United States Patent

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[54] **METHOD AND APPARATUS FOR COATING TUBULAR OBJECTS**
11 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **214/338,** 117/94, 118/320
[51] **Int. Cl.** **B65h 51/00**
[50] **Field of Search** ..... 214/338, 339, 1-P, (Hollow Cylinder & Pipe Handling), (Roll Handling), (Coil, Ring & Perforated Article Handling); 118/320, 318, 321, 500, 501

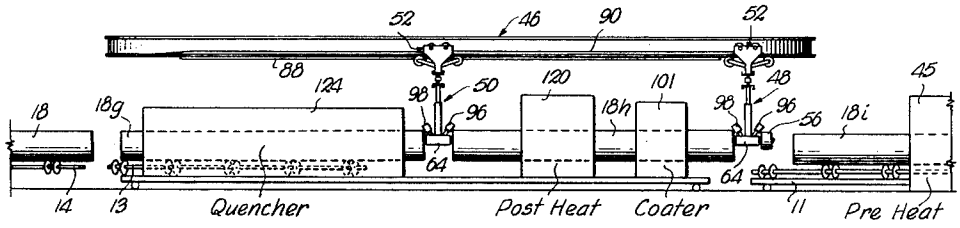
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Primary Examiner—Hugo O. Schulz
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ABSTRACT: A relatively high speed, continuous method and novel apparatus, especially adapted to large diameter steel pipe, for applying external thin-mill coatings, such as thermal setting epoxy and epoxy resins, wherein the pipe sections are successively advanced in a train and continuously rotated through numerous operating stations, and embodying a changeover from an external roller drive line to an internal conveyor system. The pipe overhead suspension system permits even mill coating over the complete surface of the pipe and precludes damage to the coating during curing and while it is in the critical fluid state.



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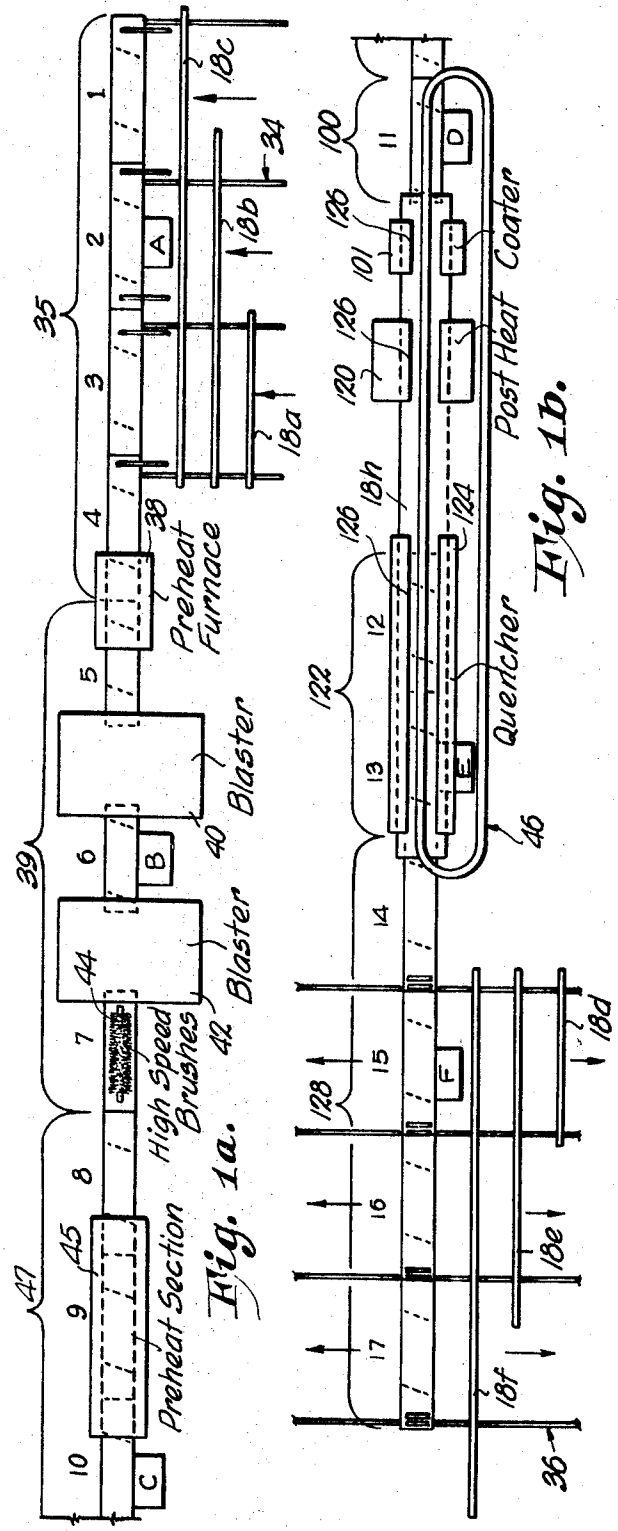


