54) PIPE COATING APPARATUS

(71) I, DAVID GARDNER, a citizen of the United States of America, of Route 11, Box 64, Conroe, Texas 77301, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Weight or coating material, when applied to a pipe, aids the pipe in sinking when the pipe is installed at offshore locations, under rivers, swamps, and the like. The weight material is preferably applied to the pipe with relatively uniform thickness and density. The apparatus of the present invention is particularly adapted to apply weight material which is uniform in thickness and density. For a given installation, it is often necessary to vary the total weight of material on a pipe. It is sometimes necessary to vary the density because density is often related to the compressive strength of the concrete weight material. For instance, if it is to be exposed to rough handling, the strength which is acquired must be fairly uniform.

The present invention provides an apparatus for placing coating material on a pipe which will move along a path parallel to the pipe axis while rotating about that axis, which comprises a roller positioned approximately below the path of the pipe and having its surface spaced a pre-determined distance from the exterior surface of the pipe, a conveyor belt arranged to move its outer surface towards and over said roller in endless fashion, means for receiving and dispensing by gravity flow a supply of coating material on to the surface of the conveyor whereby the conveyor belt is arranged to carry coating material from the dispensing means towards a pipe for compression between the pipe and the conveyor belt and to adhere to the pipe.

The invention also provides a method of coating a pipe comprising the step of placing coating material by gravity feed on an endless conveyor which moves towards and over a roller beneath the pipe bath and helically rotating the pipe for adhesive contact with the material as the endless conveyor is moved laterally under the pipe, to extend the coating around the pipe by helical turns while later-

ally supporting one turn to compress it between the conveyor and the pipe.

The conveyor acts to smooth the coating both internally of the coating material slurry and on the surface. Normally when slurry is delivered to a coating apparatus it is dumped through a housing from a mixing source, typically conveyed by a conveyor or screw transfer machine, and may entrap air bubbles. The viscous nature of the slurry normally prevents escape of air bubbles. In its preferred form the apparatus of the present invention avoids entrapped air bubbles by placing the slurry on the conveyor belt where it is scraped as it emerges from a slot, thereby eliminating some of the bubbles. It is compressed between a compression roller and the pipe itself which compresses and removes many of the remaining air bubbles. Through this technique, the size and number of the bubbles are substantially reduced, measurably eliminating air voids in the concrete coating after it has been applied.

In the coating of a pipe, the slurry is applied in multiple turns in helical fashion about the pipe. Adjacent turns preferably overlap somewhat. This is desirable as opposed to abutting adjacent turns and running the risk of a weakness in the coating after it has cured at the junction of adjacent turns. The overlapped turns of coating material provide compression at the region of overlap which turns are adequately comingled to form a unitary coating as opposed to one which has a helical plane of weakness running through it.

The overlapping of adjacent turns of coating material creates a problem which is cured by the alternative embodiment to be described hereinafter. Each turn of coating material incorporates a layer of reinforcing mesh. On the exterior, a weather proofing or outer wrap is applied. The alternative embodiment to be described places the reinforcing mesh in the slurry as it is applied at an offset location. This enables adjacent turns to overlap without bending the reinforcing mesh. It is desirable that the reinforcing mesh in the cured coat of weight material form a concentric cylinder. Adjacent edges of it lap one another, but it is undesirable that the edges be folded under. The same is

also true of adjacent turns of the outer or protective wrap. When a first turn is applied, it is not desirable that the next turn be placed over the wrap and folded under. This increases the likelihood of leaks in the outer wrap. The preferred embodiment accommodates this problem by aligning the outer wrap, the reinforcing mesh, and the rectangular shaped strip of coating material with offsets so that the coating material is overlapped without distorting the finished shape of the reinforcing mesh and the outer wrap.

