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M. C. GREEN

2,520,397

SPRAYING APPARATUS FOR INTERNALLY COATING PIPES

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2 Sheets-Sheet 1

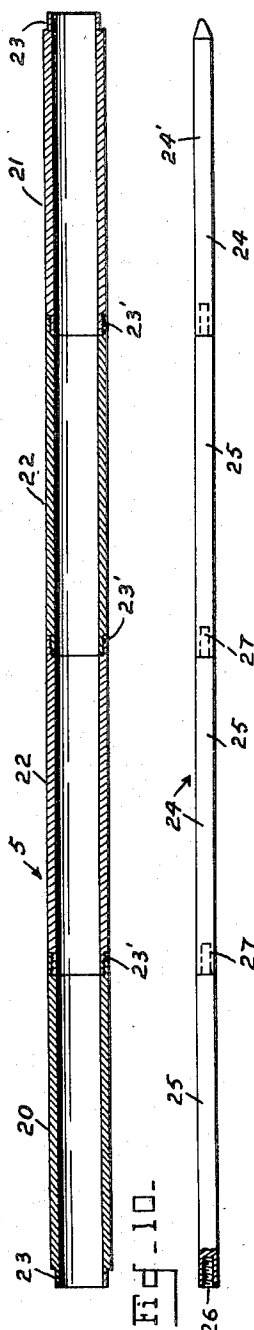
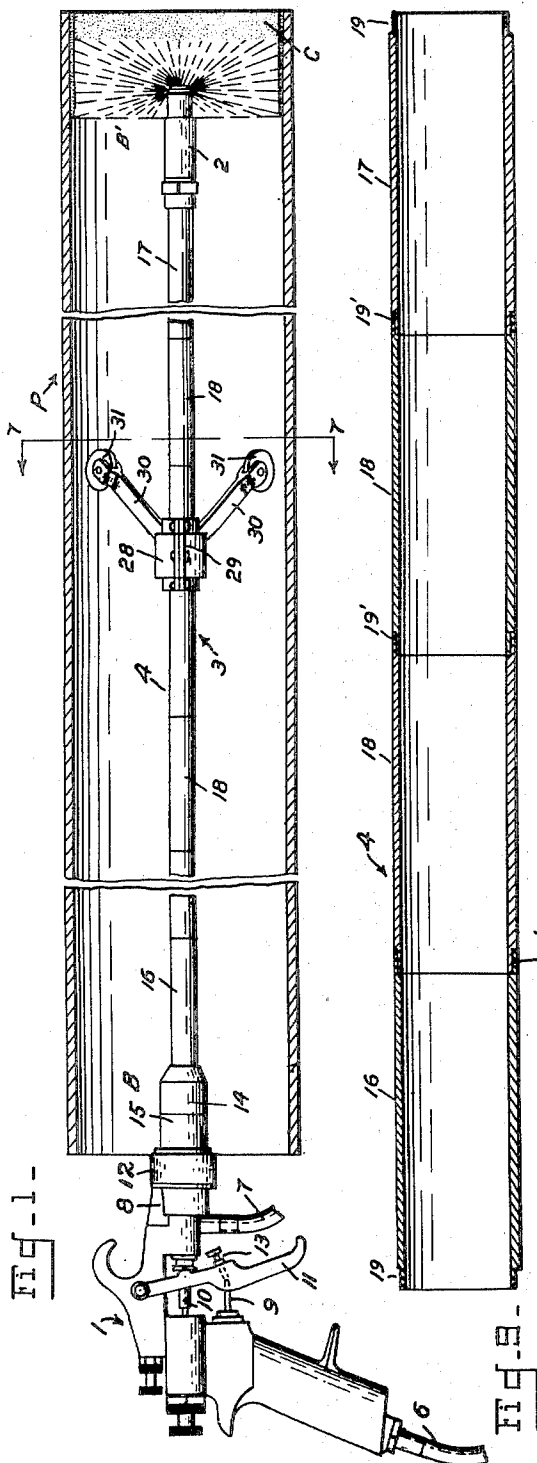
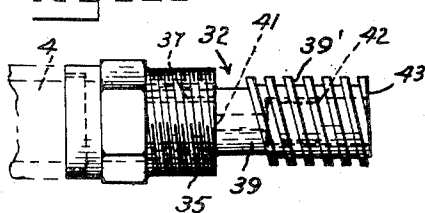
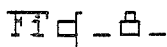
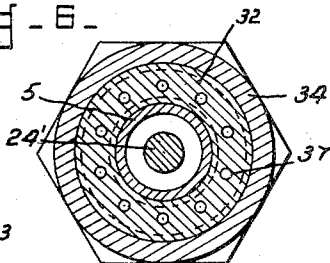
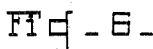
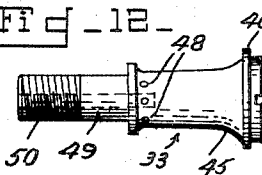
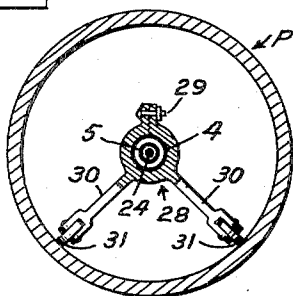
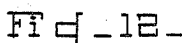
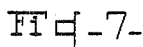
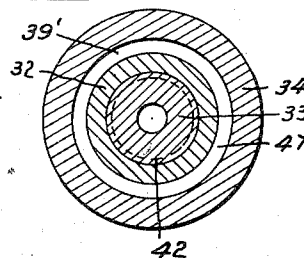
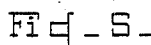
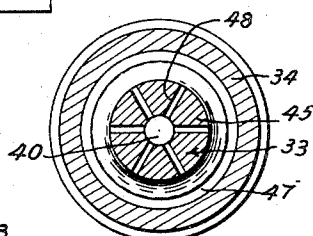
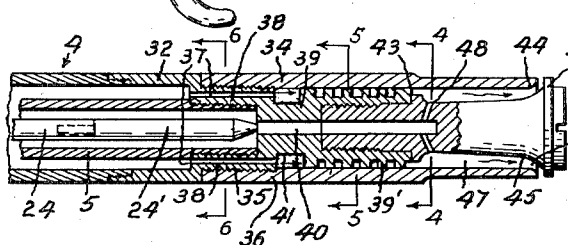
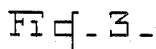
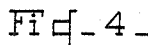
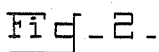