Fig. 1a.

Fig. 1b.

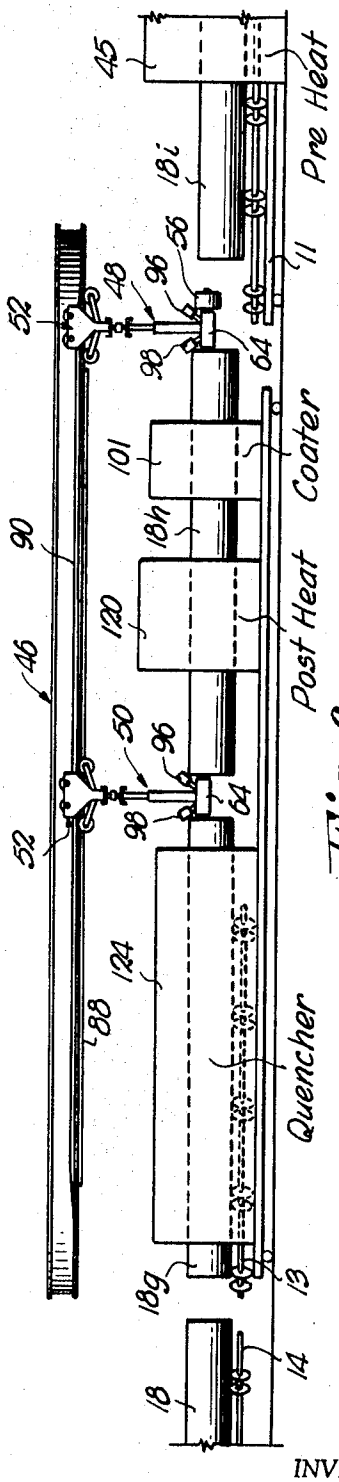


Fig. 2.

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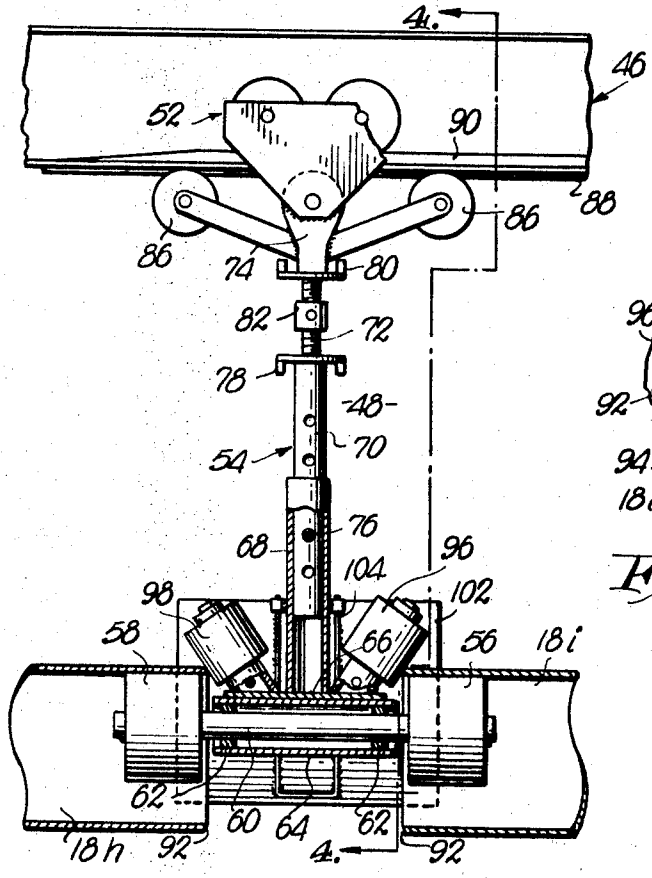


Fig. 3.

