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METHOD FOR EXTERNAL COATING OF CYLINDRICAL OBJECTS

Filed Nov. 6, 1970

FIGURE 1

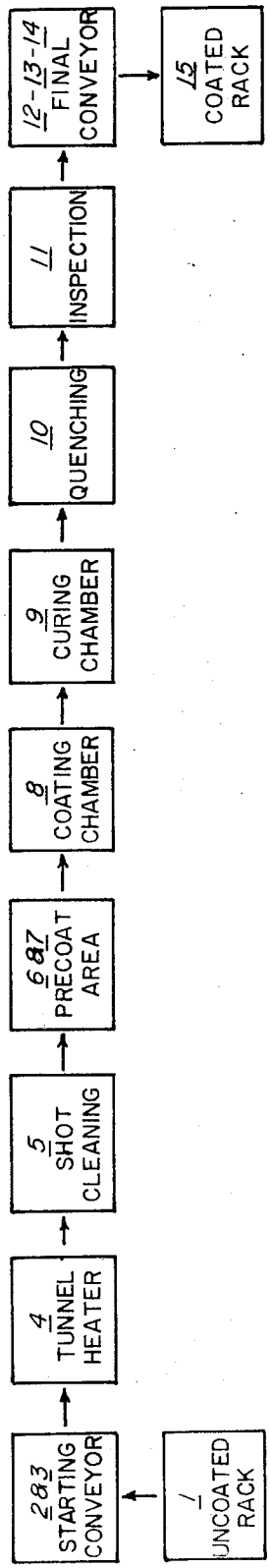


FIGURE 2

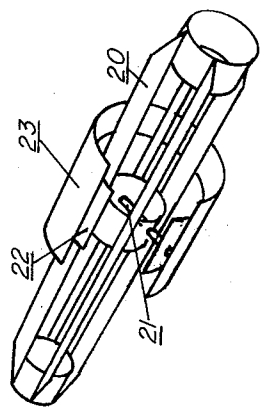
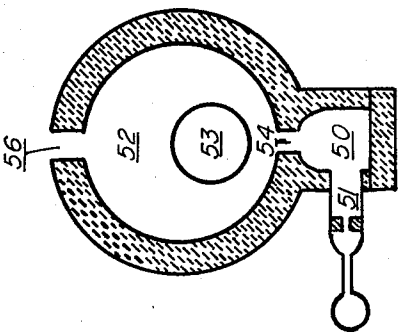


FIGURE 3



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METHOD FOR EXTERNAL COATING OF CYLINDRICAL OBJECTS

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ABSTRACT OF THE DISCLOSURE

An improved method and apparatus for the external coating of cylindrical objects in such a manner to accomplish the entire process including heating and surface preparation, coating application, curing, quenching and inspection in one continuous operation without interruption of the total process, including the coupling of the objects to be coated and to pass said coupled objects as one continuous entity through the entire process, with the provision for rotating the said objects around their longitudinal axis in a manner so as to obtain the most effective cleaning and heating and to provide a final coating which is even, with a minimum of pinholes and voids.

This invention relates to an improved method and apparatus for the external coating of cylindrical objects such as tubing and pipe. The method involves the connecting of said objects end to end in such a manner that in effect work is done on one continuous tube. The method further involves the heating, cleaning, coating, cooling, and inspecting the processed articles in one continuous operation without interruption of the total process. The method includes and recommends, but does not restrict itself to the process of heating followed by cleaning to obtain maximum coating adherence which was previously disclosed in our United States patent application Ser. No. 74,388 filed Sept. 22, 1970.

The method and apparatus may be utilized to coat said objects with a wide range of materials such as, by way of example but not by way of limitation, cellulosics, chlorinated polyethers, epoxies, nylon, polycarbonates, polypropylene, thermoplastic polyesters, vinyl, and other materials capable of being atomized or suspended as particulate matter.

Various methods and apparatus have been devised for the cleaning, heating, and coating of such cylindrical objects, but in all cases the processing is done in two or more operations with no coupling of consecutive pieces (U.S. Pat. Nos. 3,155,545, 3,241,224), or coupling in only certain and separate stages of the material preparation is in many cases quite bulky and requires extensive space requirements. Due to the method of handling the material to be coated, the application under some conditions is not even and suffers from pinholes, voids, and other types of incomplete application.

It is therefore the objective of the present invention to provide a method and apparatus for applying a wide range of coatings as liquids or as powders applied in such a manner as to obtain an even coating with maximum bonding. The process is designed to accomplish all activities required for the proper heating, cleaning, coating, cooling, and inspection of the material in one continuous operation.

It is a further objective of the present invention to provide a method and apparatus whereby the material can be processed rapidly with a minimum of operating personnel.