FIG. 11-

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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SPRAYING APPARATUS FOR INTERNALLY COATING PIPES

Marion C. Green, Wichita, Kans.

Application December 5, 1946, Serial No. 714,152

2 Claims. (Cl. 91-45)

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This invention relates to a method of and apparatus for applying a protective coating to the inner surfaces of pipes or tubes so as to render them resistant to abrasion, corrosion and contamination, without materially reducing the internal diameter of a pipe or tube, and so as to reduce the deposit of solid substances on said surfaces and the amount of friction losses and wall turbulence in the flow of fluids through the tubes or pipes.

More particularly the invention relates to a method of and apparatus for coating the internal surfaces of pipes or tubes with resinous materials, particularly resins of thermoplastic type, to form a thin but highly protective lining free from laps, runs, sags or homogeneous pin-hole imperfections and having the properties specified and other desirable and important advantages. Phenolic or vinyl type resins may be mentioned as suitable for the purposes of the present invention, although my invention is not limited to the use of these particular materials.

Heretofore an attempt has been made to coat the interior surfaces of tubular articles with resinous materials, but without practical success owing to the method and apparatus employed and due to certain characteristics of the materials rendering it difficult to apply them to form a continuous coating free from laps, pin-holes, runs, tendency to scale and other imperfections, and which will set uniformly without brushing or artificial drying.

The object of my invention is to provide a method and an apparatus of highly efficient character whereby all difficulties in handling and applying such materials are overcome and whereby a coating or lining on long pipes as well as short or medium length pipes fulfilling all requirements may be produced.