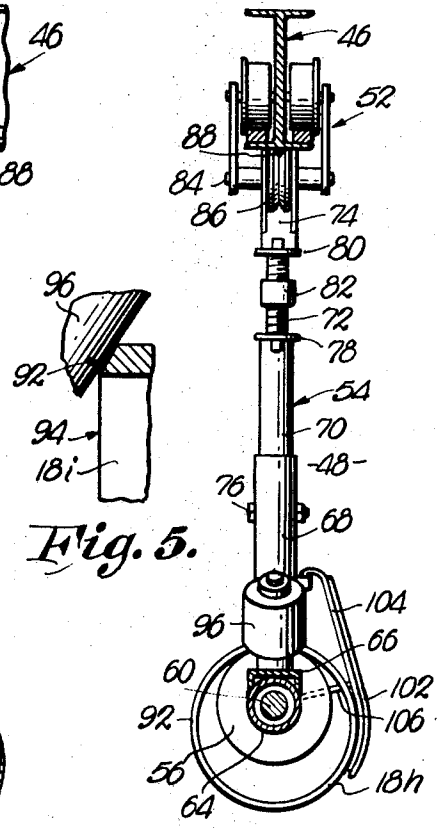


Fig. 4.

Fig. 5.

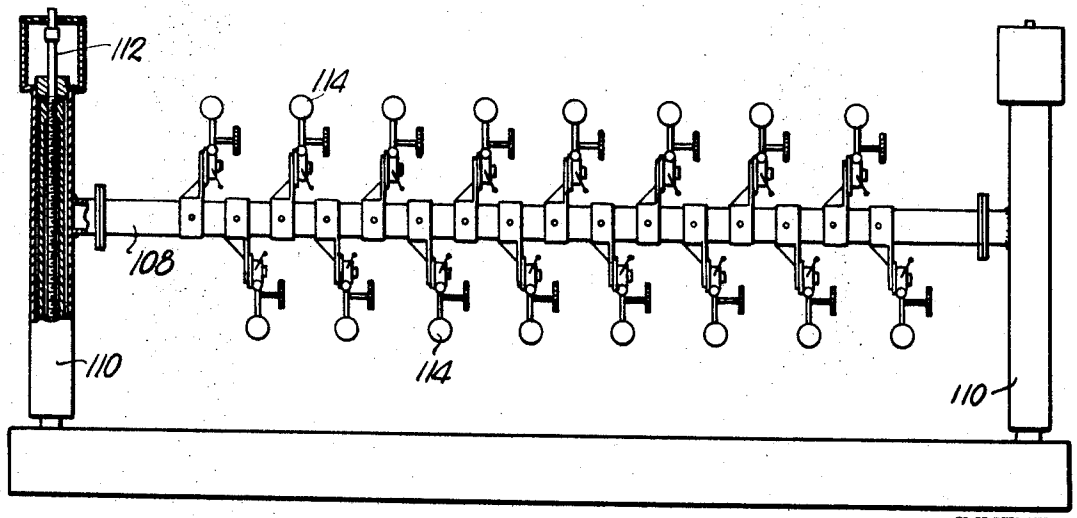


Fig. 6.