In one preferred embodiment of the invention the apparatus incorporates a vertically directed funnel above a housing. This serves also as a storage hopper. It is preferably generally rectangular, having one wall or side removed. It has a slot at the bottom of that side with an adjustable gate which moves to a selected vertical height whereby the concrete coating material is delivered at a specified thickness. The chute is open at the bottom. It is arranged immediately above a conveyor having a width equal to or greater than the chute. The conveyor belt travels in an endless route, passing over two rollers and travelling between them. One roller is positioned beneath the pipe to be coated and is normally axially aligned. The other roller is parallel to the first and located to the side. The housing which receives the coating material is above the conveyor belt and between the two rollers which support the conveyor belt. The coating material is applied with a reinforcing mesh which passes through an elongate eyelet above the conveyor. The housing is spaced just above the conveyor belt to controllably space the reinforcing mesh which is carried along and parallel with the conveyor belt. The coating material falls onto the top of the mesh and fully surrounds it, and is carried on the conveyor belt. An outer wrap material is selectively incorporated. The materials all travel from the side of the pipe toward the pipe as the conveyor rotates, moving the materials. Air bubbles in the slurry are present as the slurry passes beneath the gate which cuts a portion of the materials from the top, achieving some compression and avoidance of air voids. The materials are compressed against the pipe between the roller and the pipe itself. This assures proper application of the materials and avoidance of most voids in the weight material after it cures.

The other preferred embodiment of the present invention incorporates means for laterally offsetting the outer wrap, the reinforcing mesh, and the slurry so that adjacent turns of the slurry overlap while the outer wrap and the reinforcing mesh are formed concentrically planar about the pipe and are overlapped rather than folded under. In the application of the slurry, this means that one turn is first applied and a marginal

edge of it is left uncovered with outer wrap material. This exposed portion of the turn subsequently rotates around, and it is that portion which is overlapped with the next turn of coating material, thereby comingling the two turns and creating a strong junction between them. The margin of exposed coating material is compacted by an alternative conveyor which is relatively narrow. It need only be as wide as or slightly wider than the exposed margin, perhaps two or three inches in comparison with the main conveyor which can be any width desired. The secondary conveyor traverses the same path as does the top portion of the conveyor. It travels part way around the pipe to a pulley and is then returned to other pulleys back to the point of beginning for the endless conveyor.

This embodiment further discloses a fixed pivotal mounting enabling it to rotate the conveyor belt, the hopper system, and all of the apparatus so as to vary the helical lead of the coating material applied to the pipe.

The invention will be more readily understood from the following description of embodiments of coating apparatus, given by way of example only, with reference to the accompanying drawings of which:—

Figure 1 is a perspective view of one form of coating apparatus.

Figure 2 is a perspective view of an alternative coating apparatus which is pivotally mounted to rotate as a unit and which illustrates a means incorporating a secondary conveyor which temporarily holds and compacts the margin of each turn of material applied to the pipe.

Figure 3 is a view along the line 3—3 of Figure 2 showing the marginal turn which is laterally offset from the reinforcing mesh and the outer wrap material, and,

Figure 4 is a sectional view along the line 4—4 showing the relationship of the reinforcing mesh, the main conveyor, and the secondary conveyor.

The apparatus of the present invention is intended to be used with pipe handling apparatus which customarily includes means for handling the pipe as it travels inbound, i.e. towards the coating apparatus and parallel with its axis, and means for handling it as it travels outbound, i.e. away from the coating apparatus. The pipe is moved axially and is simultaneously rotated. The pipe increases in diameter and weight after the coating material is placed on it. The outboard apparatus must handle larger diameter pipe with more weight.

The apparatus of the first form of the present invention is identified at 10 in Figure 1. It includes an upwardly facing funnel which opens into a rectangular housing 14. It serves as a temporary storage container and is preferably rectangular, or even square,

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in cross section. It is preferably open at the bottom. It is arranged immediately above a conveyor belt 16 which travels between a first roller 18 and a second roller 20. The rollers are preferably equal in length and diameter, although it is not required that they be matching in these dimensions. The conveyor belt 16 is an endless belt travelling in a clockwise direction as viewed in the drawing. The conveyor 16 is preferably a rubber belt. The conveyor 16 has a width equal to or greater than the width of the housing 14. This is to enable the conveyor 16 to close the bottom of the housing 14. The conveyor 16 is positioned immediately below the bottom open end of the housing 14 to define a relatively narrow gap. In addition an elongate eyelet (in the form shown in Figure 4) is located above the gap. The slot enables a reinforcing mesh 22 to be introduced through the eyelet between the belt 16 and the housing 14. The narrow gap receives an outer wrap material 24. The reinforcing mesh and the outer wrap 24 are carried at controlled vertical heights on the conveyor belt somewhat in a sandwich arrangement. The mesh is preferably equal in width to the housing 14 while the outer wrap 24 is wider. This enables the wrap materials to receive the coating material thereon as will be described.

