FLUIDIZED COATING OF PIPE

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Fig.1.

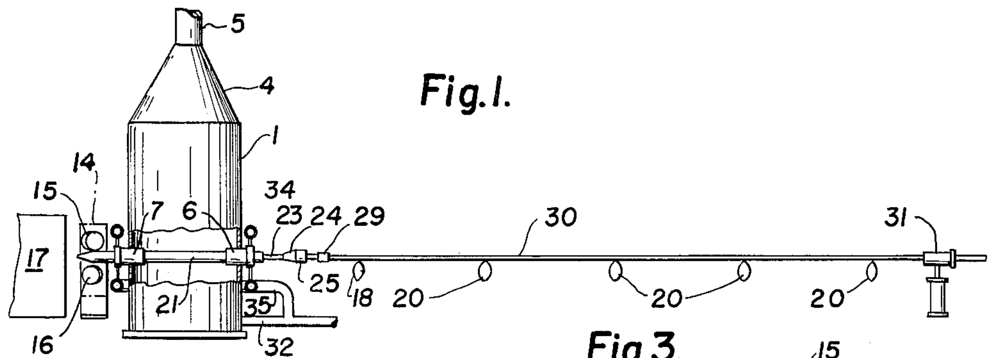


Fig.3.

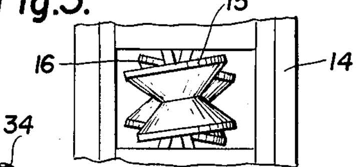


Fig.2.

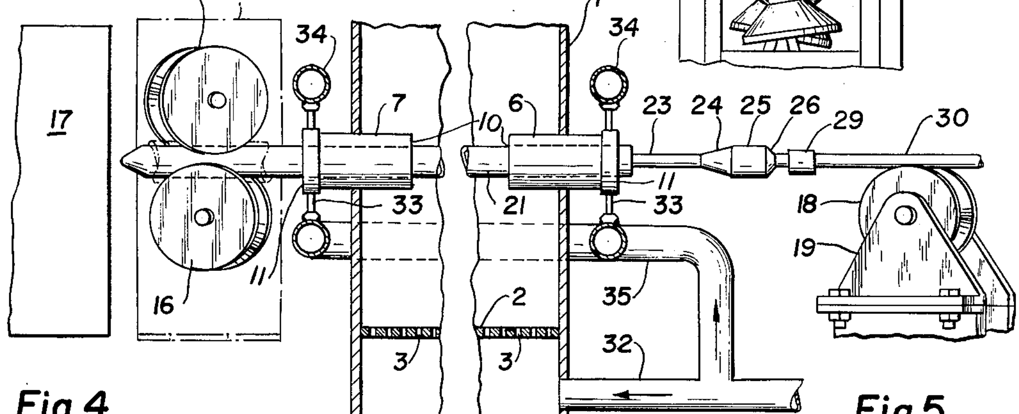


Fig.4.

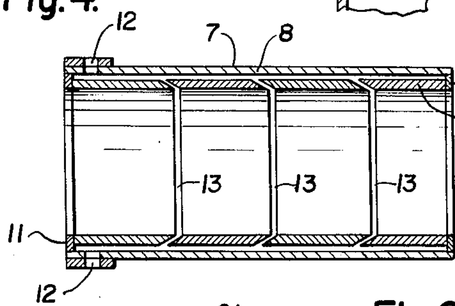


Fig.5.

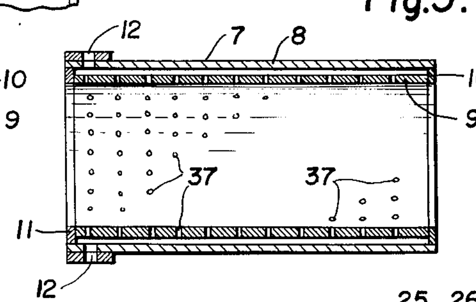
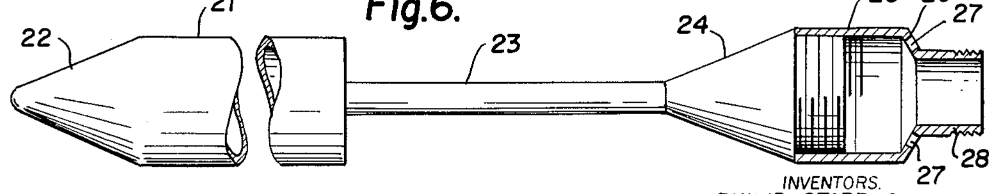


Fig.6.