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PATENTED JUN 1 1971

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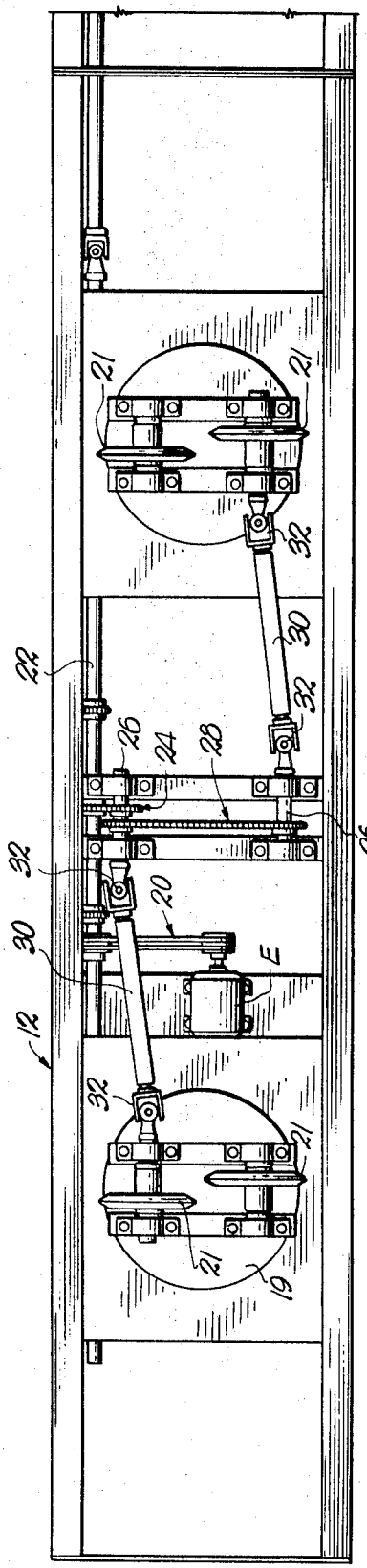


Fig. 7.

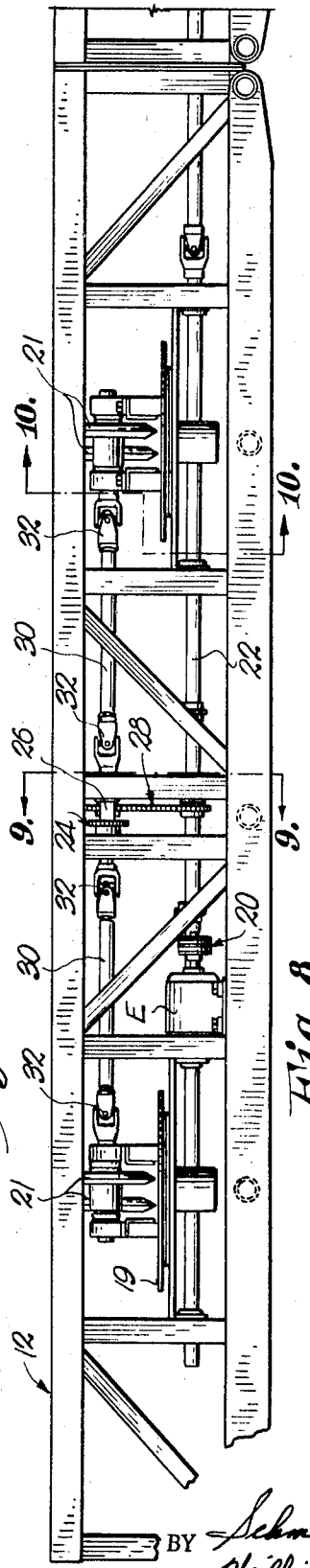


Fig. 8.

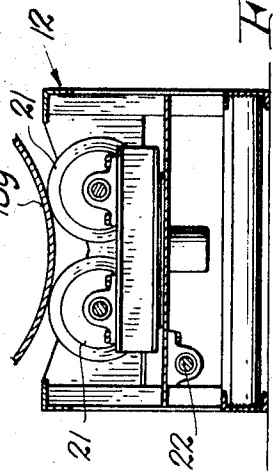


Fig. 10.

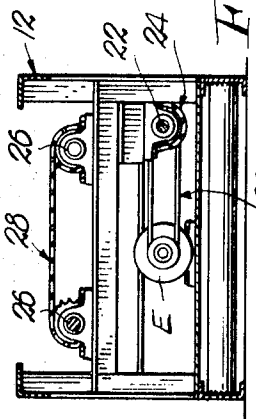


Fig. 9.