The housing 14 has a structural reinforcing frame member 26 at its lower edge to maintain rigidity and structural integrity. It serves as a guide directing the reinforcing mesh 22 and the outer wrap material 24 to a point above the conveyor but below the housing 14. The members 22 and 24 are preferably obtained from commercially known sources and are typically spooled in lengths of several hundred or several thousand feet. They can be obtained in multiple widths. The reinforcing mesh is routinely obtained with a selvage wire along one or both edges to prevent stretching. The mesh is sometimes called chicken wire, although this nomenclature is not fully descriptive of the screen wire.

The housing 14 receives and stores a substantial quantity of coating material to smooth the supply. As will be noted, the conveyor 16 travels from left to right, picking up the coating material and carrying it to the right. The amount which is dispensed is selectively controlled. The lower edge 28 of the wall of the housing 14 faces the pipe. The gap between the conveyor 16 and the lower edge 28 is rather wide. The gap is selectively controlled by adjustably positioning the gate 30 to close the gap or slot. The gate 30 is selectively locked in position by means of adjustable bolts joined to the housing 14 which protrude into slots 32 in the gate 30. The bolts are engaged with nuts 34 to clamp the gate 30 at a selected height.

This controls the thickness of material which is placed on the conveyor 16 for subsequent application to the pipe.

The conveyor 16 hangs limp on the lower side of the rollers 18 and 20. It carries substantial weight beneath the housing 14. A support plate 36 is located below the top run of the conveyor belt 16. It is located between the rollers 18 and 20. The left hand edge of the reinforcing plate 36 is immediately adjacent a point where the belt 16 tangentially leaves the top of the roller 18. It extends fully across the space between the rollers 18 and 20 and almost to the point where the conveyor belt 16 tangentially contacts the top of the roller 20. This prevents sag of the belt in the middle where it carries substantial weight. The belt is able to slide smoothly on top of the plate 36 and it carries with it the reinforcing mesh 22, the outer wrap material 24, and the unset slurry material of prescribed thickness.

The housing 14 is formed of facing side walls 40 and 42 which are vertically arranged. They define the maximum width of the coating material to be applied. Their width is preferably equal to or less than the width of the conveyor 16. The width may be several centimeters more narrow to enable the conveyor belt to overlap the reinforcing mesh 22. It may be desirable in some instances to overlap the reinforcing mesh between adjacent turns of the helical coating material applied in a spiralling pattern along the pipe. This is permissible, and can be achieved with no particular problem other than obtaining materials of the desired width. The facing side walls 40 and 42 extend vertically and parallel to one another. They define the housing and further limit lateral movement of the wet and flowing weight materials. The side wall 40 includes a parallel extended wall portion 46 which extends along the conveyor 16 and above the plate 36 to the near vicinity of the pipe to be coated, the pipe itself being identified at 50. The pipe 50 approximately matches a contoured edge 52 on the plate 46 which enables the pipe 50 to be positioned snugly near the guide plate 46. The plate 46 prevents loss of coating material to the side. The plate 46 approximately conforms to the pipe 50, although it need not be contacted against it. A slot in the range of one to three centimeters between the contoured edge 52 and the pipe 50 is permissible, for example. With this in view, the slurry material is captured so that it must be carried to a point where it is applied to the pipe 50.

Similar guide plates are positioned on opposite sides of the conveyor 16 and they are similarly constructed, having similar curved or contoured edges like that shown at 52. When the apparatus is to be used for coating pipe of different sizes, it may be

necessary to reshape the plate 46 or to install a substitute plate having a different radius of curvature at 52. The roller 20 is positioned a specified distance from the pipe 50. The roller 20 cooperates with the pipe to specify the thickness to which the coating material is to be applied. This is adjustable over a desired range. The side or guide plate 46 has a vertical dimensions which enables the roller 20 and the pipe 50 to be positioned relatively close together or spaced far apart. This vertical dimension may also have to be varied to obtain rather thin coating on the pipe 50. Variations in this height and radius of curvature 52 can be readily achieved by substituting guide plates 46 which differ at the respective dimensions mentioned. It is not essential that the guide plate extend all the way around, because the cohesive nature of the slurry keeps it jelled and in contact with the adjacent turn.