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FLUIDIZED COATING OF PIPE

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Our invention relates to a process for coating the exterior of metal tubes or pipes with thermoplastic resins and the like, and to apparatus therefor. It is more particularly concerned with method and apparatus for progressively coating elongated pipes and continuously coating a succession of such pipes one after another.

It is known to coat metal articles with polyethylene, nylons, and like thermoplastic materials by dipping the heated article into a fluidized bed of fine particles of the coating material. Such a process is disclosed in U.S. Patent 2,844,489 issued to E. Gemmer on July 22, 1958. The process there described is unsuitable for elongated articles because the fluidized bed of coating material particles must be large enough to enclose the article in its entirety. It is an important object of our invention to provide a process and apparatus for progressively coating a long pipe or tube by passing it lengthwise through a fluidized bed of solid discrete particles of the coating material.

It is another object of our invention to provide a process and apparatus for heating a pipe, passing it through a fluidized bed of coating material particles so as to form progressively a coating on the pipe, and rapidly cool the coated pipe so that its coated surface is not marked by conveyor rolls and the like. It is another object of our invention to provide process and apparatus for passing an elongated article through a fluidized bed without permitting particles of the bed to escape therefrom. Other objects of our invention will become apparent from the following description thereof.

If an article to be coated is heated to a temperature somewhat above the melting point of the coating material and is then introduced into a fluidized bed of unheated particles of that material, individual particles of the coating material will adhere to the hot surface of the article and melt thereon so as to fuse with other particles into a continuous coating. The coated article cannot immediately make contact with any supporting means because the hot coating is soft and easily marked or scraped off. The heated article, particularly if it is a small diameter metal pipe or tube, has a tendency to sag between supports and this tendency places a limit on the distance between the points of support for the freshly coated pipe. We have found that metal pipe must be rapidly cooled or quenched immediately after it is coated if the coating is to be applied progressively. We have found that inside cooling or quenching of metal pipe is several times as effective as outside quenching. We have also found that the means for internally quenching the pipe can be a part of a mandrel over which the pipe passes through the fluidized bed.

An embodiment of the apparatus of our invention presently preferred by us is illustrated in the attached figures to which reference is now made.

FIGURE 1 is a schematic elevation of our apparatus.

FIGURE 2 is an elevation partly in section of the mandrel and associated apparatus of our invention which defines the path of travel of the pipe through the coating chamber.

FIGURE 3 is a plan view of the guide rolls of FIGURE 2.

FIGURE 4 is an elevation in section through a port of our invention.

FIGURE 5 is an elevation in section through a port of another design.

FIGURE 6 is an elevation partly in section of a portion of our mandrel and quenching apparatus.

The coating of the pipe takes place in a tank or chamber 1 having a bottom plate 2 provided with perforations 3—3 smaller in diameter than the particles of the coating material. Chamber 1 below bottom plate 2 is connected to a source of air under low pressure, not shown, through duct 32. The top of chamber 1 is closed by a hood 4 that tapers upwardly and inwardly to an exhaust duct 5 which is connected to a suction fan, not shown. Chamber 1 is provided with entry port 7 and exit port 6 for the pipe to be coated, these ports being positioned opposite each other at a level intermediate bottom plate 2 and hood 4 of chamber 1.

Ports 6 and 7 are of identical construction, and are shown in detail in FIGURE 4. Each port comprises a tubular inner wall 9 surrounded by a tubular outer wall 8 spaced therefrom. Outer and inner walls 8 and 9 are connected by a annular wall 10 at their ends which are inside chamber 1 and by an annular wall 11 at their outer ends. Radial openings 12—12 are provided in outer wall 8 near end 11 and connect through pipes 33—33 to manifold 34 which, through duct 35, communicates with a source of air under low pressure, not shown. Inner wall 9 is provided with inclined annular slots 13—13 extending around substantially the entire circumference of inner wall 9. The slots are inclined toward chamber 1 from outside to inside of inner wall 9. Ports 6 and 7 are positioned in the walls of chamber 1 so that they can be adjusted toward or away from each other along their common longitudinal axis, as is desired.