The processes now in use normally involve the cleaning of the objects to be coated to a white metal followed by the heating of said objects to a sufficient temperature for proper

coating. The methods described in this invention proposes the application of heat sufficient for the coating operation followed by shot cleaning and burnishing, if necessary, then immediately coating the heated and cleaned material before appreciable oxidation or corrosion can take place. The method described in this invention makes allowance for either mode of operation, and while the latter order of treatment is proposed, it is not meant to preclude the use of the alternate order of material preparation.

With these and other objects in view, the invention consists of the method, and the construction, arrangement and combination of the various parts of the apparatus, whereby the objects contemplated are attained, as herein set forth, defined in the appended claims and illustrated in the accompanying drawings.

In the drawings:

FIG. 1, a block diagram of the process described in the invention.

FIG. 2, a perspective view of a typical coupling.

FIG. 3, a cross section view of a high intensity heater.

The material to be coated is passed through the apparatus in the following manner as illustrated in FIG. 1. A length of pipe, tube or cylinder, complete with coupling, FIG. 2, affixed to the leading end, is transferred from the storage rack, area **1**, to the starting conveyor section **2**, as soon as the previous piece has advanced sufficiently to be clear of the succeeding piece. As soon as the material is on the conveyor, that section of the conveyor is speeded up through the speed-up device **3** to move the new piece up to a position to couple with the work ahead. This coupling is maintained through the entire process until the finished piece is checked for voids and ready for unloading.

The coupled cylinders supported on the conveyor wheels are being rotated around their axes as well as being advanced by the conveyor system. In the first step of the material preparation the cylinders are advanced through the high intensity heating system **4** described in more detail later. The cylindrical pieces being rotated around their axes while being advanced through the heaters permit heat to be applied rapidly without problems of uneven heating or warping. The advantage of applying heat at this stage is five fold:

(1) Any protective coating such as varnish, lacquer, paint, or preservatives, including old resinous coatings applied to the cylinders at the factory or mill for surface protection as well as the coating applied on the shielding ring of the couplers from previous runs in the coating machine is charred sufficiently to be easily removed in the cleaning step.

(2) The couplings are heated with the pipe and do not draw heat from the ends of the pipe as in the case when cold couplings are placed on the heated pipe just prior to coating (U.S. Pat. No. 3,241,224).

(3) The material is brought up to temperature and time is allowed for the heat to be distributed evenly over the entire surface prior to coating, resulting in a more even cure.

(4) Heat absorption of the uncleaned pipe is greater than that of cleaned pipe due to the higher reflectance of the cleaned surface.

(5) The material is brought to a temperature sufficient that no additional heating is required after cleaning, which results in a surface free of oxidation for the immediate application of the coating material for maximum adhesion.

Immediately after leaving the heating system **4**, the cylindrical pieces enter a shot cleaning chamber **5** where the material is cleaned to a white metal. Since the cylindrical pieces are revolving in a spiral the continuous shot blasting of the material results in an even and thorough cleaning of the entire exterior surface.

As the material leaves the shot blasting chamber **5** it may be burnished with a high speed wire brush **6** to re-

move any steel slivers or embedded shot from the previous operation. At this stage any shot held by the shield of the couplings is blown out by a blast of compressed air.

Following the burnishing step (if included) the temperature of the material to be coated is monitored with an optical heat sensing device **7**. This device may be coupled with controls associated with the high intensity heating system **4** to provide for automatic temperature control if so desired. The material temperature may be monitored immediately after leaving the heating system but it has been found that the most accurate temperature readings are obtained just prior to coating since the material surface is most uniform at this stage. At this stage any precoating or priming steps may be added as required by the process before the material is conveyed into the coating chamber.

Immediately after the temperature is monitored the cylinders to be coated enter the coating chamber **8** with the spiral motion being maintained by the conveyor system. Within the coating chamber a number of spray nozzles (the number dependent on the amount of coating material to be applied) are positioned around the periphery of the cylinders, with the nozzles to be placed on one or more planes perpendicular to the axis of the cylindrical pieces being coated.

With the material being rotated while advancing through the coating chamber, any one point on the surface of the cylinder will be exposed to spray from essentially all operating nozzles, and receives in effect multiple applications of the coating material which insures an even and holiday free application even if a portion of the spray nozzles were not operating to proper output. Under typical coating conditions with the system described in this disclosure 1¼ inch diameter pipe traveling at a speed of 55 feet per minute was coated with an 8 mil epoxy coating using 4 nozzles with an air pressure of 4 to 6 p.s.i. Under these conditions the epoxy powder usage was approximately 75 lbs./hour. When coating larger diameter pipe (10 inch diameter pipe at a speed of 15 feet/min.) 8 nozzles were used with an air pressure of 12–15 p.s.i., applying approximately 130 pounds of powder per hour.