In application, the pipe 50 is rotated and each turn of the helix of materials which are applied thereto shoulders against the previously applied helical turn. Because of this virtue, it is not necessary for the conveyor 16 to have guide plates 46 on both sides to extend perhaps as much as 180° around the pipe. The multiple turns of coating material applied to a single joint of pipe requires that each turn shoulder against and butts the the previously applied turn. Only one side is unsupported and this lasts only momentarily during the first turns until the pipe has been rotated for a second turn where the adjacent layer of material is applied to it. The apparatus for applying coating material is preferably adjustable in spacing from the pipe 50. The pipe 50 is supported a specified distance above the roller 20 without regard to the diameter of the pipe. The vertical spacing is fixed for a selected size of the pipe. It may be desirable to adjust this spacing to apply a different thickness of coating material to the pipe. To accomplish this, the guide plate 46 may require substitution to change the vertical dimension of the contoured encircling edge 52. Further, the roller 20 is supported on a shaft 56 which extends at both ends of the roller 20 and is received in a slot 58 of a support plate 60 (one at each end) for purposes of alignment. The shaft 20 is locked in position in the slot 58 by means of nuts which thread on the ends of the shaft. The roller 20 can either free-wheel on the shaft 56 by means of bearing assemblies preferably placed at least at each end of the roller 20, or it can be powered.

The plate 36 preferably moves upwardly and downwardly also and is preferably supported by a shaft 60A which extends into a similar slot 62 in a support plate 64. The support plate 64 aligns the shaft 60A so that it can be securely held in direct alignment with the remainder of the apparatus while

being raised and lowered. The shaft 60A again is preferably locked by placing threaded bolts on both sides of the plate 64 with appropriate lock washers which secure the shaft at a specified elevation relative to the slot 62 and secure the plate 36 at a specified elevation. A similar shaft is preferably mounted on the lower side at the left end of the plate 36 fairly near the roller 18. Through this arrangement, the two ends of the plate 36 can be raised and lowered, thereby positioning the plate below the conveyor belt 16 to adjust the height of the belt 16 relative to the pipe 50 and vary the thickness of the coating material applied to the pipe 50. In normal use of the apparatus, the roller 20 is moved upwardly and downwardly jointly with the plate 36. It is preferable to maintain the top surface of the plate 36 approximately on a tangent line between the rollers 18 and 20.

The shaft 65 connects with the roller 20. The roller 20 can be driven. The shaft 65 supports a sprocket gear or pulley 66 which is engaged with a chain drive or belt 68 which extends to a controllable speed prime mover, not shown. This enables rotation of the roller 20 at a specified rate of speed to control the speed at which the material is applied to the pipe 50. The reinforcing mesh 22 is pulled toward the pipe 50 by either of two power sources. The first source is rotation imparted to the pipe itself. The pipe is urged axially and simultaneously rotated through the equipment. The first turn of the coating material which is applied in a helix along the pipe is anchored to the pipe using known techniques to fasten the reinforcing mesh. After the first turn has been completed, the reinforcing mesh 22 (being fixed to the pipe by adherence) is drawn through the equipment to encircle the pipe. This continues as the pipe rotates and traverses the equipment. In this arrangement, the conveyor belt 16 may readily free-wheel, carrying the weight of the materials which are applied to the pipe. Alternatively, the roller 20 may be powered through the apparatus described above. A variable control prime mover is preferably used so that the conveyor 16 travels at a controlled rate which is adjustable to approximately match the rate at which the reinforcing mesh 22 is drawn through the equipment. The mesh 22 is preferably advanced on the belt in a non-skid fashion. Preferably the belt carries the bulk of the weight to avoid undue pulling on the mesh. A vibrator mechanism 70 is attached to the support plate 36. It is preferably a multiple or variable speed vibrator mechanism which imparts vibration to the concrete slurry. This aids in removal of bubbles and provides an improved uniformity to the coating material applied to the pipe. The frequency and amplitude may be varied to

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vary the effect on the weight material dependent on a variety of circumstances.