A roll stand 14 in which are journaled upper guide roll 15 and lower guide roll 16 is positioned adjacent entry port 7. Rolls 15 and 16 have V-grooved surfaces, and are mounted on horizontal axes which are skewed with respect to each other in plan, as is shown in FIGURE 3. The axes of rolls 15 and 16 are each skewed with respect to the common axis of ports 6 and 7, but in opposite senses. It is known that a pipe passing over a skewed V-grooved roll will be caused to rotate about its own axis thereby.

A pipe heating furnace 17 is positioned adjacent roll stand 14.

Adjacent exit port 6 and spaced therefrom along the projected common axis of ports 6 and 7 is a conveyor roll 18 which is identical with roll 16 previously described. Roll 18 which is journaled in stand 19 at the same angle of skew as roll 16 is followed by successive conveyor rolls 20—20, spaced from each other along the projected common axis of ports 6 and 7. Rolls 20—20 are identical with rolls 16 and 18, and together with rolls 16 and 18 provide a path of travel for pipe.

A mandrel 21 extends through ports 6 and 7 and into the space between rolls 15 and 16, and in the absence of a pipe is supported by those ports and roll 16. The free end 22 of mandrel 21 is tapered to a rounded point, and is spaced from heating furnace 17. Mandrel 21 is of a diameter slightly less than the inside diameter of the pipe to be coated so that the pipe will slide over the mandrel, and is conveniently hollow. Mandrel 21 is attached to rod 23 which through tapered portion 24 is attached to a hollow spray head 25. Spray head 25 is of substantially the same outside diameter as mandrel 21, and is connected to a smaller diameter water pipe 28 spaced therefrom. The annulus 26 which connects spray head 25 with water pipe 28 is a frustum of a shallow cone and is provided with openings 27—27 circumferentially spaced from each other so as to direct sprays of water against the inside of pipe passing over spray head **25**, away from coating chamber **1**.

Pipe **28**, through coupling **29** is connected to water supply pipe **30**. At a distance from chamber **1** pipe **30** is supplied with water by means **31** which are rapidly connected to and disconnected from pipe **30**.

An alternative form of port is shown in FIGURE 5. It is similar to that of FIGURE 4, except that inner wall **9** is provided with perforations **37—37** smaller in diameter than the particles of the coating material.

The process of our invention will now be described with reference to the above described and illustrated apparatus. Dry pulverulent coating material is charged into chamber **1** on bottom plate **2**. The charge is adjusted so that its top surface is just below ports **6** and **7**. Lengths of pipe to be coated are heated in furnace **17** to a temperature sufficient to sinter the coating material in chamber **1**. A heated pipe from furnace **17** is passed between rolls **15** and **16** and over tapered end **22** of mandrel **21** into entry port **7**. As the pipe enters port **7** air is introduced into chamber **1** through ducts **32** and **35**, and the suction fan connected to duct **5** is started up. Air sweeps into chamber **1** through the space between the pipe and inner wall **9** of port **7** and the space between mandrel **21** and inner wall **9** of port **6**. Air also enters chamber **1** through perforations **3—3** in bottom plate **2**. These air streams fluidize the bed of particles of coating material, and cause its upper surface to rise above ports **6** and **7**. The heated pipe, rotating about its axis, moves through this fluidized bed, over mandrel **21**, and becomes coated with particles of the coating material which sinter with each other and fuse together to form a continuous homogeneous coating on the pipe.

The sweep of air into chamber **1** through ports **6** and **7**, aided by the air blown through slots **13—13** in inner wall **9** of ports **6** and **7** creates an air curtain or seal that prevents particles of the coating material from escaping through the clearance space between the pipe and ports **6** and **7**.

When the leading end of a pipe carrying a hot coating emerges from port **6** and passes over spray head **25** water is supplied thereto through pipe **30**. The water leaves spray head **25** through openings **27—27** as jets or sprays directed against the inside of the hot pipe and away from chamber **1**. The hot coating is therefore cooled from the inside out, and is hard when the leading end of the pipe reaches conveyor roll **18**. The pipe then proceeds over successive rolls **20—20** until the full length has been progressively coated and quenched. The inclined sprays from openings **27—27** of spray head **25** cause the quenching water to flow along the pipe in the space between the pipe and water pipe **30**, and out the leading end of the pipe as it passes over rolls **20—20**.