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METHOD AND APPARATUS FOR COATING TUBULAR OBJECTS

It is an important object of the present invention to provide a simple, rapid and inexpensive, continuous pipe coating system, involving six separate, automated operations of preheating, cleaning, heating to a desired temperature, powder coating, fast curing, and quenching, wherein the bare pipe enters at one end of the assembly, proceeds without interruption in a straight line while it is continuously rotated, and emerges fully coated and ready for loadout, at a relatively high rate of approximately 22 feet per minute, for example, all with the assurance that the coating has been uniformly applied throughout the outer surface of the pipe and has not been damaged in any manner during the process by the novel equipment employed in the assembly, or otherwise.

Another important object of the instant invention is the provision of unique internal support means for the pipe, placed in the system at the zones of coating and curing, and operable to continue the linear advancement and rotation without interruption, coupled with the outstanding advantages of even coating and absolute protection against damage until the coating is capable of withstanding external support of the pipe. In the drawings:

FIG. 1*a* is a schematic plan view showing a portion of a system or assembly embodying the apparatus for coating tubular objects of the present invention and illustrating the method employed through use of such apparatus;

FIG. 2 is a side elevational view, partially schematic, showing a portion of the apparatus, including the overhead suspension system;

FIG. 3 is an enlarged, fragmentary view similar to FIG. 2, partially in section, showing one of the pipe suspension units;

FIG. 4 is a cross-sectional view taken on line 4–4 of FIG. 3;

FIG. 5 is a detailed cross-sectional view of a portion of FIG. 3, still further enlarged;

FIG. 6 is an elevational view of the coating unit;

FIG. 7 is a plan view of one of the external pipe-supporting and rotating sections;

FIG. 8 is a side elevational view of the structure shown in FIG. 7; and

FIGS. 9 and 10 are cross-sectional views taken on lines 9–9 and 10–10 respectively of FIG. 8. A number of identical units 1—17 inclusive, shown in FIGS. 1*a* and 1*b*, are each adapted to support the pipe 18 from therebeneath in contact with its outer surface through use of longitudinally spaced pairs of peripherally beveled rollers 21 that are laterally spaced and relatively offset (see FIGS. 7—10 showing unit 12 by way of example). One roller of each pair is driven by a motor such as motor E (preferably hydraulic) through belt and pulley means 20, jack shaft 22, intermeshing gears 24, stub shafts 26, chain and sprocket wheel means 28 and coupling shafts 30 provided with universal joints 32. Accordingly, the unit 12 not only rotates the pipe 18*g* continuously about its horizontal, longitudinal axis but advances the pipe 18*g* without interruption along a linear path of travel that is parallel with such axis. Some of the motors are of the variable speed type, as will be subsequently explained.

The system embodies, as aforesaid, an aligned series of 17 such units, so designated 1—17 inclusive in FIGS. 1*a* and 1*b*, driven by six motors, marked A—E inclusive. Motor A drives units 1—4 inclusive through a common jack shaft 22. In a similar manner, motor B drives units 5—7; motor C drives units 8—10; motor D drives unit 11; motor E drives units 12 and 13; and motor F drives units 14—17.

The incoming bare pipe sections 18 of various sizes (for example, 6—42 inches inside diameters) and of various lengths (Fig. 1*a* shows, for example, three pipe sections 18*a*, 18*b* and 18*c* that are 20, 40 and 60 feet long, respectively) are loaded on rack 34 for transfer to a first station 35 (units 1—4). The coated pipe sections 18*d*, 18*e* and 18*f* are shown in FIG. 1*b* transferred from units 15, 16 and 17 to another rack 36 ready for loadout.

The tandem roller units 1—4 continuously rotate the sections 18, and advance the same one at a time without interruption at a variable rate of speed, but generally at about 60 feet per minute (i.e., an increment of advancement per revolution, controlled by the location of the support rollers 21, which may be adjusted by the rotation of disc mounting means 19 shown partially in FIGS. 7 and 8) to a preheat furnace 38 to raise the temperature of the pipe to approximately 100° F. to remove moisture, all, of course, depending also upon humidity conditions at the time of operation.