The apparatus has many advantages in operation. The concrete material is accumulated in the housing to a substantial depth, perhaps as much as fifty or one hundred centimeters. It can be supplied evenly or in spurts, as might occur with a batch mixing plant. The housing 14 serves as an accumulator which smooths out the peaks and valleys in the supply rate. The gate 30 is adjusted to some selected height. It might be set at ten centimeters, for instance. The coating material which passes beneath the gate will have a thickness of about ten centimeters prior to compression. This thickness is maintained, although it may tend to settle slightly due to the escape of bubbles and collapse of voids in the tacky material as a result of vibrations imparted to the plate 36. The thickness of a coating itself may be a thickness such as eight centimeters. The coating material is compressed between the roller 20 and the pipe 50. The reinforcing mesh 22 is forced into the tacky concrete slurry and imbeds permanently therein, providing structural strength and integrity to the concrete cured on the pipe. The reduction of thickness achieved by compression between the roller 20 and the pipe 50 squeezes the last bubbles from the material and provides a rather uniform or controlled density of coating material. The coating material is thus captured as it approaches a point between the two rollers. Any excess coating material is squeezed to the left but is continually fed back to the right as viewed in the drawing so that it is applied to the exterior of the pipe. As it is squeezed down on compression between the two rollers, it achieves a desired thickness as a result of the compression and has a uniform density. The outer wrap material 24 moves with the reinforcing mesh 22 and provides exterior waterproofing membrane around the coated pipe.

Figure 2 shows an alternative embodiment 100. It is supported on a base 102 which is positioned appropriately in line with a pipe handling apparatus. The base 102 supports a threaded shaft 104. The shaft 104 is received through a pair of openings in a rotatable pivotal connection 106. The pivotal connection 106 is attached to a generally horizontal beam 108. The beam supports the apparatus shown in Figure 2.

The beam supports suitable horizontal shafts (not shown) which support rollers 110 and 111. The rollers support and align an endless belt conveyor 112. It is preferably quite wide in the same manner as the conveyor shown in Figure 1. The beam 108 supports an additional beam 114. The beam 114 passes beneath the conveyor and supports a plate 116 parallel to the conveyor which prevents the conveyor from drooping or sagging

between rollers. The plate 114 is fixed in height vertically relative to the conveyor to provide consistent support.

The beam 108 supports (by means broken away for sake of clarity) the vertically directed generally rectangular housing 120. The housing is formed of four walls, including walls 122 and 124. They extend upwardly to a funnel 126. Concrete is delivered in a viscous state into the funnel and accumulates therein. The housing is hollow at the interior and has an open bottom which terminates at the conveyor belt.

The housing aligns the layer of viscous coating material which is shaped into a generally rectangular cross section before application and aligns it with the reinforcing mesh 130 and the outer wrap 132. As shown in Figure 4, the outer wrap 130 is shown passing through an eyelet 134. The eyelet is attached to an end wall 138 of the housing. The plate 136 is adjustable upwardly and downwardly. It is moved by operation of bolts 140 which are tightened and loosened. They clamp the plate 136 at selected heights in vertically arranged parallel slots shown in Figure 4. The movement upwardly and downwardly of the plate 136 adjusts the eyelet 134 and varies the height of the reinforcing mesh in the rectangular ribbon of coating material moved from the housing on top of the conveyor 112. The outer wrap 132 is free to move laterally of the reinforcing mesh 130. More will be noted concerning this hereinafter.

Returning to Figure 2, the wall 124 of the housing supports a gate or plate 144. It is adjustable upwardly and downwardly relative to the housing. It is locked in position by means of bolts which extend through slots. The gate 144 supports a pair of protruding tabs 146 which hold and position a roller 148. The roller is mounted on a shaft for free-wheeling contact against the top of the ribbon of coating material carried on the conveyor belt. The wall 124 has an opening 150 cut in it at its lower bottom edge. The conveyor emerges through the opening 150. The opening contours the volume of slurry in the housing and a generally rectangular ribbon is carried through the opening 150 on the conveyor. The width is determined by the width of the opening 150. The height is determined by the maximum height of the opening 150 but is further limited by the position of the roller 148. The roller 148 is a device which regulates the thickness of the ribbon applied to the pipe and rolls against the surface of the ribbon of material tending to squeeze a portion back toward the housing and further tending to squeeze air bubbles from the slurry material. The roller 148 serves as a means which levels and smooths the top face of the ribbon of viscous material and determines the thickness there-

even where adjacent turns are crushed together at their edges, sufficient flow through the reinforcing members enables the reinforcing mesh to remain relatively fixed without
5 deflecting along its edges. The adjacent turns of slurry comeingle and increase in strength at the abutting edges of the applied coating material.