When the trailing end of the pipe has emerged from port **6** the air pressure and the suction fan are shut off. Means **31** is disconnected from water pipe **30** and the coated pipe is withdrawn over water pipe **30**.

The distance between roll **16** and roll **18**, between which the pipe is unsupported, is small compared with the length of the pipe. The leading end of the pipe, which is cantilevered until it reaches roll **18**, is more than counterbalanced by the remainder of the pipe in the heating furnace **17**, and is stiffened by mandrel **21** which initially is colder than the pipe. The hot coating therefore does not scrape against port **6**, and is hardened by spray **25** before it reaches roll **18**.

We find that in coating ordinary steel merchant pipe the heat stored in the pipe is entirely sufficient to sinter the particles of coating material together into a homogeneous coating, and that the pipe can be quenched as soon as it leaves the coating chamber.

We find that in coating ordinary steel merchant pipe the coating hardens or solidifies much faster if the pipe is quenched from the inside than if the quenching liquid is delivered directly to the plastic coating on the outside of the pipe. With inside quenching ordinary sizes of pipe can be progressively coated at least three times the speed possible with outside quenching.

We claim:

1. The process of providing pipe with a homogeneous sintered coating formed from dry, pulverulent solid material comprising heating the pipe to a temperature above the sintering temperature of the coating material, progressively moving the heated pipe axially along a horizontal path over a supporting mandrel through a fluidized bed of the coating material and rotating the pipe about its axis, whereby a uniform, homogeneous layer of coating material is progressively formed on the pipe, and without re-heating the pipe supplying cooling fluid to the coated pipe whereby the coating material is progressively solidified on the pipe.

2. The process of claim **1** in which the cooling fluid is supplied to the interior of the pipe.

3. The process of claim **1**, including the steps of closing off the leading end of the pipe as it enters and passes through the fluidized bed and closing off the trailing end of the pipe as it passes through and leaves the fluidized bed.

4. The process of claim **2** in which the cooling fluid is supplied to the interior of that part only of the pipe which has moved out of the fluidized bed.

5. The process of providing pipe with a homogeneous sintered coating formed from dry, pulverulent solid material comprising heating the pipe to a temperature above the sintering temperature of the coating material, moving the heated pipe axially along a horizontal path through a closed chamber containing a bed of dry, pulverulent solid coating material the upper surface of which is below the pipe, rotating the pipe about its axis during its movement through the chamber, introducing a fluidizing gas into the bottom of the bed at a pressure sufficient to fluidize the bed and cause its free surface to rise above the pipe, whereby a uniform homogeneous layer of coating material is progressively formed on the pipe, and introducing fluidizing gas into the chamber around the pipe at a pressure sufficient to prevent the escape of the pulverulent coating material.

6. Apparatus for providing pipe with a homogeneous sintered coating formed from dry, pulverulent solid material comprising a closed chamber adapted to contain a bed of the dry, pulverulent solid material, a bottom for the chamber provided with means for introducing a gas to fluidize the bed of the dry, pulverulent solid material, entry and exit ports in opposite sides of the chamber intermediate the top and bottom thereof aligned to provide a horizontal path of travel for pipe through the chamber, means for moving the pipe along the horizontal path of travel through the chamber and for rotating the pipe about its axis, and a mandrel positioned along the path of travel away from the chamber and extending through the exit port into the entry port so that the pipe passes over the mandrel as it passes through the chamber.

7. Apparatus of claim **6** in which the entry and exit ports are sleeves provided with means for introducing a gas to fluidize the bed.

8. Apparatus of claim **6** in which the entry and exit ports are double-walled sleeves provided with channels from outside to inside of the sleeve inner wall inclined toward the chamber, and including means for introducing fluidizing gas into the space between the sleeve inner and outer walls.

9. Apparatus of claim **6** in which the entry and exit ports are double-walled sleeves, the inner wall being provided with a plurality of openings smaller in diameter than the particles of the pulverulent solid material.

10. Apparatus of claim **6**, including a cooling fluid conduit positioned along the path of travel and connected to the mandrel, a nozzle at the connected end of the conduit provided with channels from inside to outside of the nozzle inclined away from the mandrel, and means for introducing cooling fluid under pressure into the conduit.

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