At a second station 39 the units 5—7 move the sections 18 through a pair of blasters 40 and 42. These two blast machines clean the pipe, i.e., remove all rust and mill scale, leaving a surface which will form a high strength bond with the epoxy or plastic resin coating later to be applied. The relatively sharp grit used in blaster 40 to effectively clean the pipe leaves an anchor pattern that is normally too deep. Therefore, shot is employed in blaster 42 to peen or smooth out the exterior surface of the pipe.

In order to avoid loss of the abrasives through the pipe inlets and outlets of blasters 40 and 42, the ends of the pipe sections 18 are brought close together though not in abutment. Such close spacing (approximately one-sixteenth of an inch) is maintained by the operator who controls the variable speed of the motor A. Before the sections 18 leave the second station 39 they are subjected to the last cleaning operation, i.e., to high speed brushes 44 (about 1800 r.p.m.) which remove all abrasive that has become embedded in the pipe.

While the sections 18 are on the rack 34 their ends are closed by removable plugs (not shown) to avoid collection of abrasive therewithin. These plugs are removed before the pipe sections 18 move to a third station 47 by slowing down the variable speed motors A and B to about 25 feet per minute for a sufficient period of time to present a gap of about 3 feet between the sections 18.

At the third station 47 the units 8—10 advance the sections 18 through an infrared preheat oven 45 which raises the metal temperature to about 350° F. At this juncture there is a changeover to an internal support of the pipe sections 18, reference now being had to FIGS. 1*b* and 2—5.

A support in the nature of an oblong overhead track 46 (FIG. 1*b*), consisting of an H-beam (FIG. 4), having one of its longitudinal stretches spaced above and in alignment with the linear path of the sections 18, is adapted to receive a plurality of identical hangers or carriers in suspended relation thereto. Only two carriers, designated 48 and 50 respectively, have been shown in the drawings. Manifestly, sufficient carriers are provided to insure uninterrupted advancement of the pipe sections. Five such carriers have been found adequate for an operation proceeding at the speeds described herein. Hanger 48 has a wheeled trolley structure 52 on track 46 from which depends apparatus 54, including a vertically extensible upright, for varying the height of a pair of rotatable devices 56 and 58 in the nature of rollers fixed to a shaft 60.

Shaft 60 is carried by bearings 62 within a horizontal tube 64 that is in turn secured rigidly to a crosshead 66 rigid to the lower end of a vertical tube 68. In addition to tube 68, apparatus 54 includes a rod 70 (telescoped in tube 68), a screw 72 and a nut 74. Crossbolts 76 pass through selected cross holes in tube 68 and rod 70 to permit vertical adjustment to accommodate pipes of any of a number of diameters. The upper end of rod 70 is tapped to receive screw 72, and locknuts 78 and 80 on screw 72 bear against rod 70 and nut 74 respectively. A suitable tool passing through head 82 of screw 72 may be used to make fine adjustments of the distance between rod 70 and nut 74.

Nut 74 hangs from trolley 52 by means of a cross pin 84 and has a pair of opposed pulleys 86 which ride along guide strip 88 on track 46 so as to maintain shaft 60 horizontal as well as parallel with the longitudinal axes of pipe sections 18. If desired, track 46 may also be provided with risers 90 within the paths of the trolley wheels for purposes hereinafter explained.

Pipe sections 18 are normally provided with an external, circumferential 60° chamfer 92 at each of their ends, each ter-

minating in an outermost, annular feather edge **94** which must be protected because such edges **94** are held in abutment during welding of the sections **18** together in ultimate use. Such protection is afforded by use of a pair of roller retainers **96** and **98** on tube **64** set at an incline of about 55° so as to abut chamfers **92** remote from and in spaced relation to edges **94** as best seen in FIG. **5**.