The outer wrap 132 is offset measurably.
10 This exposes the margin on one edge of the freshly applied turn to enable it to be comingled with the next turn. In like manner, the opposite edge of the outer wrap 130 laps over the prior turn. Lapping over protects
15 the previous turn and covers the margin of the previous turn, thereby covering the entirety of the pipe. This fact is brought out more clearly on viewing Figure 3. The margin is shown at 180. The outer wrap 132 is
20 shown laterally displaced to the right of Figure 3. It is abutted against the secondary conveyor 160 which replaces the outer wrap momentarily and for a portion of the turn applied to the pipe. The outer wrap 132 thus
25 covers over the margin 180 of the previous turn. The margin 180 is left so that the two adjacent turns are crushed together with the viscous material flowing sufficiently to enable a smooth joint to be made. There is no
30 lump or mound formed at the point of overlap. The roller 110 and conveyor 112 are sufficiently wide to crush the two turns together and form a smooth outer surface. This it will be observed in Figure 3 that the
35 turn then being applied is supported on its outer face by the conveyor and the roller and is laterally supported on its left and right. This enables good adherence to the pipe, consistency and coating density, and further
40 causes the freshly applied material to adhere, thereby making handling of the freshly coated pipe much easier. The reinforcing mesh is readily repositioned in the coating material. The eyelet 134 shown in Figure 4
45 is raised to bring the mesh closer to the pipe, and can be lowered to be near the surface.

The foregoing is believed to fully and adequately describe operation of the embodiment 100. It can be adjusted in location as
50 a unit by rotation about the shaft 104. This adjusts the lead angle of the helical turns applied to the pipe. The entire apparatus can be raised and lowered by adjusting the location of the connective flange 106 on the
55 mounting shaft 104. When it is lowered or raised, it enables a greater or lesser thickness of coating material to be applied. This is particularly true since the pipe is supported at a fixed elevation relative to the conveyor
60 system. The apparatus can be used to control the precise location of the reinforcing mesh. This enables the mesh to provide optimum support to the coating material after it has been applied.

65 The entire apparatus can be positioned

with the roller located precisely below the pipe of offset. The roller and conveyor belt combination is able to smooth the entire width of the helical turn applied to the pipe. Indeed, the roller can be positioned below
70 the pipe and slightly to the side so that compaction is between the pipe and the conveyor belt, not the roller. It is not necessary to locate the roller far to the side, rather, the lateral displacement should be
75 just enough that the conveyor, appropriately supported and hence a planar surface or approximately so, provides full width support beneath the ribbon of material such that the helical turn is compressed across its full
80 width. Full width compression forms the smoothest surface. Thus, lateral displacement of the roller from a precise vertically fixed position is acceptable so long as a smoothing compression surface beneath the pipe is
85 included.

Compression of the slurry uses the weight of the pipe. The compressive load on the slurry is sufficient to remove bubbles and smoothly applying the coating. The strength
90 of the cured coating is enhanced.

The coating material is able to include large aggregate. For example, suppose a coating of eight centimeters is to be applied. The aggregate can be as large as the thick-
95 ness ideally; in practice, the maximum aggregate should not exceed one half the thickness of the coating. This permits two pieces of gravel aggregate to "stack" without creating a bulge in the aggregate. The likelihood of
100 three pieces stacking is so small as to be of no consequence.

WHAT WE CLAIM IS:—

1. An apparatus for placing coating material on a pipe which will move along a
105 path parallel to the pipe axis while rotating about that axis, which comprises a roller positioned approximately below the path of the pipe and having its surface spaced a pre-
110 determined distance from the exterior surface of the pipe, a conveyor belt arranged to move its outer surface towards and over said roller in endless fashion, means for receiving and dispensing by gravity flow a supply of coating
115 material on to the surface of the conveyor whereby the conveyor belt is arranged to carry coating material from the dispensing means towards a pipe for compression between the pipe and the conveyor belt and to
120 adhere to the pipe.

2. The apparatus of claim 1 including a supportive surface means beneath said conveyor belt for supporting said belt when a load of coating material is placed thereon.

3. The apparatus of Claim 2 including a vibrator for imparting vibration to the supportive surface and thus to material on the conveyor.

4. The apparatus of any of Claims 1 to 3 including a supply of reinforcing material for
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even where adjacent turns are crushed together at their edges, sufficient flow through the reinforcing members enables the reinforcing mesh to remain relatively fixed without deflecting along its edges. The adjacent turns of slurry comingle and increase in strength at the abutting edges of the applied coating material.