Using the multiple application method described above, runs in excess of two thousand lineal feet of pipe have been coated with no holidays. With the coating methods now in common usage it is not unusual to find 2 to 5 holidays in each 42 foot length of pipe.

After leaving the coating chamber **8** the coated material is enclosed in a tunnel or curing chamber **9** where the temperature of the material is maintained by auxiliary heat sufficient to insure a proper curing of the coating. Where the coating process does not require the use of a post application curing stage this area may be used for preliminary cooling.

Following proper curing of the coating, the cylinders are subjected to a spray of water in the quench area **10** for the cooling and setting of the coating and the cooling of the cylinders to handling temperature. Again, with the work being conveyed in a spiral fashion the application of the quenching spray is distributed evenly over the circumference of the work resulting in even cooling and no warping of the coated material.

The entire surface of the coated cylinders are monitored with an electrical apparatus **11** (jeeper) to detect any voids in the applied coating. The jeeper contact, because of the spiral motion of the coated cylinders, consists of a brush, rollers, sponge, pad, or the like, (depending on the apparatus used) wide enough to cover the advance made by the cylindrical object during one revolution. When a wet sponge, pad or the like is used, a surface active agent is added to the water to reduce the water repellancy of the coating thus insuring detection of even minute breaks in the applied coating. The grounding lead to the jeeper is attached to the conveyor in the area of the wire brush **6** or other areas where contact may be made with the bare metal of the cylinders, with electrical connection being maintained through the couplings. An automatic marking device may be incorporated into the jeeper to identify any areas needing repair.

As soon as a coupling (FIG. 2) passes through the monitoring station **11** indicating a junction of two cylinders, the final portion of the conveyor system **13** is speeded up through use of another speed up device **12**. The increased r.p.m. of the conveyor wheels in the final section results in the more rapid advance of the lead piece causing a separation at the connector. As soon as the leading cylinder advances sufficiently for a clear separation from the preceding piece it may be lifted from the conveyor line **13** with the kickoff mechanism **14** and deposited on the receiving rack **15** for final inspection, marking and loading.

The various sections of the above apparatus are described as follows:

The work conveyor consists of a series of powered wheels assembled in pairs in such a manner as to support the cylinders between them, and canted at such an angle as to advance the cylinder as well as turn it around its axis when the wheels are rotated. Conveyor wheels are placed between the various units of the apparatus as well as the conveyor lines at the start and finish of the process in order to support the material and maintain a revolving and forward motion which results in a spiral type movement of the surface of the cylinder.

The speed of the wheel rotation is adjustable to control the rate of material rotation. Two factors are critical in the selection of conveyor speed. (1) The rate of heating, and (2) the rate of coating application. The speed of rotation should be sufficient to assure even heating on the circumference of the material to prevent warping. The rate of rotation and advance of the material must be sufficient for the total application of the coating material within the setting time of the material to prevent an overspray effect. The rates of rotation may range from approximately 5 r.p.m. on large diameter pipe traveling at speeds of 8 to 10 feet/minute up to 120 r.p.m. or more for small diameter material being coated at speeds of 60 to 90 feet/minute.

The angle of the conveyor wheels are adjusted to advance the material at a rate which permits an even distribution of the coating material consistant with the application limitations of the coating material, and the arrangement of the coating equipment. The usual rate of advance ranges between 3 and 12 inches/revolution. The rate of advance cannot exceed the width of the coating area. The angle of the conveyor wheels are set in such a manner that the beginning of the line has a slightly faster forward advance than the center or end sections resulting in a constant pressure of the cylinders on the interpoised couplings. In addition, speed change devices **3** and **13** are placed in the power train of the conveyor system in such a manner that the conveyors at the beginning of the operation and the end of the apparatus may be speeded up to permit cylinders to be coupled at the start and uncoupled at the end of the process without stopping or changing the speed of the cylinders in the processing areas.

The couplings used for the connecting of consecutive cylinders, pipes, or tubes when in the process of being prepared and coated are described as follows, with a general description, but with the understanding that the specific structure may vary as required by the size of the cylinders being coupled.

The coupling, as illustrated in FIG. 2, is based on a skeleton type framework **20** loosely fitting the inside of the cylinders being processed, constructed in such a manner as to afford a minimum amount of contact on the inside walls of the cylinders being processed to maintain minimum heat transfer while at the same time having sufficient contact as to maintain a stable physical and electrical contact, and to afford adequate heat conduction to maintain an even temperature throughout the entire length of the pipe. On this framework is mounted by a

single pivoting rod **21**, a sealing ring **22** with the same outside diameter as the cylinders being connected, and if so required, a shielding ring **23** with sufficient space between it and the sealing ring **22** to prevent entrapment of the cleaning shot. The purpose of the sealing ring **22** is to prevent shot and other material from collecting inside the work material during the cleaning and other operations.