Referring now again to FIGS. **1***b* and **2**, the operator initially manipulates the carrier **48** to insert its roller **56** into the leading end of a pipe section **18** emanating from unit **11** at the fourth station **100**. Continued advancement of the pipe section by unit **11** moves the carrier along track **46** with the leading end of the pipe section supported on the track by the carrier. While the trailing end of the pipe section is supported on unit **11** and after the trailing end moves beneath track **46**, another carrier **50** is manipulated around the track to a position where its roller **58** is inserted into the trailing end of the pipe section. The rate of advancement of the next succeeding pipe section **18** is then increased by increasing the speed of motor D to bring the leading end of this section into coupled relationship over roller **56** of carrier **50**.

Noteworthy in FIG. **2** is the fact that such procedure has previously taken place with respect to section **18***g*. Thus, pipe section **18***h* is shown supported by rollers **56** and **58** of carriers **50** and **48** respectively. In FIG. **2** also, the section **18***g* is shown supported by roller **58** of carrier **50**, as well as by units **12** and **13**. Chamfers **92** of sections **18***g* and **18***h* bear against the rollers **98** and **96** respectively of carrier **50**. Both rotation and advancement of section **18***g* by the units **12** and **13** are transmitted to section **18***h* through shaft **60** of carrier **50**.

In FIG. **2**, after insertion of roller **58** of carrier **48** into rotating section **18***h*, as shown, the motor D is speeded up to advance the pipe at about 60 feet per minute so as to thread the rotating section **18***i* onto the roller **56** of carrier **48**. As soon as the chamfer **92** of section **18***i* abuts the roller **96** of carrier **48** (FIG. **3**) both rotation and advancement of section **18***h* are transmitted through shaft **60** of carrier **48** from section **18***i*, the speed of the latter having been reduced to about 22 feet per minute. As soon as the trolley **52** of carrier **48** reaches riser **90** the rollers **58** and **56** of carrier **48** tighten against the sections **18***h* and **18***i* therewithin as shown in FIG. **3**.

Before the hangers **48** and **50** traverse coater **101** the operator places a cutback asbestos shield **102** thereon which is so shaped as to cover the rollers **96** and **98** and the ends of the pipe sections **18***h* and **18***i* as shown in FIGS. **3** and **4**. Rod support **104** for shield **102** has its upper ends hooked over tube **68** and is provided with a lateral extension **106** which bears against tube **64**.

Within the coater **101** there is provided, as shown in FIG. **6**, a manifold **108**, carried by standards **110** which may be vertically adjusted by screw **112**. Two rows of eight guns **114** each on manifold **108** direct the epoxy coating powder in one direction against the rotating pipe sections **18** as they pass through coater **101**.

The temperature of the pipe sections **18** in the coater **101** is approximately 325° F. which is sufficiently high to flow the epoxy or thermosetting plastic powder (such as vinyl) onto the pipe sections **18** and effect the electrostatic coating thereof. Such temperature is not high enough, however, to cure the coating, permitting adequate flow time to provide better coverage with a uniform coat of about 9 to 12 millimeters. The two banks of guns **114** and the spaced guns **114** themselves place successive layers of the powder onto the rotating pipe sections **18** as they pass along the manifold **108**.

By the time the coating reaches post cure oven **120** it is relatively solid and at this point the temperature is raised by infrared heaters to roughly 450° F. where curing takes place rather quickly. Many materials of the kind contemplated herein will not cure below 400° F.

The shield **102** accomplishes the objectives of keeping the powder from entering the pipe ends as it passes the coating station **101**, protecting the hangers **48** and **50** from being coated, and preventing contamination of the chamfers **92**.

After the pipe leaves the post heat station **120** it passes to a seventh station **122** containing a quencher **124** wherein, through a water bath or otherwise, the temperature is quickly and appreciably lowered. Note the longitudinal slots **126** in the tops of coater **101**, oven **120** and quencher **124** (FIG. **1***b*) which clear the hangers **48** and **50**. As the pipe emerges from quencher **124**, shield **102** is removed, the powder is stripped therefrom, and shield **102** returned to the front of the line for reuse.