In the accompanying drawings, showing a type of apparatus embodying my invention and carrying the method into practice:

Fig. 1 is a vertical longitudinal section through a pipe to be coated and showing the apparatus as disposed for use in the pipe and showing also a portion of a coating which has been formed on the pipe;

Fig. 2 is a view on an enlarged scale, partly in side elevation and partly in vertical longitudinal section, through the inlet or gun head end of the apparatus;

Fig. 3 is a vertical longitudinal section through the discharge or spray head end of the apparatus;

Figs. 4, 5 and 6 are transverse sections on a

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larger scale on the lines 4-4, 5-5 and 6-6 of Fig. 3;

Fig. 7 is a cross section on the line 7-7 of Fig. 1;

Fig. 8 is an enlarged detail view of a section of the spray head;

Figs. 9 and 10 are longitudinal sections through the air and fluid conductors of the barrel;

Fig. 11 is a side elevation, with a portion in section, of the needle valve control rod; and

Fig. 12 is a view of the nozzle section of the spray head.

Referring now more particularly to the drawings, A designates a spraying apparatus embodying my invention and of a type adapted for the carrying out of my novel and improved method of lining pipes or tubes, which apparatus includes in its general organization a gun head 1, a spray head 2, and an interconnecting barrel or body portion 3 including outer and inner air and spray liquid conducting pipes or tubes 4 and 5, respectively, each of which is preferably variable in length to space the heads desired distances apart for the internal coating of pipes or tubes which vary in length within a predetermined or practicable maximum range.

The head 1 is or may be a spray gun body or head of standard type, except as hereinafter described, which serves as a manipulating device whereby the apparatus may be moved forward and backward in the pipe P which is to be coated. The head 1 also serves as a manifold conductor from which the compressed air and coating liquid from suitable sources may be supplied to the head 2 through the interconnecting barrel 3 formed by the pipes 4 and 5 in a regulated manner for discharge by the head 2 in the form of spray against the internal surface of the pipe P. As shown, the head 1 is provided with an air inlet 6 and a fluid inlet 7 for the admission thereto of compressed air and coating solution from suitable sources of supply, a discharge nozzle 8, an air control valve 9, a fluid control valve-rod-member 10, a trigger 11 for operating said valves, and an air sleeve or coupling member 12 in threaded engagement with the nozzle 8 for detachably clamping the sleeve thereto. All of these parts are or may be of standard construction except that the valve member 10 instead of controlling a port formed directly in the head 1 constitutes part of a valve rod extended through the barrel and terminating in a needle valve member controlling a port formed in the head 2. The gun head construction is further modified to provide an adjustable valve regulator 13 on the trigger

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11 to secure certain novel supply and cut off actions of the air and solution control valves, as hereinafter described. The gun head construction is or may be still further modified with respect to the sleeve 12, if desired or required, for coaction with an adjustable supplemental air sleeve formed of adjustably connected members 14 and 15 disposed between the member 12 and the adjacent end section of the conductor 4. The members have suitably packed air-tight joints and said members are provided with air ports 12'.

The pipe 4, through which compressed air is supplied to the head 1 to discharge the coating liquid in the form of spray, forms the casing of the barrel or body in which the conductor 5 is enclosed and comprises detachable end sections 16 and 17, and one or more intermediate sections 18, extending between the sleeve member 14 and head 2 and having fluid-tight lapped and friction joint connections 19 with said sleeve member and head and fluid-tight lapped friction joint connections 19' with each other. The connection between the sleeve members 14 and 15 is of threaded type or otherwise such as to adapt the sleeve section 14 to be employed as an adjusting member, as hereinafter explained.

The pipe 5, through which the coating liquid is supplied to the head 2, comprises, as shown, end sections 20 and 21 and one or more intermediate sections 22. The outer ends of the end sections 20 and 21 have telescopic fluid-tight screw joint connections 23 with the respective heads 1 and 2, and the inner ends of said sections and the ends of the intermediate sections 22 also have interengaging telescopic and threaded fluid-tight sleeve joint connections 23' by which they are detachably coupled together. These intermediate sections are interchangeable with each other and one or more of them may be used in connection with the sections 20 and 21 to vary the length of the fluid conductor 5 and the length of the conductor 4 for coating pipes or tubes of different lengths.