The outer wrap 132 is offset measurably. This exposes the margin on one edge of the freshly applied turn to enable it to be comingled with the next turn. In like manner, the opposite edge of the outer wrap 130 laps over the prior turn. Lapping over protects the previous turn and covers the margin of the previous turn, thereby covering the entirety of the pipe. This fact is brought out more clearly on viewing Figure 3. The margin is shown at 180. The outer wrap 132 is shown laterally displaced to the right of Figure 3. It is abutted against the secondary conveyor 160 which replaces the outer wrap momentarily and for a portion of the turn applied to the pipe. The outer wrap 132 thus covers over the margin 180 of the previous turn. The margin 180 is left so that the two adjacent turns are crushed together with the viscous material flowing sufficiently to enable a smooth joint to be made. There is no lump or mound formed at the point of overlap. The roller 110 and conveyor 112 are sufficiently wide to crush the two turns together and form a smooth outer surface. This it will be observed in Figure 3 that the turn then being applied is supported on its outer face by the conveyor and the roller and is laterally supported on its left and right. This enables good adherence to the pipe, consistency and coating density, and further causes the freshly applied material to adhere, thereby making handling of the freshly coated pipe much easier. The reinforcing mesh is readily repositioned in the coating material. The eyelet 134 shown in Figure 4 is raised to bring the mesh closer to the pipe, and can be lowered to be near the surface.

The foregoing is believed to fully and adequately describe operation of the embodiment 100. It can be adjusted in location as a unit by rotation about the shaft 104. This adjusts the lead angle of the helical turns applied to the pipe. The entire apparatus can be raised and lowered by adjusting the location of the connective flange 106 on the mounting shaft 104. When it is lowered or raised, it enables a greater or lesser thickness of coating material to be applied. This is particularly true since the pipe is supported at a fixed elevation relative to the conveyor system. The apparatus can be used to control the precise location of the reinforcing mesh. This enables the mesh to provide optimum support to the coating material after it has been applied.

The entire apparatus can be positioned

with the roller located precisely below the pipe of offset. The roller and conveyor belt combination is able to smooth the entire width of the helical turn applied to the pipe. Indeed, the roller can be positioned below the pipe and slightly to the side so that compaction is between the pipe and the conveyor belt, not the roller. It is not necessary to locate the roller far to the side, rather, the lateral displacement should be just enough that the conveyor, appropriately supported and hence a planar surface or approximately so, provides full width support beneath the ribbon of material such that the helical turn is compressed across its full width. Full width compression forms the smoothest surface. Thus, lateral displacement of the roller from a precise vertically fixed position is acceptable so long as a smoothing compression surface beneath the pipe is included.

Compression of the slurry uses the weight of the pipe. The compressive load on the slurry is sufficient to remove bubbles and smoothly applying the coating. The strength of the cured coating is enhanced.

The coating material is able to include large aggregate. For example, suppose a coating of eight centimeters is to be applied. The aggregate can be as large as the thickness ideally; in practice, the maximum aggregate should not exceed one half the thickness of the coating. This permits two pieces of gravel aggregate to "stack" without creating a bulge in the aggregate. The likelihood of three pieces stacking is so small as to be of no consequence.

WHAT WE CLAIM IS:—

1. An apparatus for placing coating material on a pipe which will move along a path parallel to the pipe axis while rotating about that axis, which comprises a roller positioned approximately below the path of the pipe and having its surface spaced a predetermined distance from the exterior surface of the pipe, a conveyor belt arranged to move its outer surface towards and over said roller in endless fashion, means for receiving and dispensing by gravity flow a supply of coating material on to the surface of the conveyor whereby the conveyor belt is arranged to carry coating material from the dispensing means towards a pipe for compression between the pipe and the conveyor belt and to adhere to the pipe.

2. The apparatus of claim 1 including a supportive surface means beneath said conveyor belt for supporting said belt when a load of coating material is placed thereon.

3. The apparatus of Claim 2 including a vibrator for imparting vibration to the supportive surface and thus to material on the conveyor.

4. The apparatus of any of Claims 1 to 3 including a supply of reinforcing material for



the coating and means for placing it along the exposed surface of said conveyor belt for contact with the coating material so that it will be placed on the pipe with the coating material.

5. The apparatus of any of Claims 1 to 4 including a supply of outer wrap material and means for placing it along the exposed surface of said conveyor belt so that it will be contacted on its upper surface with the coating material and placed on the pipe surrounding the coating material.

6. The apparatus of any preceding claim including a means for levelling the supply of coating material placed on said conveyor belt.

7. The apparatus of any of Claims 1 to 6 including a means for controlling the thickness of coating material carried on said conveyor belt from said dispensing means.