Motor F is of the variable speed type so that the speed of advancement of the pipe sections may be increased when they reach station **128**. The operator thereby causes a gap to occur between the ends of adjacent sections when the ends are located between units **13** and **14**. An operation can then remove the carriers **48** or **50**, previously intercoupling the ends, since the pipes are now supported on the external support rollers. The carrier is manually moved around the track to a ready position adjacent unit **11** for use in the sequence described above.

Finally, from station **128** the coated sections **18***d*, **18***e* and **18***f* are transferred to rack **36** ready for loadout.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent is:

1. In a pipe coating assembly,
- a support;
- a carrier for each end respectively of an elongated pipe section to be coated,
- each carrier having a rotatable device adapted for insertion into the pipe section at the corresponding proximal end of the latter in supporting relation to the pipe section;
- mechanism for each device respectively rotatably attaching the same to its carrier, whereby the pipe section is rotated in response to rotative motion imparted to at least one of the devices; means for rotating at least one of said devices; and
- structure for each carrier respectively mounting the same on said support for movement along a predetermined path of travel, whereby the pipe section may be advanced along said path and simultaneously rotated as its exterior is coated.

2. The invention of claim **1**, said support including an overhead track, said structures suspending the carriers from the track.

3. The invention of claim **2**,
- each carrier having vertically extensible apparatus for varying the height of the devices.

4. The invention of claim **1**,
- said support including an overhead track,
- said structures each including an upright suspending the carriers from the track; and
- means having interengageable parts on the track and on the uprights respectively for maintaining the axes of rotation of the devices in parallelism with the longitudinal axis of the pipe section.

5. The invention of claim **1**,
- and a retainer rotatably secured to each carrier respectively and disposed for engagement with the pipe section at the proximal end of the latter, whereby to prevent movement of the pipe section along its longitudinal axis relative to the devices.

6. The invention of claim **5** wherein the pipe section has an external, circumferential chamfer at each of said ends thereof respectively, each chamfer terminating in an outermost, annular feather edge,
- said retainers being disposed for engagement with the chamfers remote from and in spaced relationship to said edges.

7. In a pipe coating assembly, a row of aligned pipe supports disposed for continuous advancement in successive order of a train of elongated pipe sections to be coated along an essentially horizontal path of travel in substantial parallelism with the longitudinal axis of the sections, said supports including:
- a first support adapted for engagement with the sections therebeneath,

said first support having means for advancing the sections along said path and simultaneously rotating the sections about said axis;

a second support disposed to receive the sections as they emanate from the first support and including:

an overhead track extending along said path,

a pair of carriers suspended from the track for movement therealong, and

a pair of opposed rollers mounted on each carrier respectively for rotation about axes parallel with said axes of the sections; and

a third support disposed to receive the sections as they emanate from the second support and adapted for engagement with the sections therebeneath,

said third support having means for advancing the sections along said path and simultaneously rotating the sections about said axes of the sections,

each carrier being adapted for disposition between a pair of sections at the ends thereof with the rollers extending into the sections, exposing the exteriors of the sections for coating while the same are suspended from the second support,

said track having means for raising the carriers as they travel along the track to place the rollers into supporting relationship to the sections,

each pair of rollers being interconnected for rotation together as a unit, whereby rotation is imparted to one section supported by the carriers therebetween from a

second section supported by the first support and by one of the carriers, and rotation is also imparted to said one section from a third section supported by the third support and by the other of said carriers.

8. The invention of claim **7** wherein is provided retainer means on each carrier respectively rotatably engaging the ends of the sections supported by the rollers thereof whereby the advancing means of the first support pushes the carriers along the track toward the third support.

9. The invention of claim **8** wherein each pipe section has an external, circumferential chamfer at each of said ends thereof respectively, each chamfer terminating in an outermost, annular feather edge,

said retainer means being disposed for engagement with the chamfers remote from and in spaced relationship to said edges.

10. The invention of claim **7** wherein the first support is provided with means for varying the speed of advancement of the section carried thereby whereby to increase the distances between the sections prior to insertion of the carriers therebetween.

11. The invention of claim **7** wherein the third support is provided with means for varying the speed of advancement of the section carried thereby whereby to increase the distances between the sections prior to removal of the carriers from therebetween.