The liquid and air conductors 5 and 4, as above described, are thus of such construction as to adapt them to be varied in length to provide an apparatus which may be used to coat a pipe or tube of any reasonable maximum length within pipe ranges and up to, for example, 60 feet, and which may be manipulated from the rear end of the pipe by the head 1 to move it forward in the pipe, for example, from end B to end B' to dispose the head 2 in starting position and then move it backward in the pipe from end B' to end B for a progressive coating action, as will be readily understood. Fig. 1 shows the device just after it has been started into action and has been moved backward a certain distance, during which it has deposited a coating C on the inner wall of the pipe at its forward end.

In practice the sleeve 14 is adapted not only for use in adjusting the length of the conductor 4 but also to tighten the same without disturbing the conductor 5, so that in the event that different metals are used in the construction of the two conductors expansion and contraction of either can be compensated for without reducing the leak-preventing efficiency of the joint connections and to enable a perfect seating of the solution control needle valve to be attained at all times, as hereinafter more fully explained.

Also extending longitudinally between the heads 1 and 2 is a needle valve control rod 24 comprising the end section 10 in the head 1, a

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needle valve section proper 24' in the head 2, and one or more intermediate sections 25, the sections 10 and 24 being suitably mounted in the heads 1 and 2 for forward or backward adjusting movements. The section 24' of this rod may have a pointed forward end serving as a needle valve, or it may be arranged to operate a separate needle valve on the head 2, whereby the amount of air supplied to project the liquid in the form of spray may be regulated by the operator from the rear end of the apparatus. The rod sections are detachably coupled to each other by coupling connections in the form of a threaded socket 26 at one end of each section receiving a threaded pin or dowel 27 on the adjacent end of an adjoining section, by which the rod sections are united together against disconnection and for movement in unison. Valve portion 24' is preferably made of bronze or other non-magnetic metal to prevent magnetizing and sticking of the needle where it comes in contact with the metal of the spray head.

In order to support the apparatus for ambulatory movement, and to properly center it in the barrel 3, a wheeled supporting carriage 28 is provided at the front end of the apparatus. This carriage may be of any suitable form and construction, but, as shown, comprises a holder in the form of a split band embracing the head 2 or a forward section of the pipe 4 and secured in position by fastening means 29, said holder having depending fork arms 30 carrying wheels or rollers 31 to engage and travel on the interior surface of the pipe P. These arms diverge outwardly at an angle and have the wheels mounted thereon at angles to ride on the side of the internal surface of the pipe so as to hold the apparatus from tilting laterally and to center the head 2 accurately in the line of the axis of the pipe 4 to cause the equal distribution of the liquid spray to all portions of the surface of the pipe about the head 2.

The spray head 2 is of 360° type and of novel construction to secure maximum working efficiency and to overcome objections to prior spray heads of this type. It comprises an inner or inlet section 32 coupled to the adjacent end of the pipe or conductor 4, an outer or nozzle section 33 and an intermediate section 34 the forward end of which comprises a sleeve spaced from the nozzle and forming therewith a sprayer. Section 32 has a threaded intermediate portion 35 in engagement with the internally threaded rear end 36 of section 34 and provided with air inlet ports 37 surrounding an internally threaded portion 38 receiving the adjacent threaded end of the forward section of conductor 5. Projecting forward from the threaded portions 35 and 38 is a reduced tubular stem 39 provided with external spiral vanes 39' forming with the surrounding wall of section 34 a correspondingly shaped channel in which the air entering through ports 37 is given a turbine effect or whirling action just prior to its admixture with the spray solution and issuance therewith through the outlet of the spray head. The body and stem portions of the section 32 are formed with a reduced passage 40, a valve seat 41, a threaded portion 42 and a shoulder 43. Section 34 has an internally flared or bell-mouthed forward end 44 to receive the correspondingly flared body portion 45 of the section 33 which terminates at its outer end in an annular spreader or deflector flange 46, the flared portions of the sections being spaced to form a mixing chamber and spray discharge