8. The apparatus of any preceding claim including a chamber in said receiving and dispensing means for receiving and temporarily holding a quantity of coating material to be dispensed onto said conveyor belt.

9. The apparatus of any of Claims 1 to 5 including a chamber in said receiving and dispensing means for storing a quantity of coating material to be placed on said conveyor belt, said chamber being at least partly defined by a wall spaced above said conveyor belt, and an adjustably positioned gate co-operative with said wall to vary the spacing above said conveyor belt, and means for moving said conveyor belt past said gate toward the pipe to carry a thickness of coating material defined by said gate on said conveyor belt beneath said gate toward the pipe.

10. The apparatus of Claim 9 wherein said gate is movable upwardly and downwardly to vary its spacing from said belt, and said receiving and dispensing means includes a pair of side walls extending to said belt at its exposed surface.

11. The apparatus of any preceding claim including means for raising and lowering said roller relative to the exterior surface of the pipe.

12. The apparatus of any preceding claim including means for raising and lowering a supportive surface means beneath said conveyor belt and said roller to vary the thickness of coating material applied to the pipe.

13. The apparatus of any preceding claim including a means for advancing and rotating the pipe relative to said belt such that in use said belt approaches the pipe at a speed approximating the tangential velocity of the pipe after the coating material has been applied.

14. The apparatus of Claim 1 including a source of coating material reinforcing mesh and means for supplying it parallel to and above the exposed surface of said conveyor

belt; and means for adjusting the height of the reinforcing mesh above said conveyor belt.

15. The apparatus of any of Claims 1 to 5 wherein said coating material dispensing means spans said conveyor belt from above and have a slot of adjustable height above said conveyor belt which adjustably controls the thickness of coating material placed on said conveyor belt.

16. The apparatus of any preceding claim including a smoothing roller means over said conveyor at a point after the coating material is placed on said conveyor belt and prior to adhering to the pipe, said roller means being arranged to smooth the coating material carried on said conveyor belt.

17. The apparatus of Claim 15 wherein said dispensing means includes an upstanding multiwalled container having one wall transverse across said conveyor belt and above said belt, and a vertically positionable gate which varies the thickness of coating material on said belt, and a smoothing roller means parallel to said gate and above said conveyor belt for smoothing the coating material on said belt.

18. The apparatus of any preceding claim including a support means for said roller which supports it for rotation about an axis in a plane parallel to the path of the pipe and which further positions the axis of the roller at an angle relative to the major dimension of the pipe to impart an angled feed of coating material to the pipe, thereby forming a helix of coating material around the pipe.

19. The apparatus of Claim 18 wherein said support means includes a pivot means which allows variation of said angle.

20. The apparatus of any of claims 1 to 4 wherein the pipe is arranged to be rotated and advanced to place the coating material on the pipe in a helical spiral and including means for placing an outer wrap on said conveyor below the coating material so that the wrap will be on the exterior of the helix after application; and, a supplemental belt means arranged for engaging the pipe at a location after coating with the coating material.

21. The apparatus of Claim 20 arranged so that the wrap of coating material will be offset laterally from the outer wrap and including means for rotating and advancing said pipe, said means having a helical advance which overlaps adjacent helical turns; means for offsetting said outer wrap as applied on each helical turn thereof; and, said supplemental belt means being located to overlay the coating material width after application, including that portion of coating material uncovered by the outer wrap.

22. A method of coating a pipe comprising the step of placing coating material by



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(18)

gravity feed on an endless conveyor which moves towards and over a roller beneath the pipe path and helically rotating the pipe for adhesive contact with the material as the endless conveyor is moved laterally under the pipe, to extend the coating around the pipe by helical turns while laterally supporting one turn to compress it between the conveyor and the pipe.

23. The method of Claim 22 including the step of placing a reinforcing mesh in the coating material at a specified height which is embedded by turns in the completed coating on the pipe.

23. The method of Claim 23 wherein adjacent turns of coating material are over-

lapped at their abutting edges to overlap the reinforcing mesh.

25. The method of Claims 22, 23 or 24 including the step of wrapping an external wrap about the coating material on the pipe which wrap is overlapped along adjacent edges.

26. An apparatus for placing coating material on a pipe substantially as described herein with reference to and as illustrated in the accompanying drawings.

For the Applicants,
A. SPENCE & CO.,
Chartered Patent Agents,
114, Downlands Road,
Purley, Surrey, CR2 4JF.

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