The shielding ring **23** is used when a cutback or uncoated area is required on the end of the tubing for threading or welding.

The sealing ring and shielding ring are secured to the framework **20** in such a manner as to afford a flexing action by the pin **21** being allowed to rotate about its axis as well as being allowed to slide lengthwise in the coupling frame. This allows the coupling sealing ring **22** to be aligned continuously with the ends of the two cylinders being coupled, and the shielding ring **23** to flex as it passes over the conveyor wheels. This flexing of the shielding ring prevents the cleaning shot from packing between the shielding ring and the outside of the coupled cylinders. Any residual shot is easily removed by an air blast after leaving the shot cleaning apparatus.

The high intensity heater (FIG. 3) is so constructed as to provide a combustion chamber **50** which is fired by multiple nozzles **51** using either liquid or gaseous fuels, and a cylindrical heating chamber **52** through which the object to be heated **53** is conveyed. Both the combustion and heating chambers are lined with high temperature refractory. In operation both chambers are heated to an incandescence. The combustion gases in chamber **50** are forced to exit at an extremely high temperature through a narrow slot **54** at a high velocity to impinge of the surface of the material to be heated **53**. The exit vent **56** for the spent gases is restricted to retain the gases until maximum heat is transferred to the material being heated **53** and the surrounding refractory **55**. In addition to the direct transfer of heat from the heated gases impinging on the cylinders **53** additional heat is radiated from the surrounding refractory **55** which is heated to an incandescence by the spent gases before being exhausted through the exit vent **56**. This system uses the principles of both convection and radiation to obtain maximum efficiency in the heating system. Heaters of this type permit a rapid start up as well as essentially instantaneous temperature control.

FIG. 3 illustrates the general structure of a burner which could be used for the heating of pipe or cylinders up to approximately 12 inches in diameter. For larger diameter pipe it is only required to replace the heating chamber **52** with a chamber of a larger diameter with supplemental burners firing directly into the heating chamber. For optimum operation of this system at lineal speeds of 10 to 90 feet per minute or more heating capabilities of approximately 25 million B.t.u.'s/hour in the small burner and 100 million B.t.u.'s/hour in the large burner would be required to heat the pipe to a temperature of 475–500° F. as is required for some coating materials. A series of burners as shown in FIG. 3 with a combined length of 18 feet has been used to heat 10-inch pipe with a ½-inch wall thickness to a coating temperature of 425° F. while moving through the system at a lineal speed of 12 feet/minute.

The use of a straight through cleaning and coating system together with the compact high intensity heaters described above make possible the adaptation of this system to portable operation. The total conveyor system together with the apparatus necessary for the total treatment of the material to be coated, heaters, shot cleaner, coating chamber, curing and quenching areas, could be permanently mounted on flat bed trailers, railroad flat cars, or barges for portability, requiring only an aligning and coupling of the lines to permit operation. Auxiliary equipment such as electrical generators, and a fuel supply such as LP gas would complete the system. This portability would permit the coating of large pipe in the area of final usage and would reduce the shipping damages incurred when coated pipe has to be shipped long distances. Depending on the method of transportation the system could be used in any area accessible to barge, railroad or truck movement.

It is thought from the foregoing description that the advantages and novel features of our invention will be readily apparent.

Obviously many modifications and variations of the various apparatus described are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. The method of externally coating successive pieces of metal cylindrical objects in a continuous operation which comprises the steps of:

rotatably advancing said pieces on a conveyor having means for accelerating the advancing pieces at the beginning of the path;

inserting a loosely fitting coupler into the forward end of an advancing piece to engage the rearward opening of another of said pieces said coupler provided with means near its center portion to seal the interior pieces against foreign material during subsequent cleaning;

heating the connected pieces to a temperature sufficient for subsequent application of a thermal plastic coating by passing through a high intensity heating chamber, descaling said heated connected pieces by shot blasting followed by means for removing residual scale or shot;

coating said descaled heated connected pieces with a thermal plastic resin;

advancing said coated connected pieces to a resin curing and quenching area; and separating the quenched pieces by means on the conveyor to sense and accelerate the most advanced piece thereby permitting the removal of the coupler and stacking of the finished pieces.

2. The method according to claim **1** wherein the coupler is provided with a shielding ring overlapping the area of adjoining ends of the pieces to protect against coating said overlapped area.

3. The method according to claim **1** wherein said thermal plastic resin is epoxy.

4. The method according to claim **3** wherein the pieces are heated to a temperature between about 425° F. and 500° F.

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U.S. Cl. X.R.

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