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passage 47 providing with the member a 360° spray outlet. The body portion of section 33 is solid or closed except at its inner end, where it is chambered and provided with solution discharge ports 48, and from this end of section 33 extends a tubular stem 49 which bears at its free end against the shoulder 43 of section 32 and is provided with threads 50 to engage the threaded portion 42, whereby section 32 is detachably secured in section 34 so that when applied thereto it connects the passage 40 and ports 48 for the supply of the spray solution to the passage 47. As shown, the forward section or needle valve member 24' of the valve rod 24 is received in the section 32 and is adapted to engage the seat and movable relatively thereto when the rod is actuated by the trigger and the usual valve controlling spring to let in or cut off the flow of solution to the ports 48. It will be noted that the head 2 comprises only three parts of simple construction and detachably connected so that they may be readily assembled for use and disassembled for cleaning, repairs or other purposes.

In the operation of the spray head 2 movement of trigger 11 actuates valves 9 and 10 to admit air and solution through conductors 4 and 5 to head 2. Air enters the head 2 through ports 37 and is given a whirling motion by the vanes 39' and flows out through passage 47, entraining therewith the spray solution entering through passage 40 and ports 48 and causing discharge of the solution in the form of spray which is deposited on the interior of pipe P to form the protective coating. The amount of discharge of the spray may be regulated by control of the valves and adjustment of section 33 of the head 1, and closing of the valves to stop the spraying action may be effected by releasing the trigger 11 to allow the valves to automatically close.

The purpose of the flaring passage 47 is to provide a mixing chamber which increases the aerodynamic flow through and from this chamber and to thereby overcome a defect in conventional 360° spray heads, which tend to clog with fluid caught on obstructing surfaces and prevent a complete 360° spray. The flaring outlet 47 provides a mixing chamber which extends from the fluid ports 48 to the outlet point with a radius contour, thus eliminating obstructions to flow and creating a more perfect aerodynamic flow, taking full advantages of the turbine effect of the air caused by the action of the vanes. This also results in an increase of the effective operating radius obtained in the use of a spray head of any given size, up to double that obtained by a conventional 360° spray head of the same spraying diameter, with a consequent increase in the volume of solution which may be projected and making possible the use of the same size spray head for greater variation of pipe diameter sizes.

In a conventional spray head of the type described the needle seat is located immediately adjacent to the mixing chamber and in close proximity to the fluid feed ports, so that on a cut off action fluid is liable to be retained and flow back into the air ports and cause clogging thereof. In my improved construction of spray head this danger is avoided as the needle port is located back and away from the mixing chamber and in such relation as to prevent flow back of solution to and possible clogging of the air ports.

In a spray apparatus of the conventional type

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referred to the air and fluid control valves are simultaneously operated for let on and cut off actions. This is objectionable, particularly when the spray head is located at any material distance from the gun head, in that if both the air and the fluid are cut off at the same time a residue of the fluid is liable to be left in the mixing chamber to coagulate or dry and clog the same. Again, the turning on of the flow of air and fluid at the same time reduces the efficiency of the spray starting action. I avoid these objections by the provision of the controller 13 on the trigger 11. This controller comprises a bolt-like threaded contact element which engages the stem of valve 9 and is adjustable to vary the opening and closing movements of said valve relative to fluid valve 10. The controller has an operating head 13^a and is adapted to be secured in adjusted position by means of a check nut 13^b. By the use of this controller 13 valve 9 may be set to open before valve 10 opens and close after valve 10 closes. By this means air may be caused to flow through outlet 47 before fluid passes through ports 41 and 48, with a result of more efficiently starting the spraying action, and with spray only, unmixed with drops of solid liquid particles, and the flow of liquid may be cut off while allowing air to flow through the vanes and spray outlet to sweep away any liquid liable to clog the mixing chamber or flow back to the vanes or ports. The spray head thus may be kept clean and free from liquid, with the result that the necessity of frequently dismantling and cleaning the spray head is avoided.

In the operation of the apparatus to carry out the method of this invention, the apparatus is introduced, head 2 foremost, into the pipe P at one end, as end B, and centered by the carriage for travel in the pipe. The apparatus is then moved forward to end B'. The valves for supplying the compressed air and coating solution to the pipes 4 and 5 are then turned on to effect the discharge from the head 2 of the liquid in the form of spray against the surrounding portion of the internal surface of the pipe P. In this operation the pipe P is supported in a substantially horizontal position so that there is no tendency of the liquid to run longitudinally of the pipe, the only tendency being that of the liquid deposited at the top of pipe P to run down at the sides of the pipe, but, as the present method permits of the use of a rapidly evaporating and drying solution, this objection is overcome and the formation of a solid film insured immediately upon the deposit of the solution. As the head 2 is acting to project the spray the apparatus is moved backward from end B' toward end B continuously in the pipe until the end B of the pipe is reached, with the result that a smooth continuous lining C is formed on the interior of the pipe, which lining is bonded to the pipe and free from laps, runs, pin holes or other imperfections. If desired, the process may be repeated one or more times in the event that a heavy coating is desired, but ordinarily from one to three coatings are generally sufficient to provide a durable coating for most purposes.

No prior method or apparatus of which I am aware has been found effective in coating the interior surface of tubular goods with vinyl resins due to certain characteristics of the materials and the difficulty encountered in applying them in order to effectuate a complete coating which is a continuous homogeneous pin hole free film that will set uniformly without brushing or dry-

ing. The only prior way that these materials have heretofore been applied to the interior surface of tubular goods has been by rolling, which requires a tilting of the pipe involving considerable labor, and then slowly turning the pipe as the material rolls slowly down the tilted angle of the pipe while the pipe is turned or rolled to cover most of the interior surface, or dipping, which requires elevating of the pipe and its insertion in a material bath. The difficulty encountered in that known method, in addition to the increased cost of handling and labor, is that the vinyl resins have to be so diluted with solvents in order to keep them liquid during the time consumed in the coating that the consistency of the material is so reduced that it is impossible to obtain a good bonding of the surface to be coated, and the decrease of resin content by the required additional solvents destroys their cohesive characteristics, and weakens the bond of the coating, as well as the bond between the coating and the metal or substance to be coated, and it is impossible to obtain by that method a uniform coating or film of the plastic to be applied, there being portions where there will be excess material, and portions where there will be insufficient material, and a resulting loss of the tensile strength of the plastic sheet, pin hole surfaces that are often not covered, and this method of coating often results in a flaking off of the coating and the lack of uniform interior surface.

The method of this invention, on the contrary, permits the use of the proper consistency of the material without excessive amounts of solvents, and enables the securing of a continuous homogeneous pin hole free film or coating that will set uniformly without brushing or any further operation as the solvents evaporate out of the plastic film uniformly without resulting in an uneven thickness of coating, and without permitting sufficient time for the material so applied to flow downward, and permits the application to be made with such small amounts of solvents that it does not have rivulets or cells where the solvents will gather, and in running out either carry away a portion of the coating or be trapped within the coating in a cell. A cell, of course, results in a lack of uniformity in the coating applied. In this method the tube does not have to be rolled or moved during the coating process, and the application can be made in the field or other place where the tubing is located, with a minimum of handling cost. The application of the plastic material by pneumatic pressure makes any drying process unnecessary. The feature of the variable length demountable extension for the conventional spray gun that is particularly important is the lack of any obstacle to the free flow of the unmixed plastic materials. Their consistency is such that they have a tendency to form almost immediately, hence it is vital that there be no obstructions in their passage through the extension that would set up a turbulent flow and cause them to start forming within the gun or extension or spray head. No mounting of the pipe to be coated is necessary regardless of the length of the section of the pipe and the entire extension, even though as long as twenty or forty feet, is quickly demountable to be transported in boxes no larger than a suitcase from place to place, and readily set up without delay.

It will be noted that as valve 24 cuts off the flow of fluid at the nozzle in a cut-off action, 75

leaving only a small amount of fluid in the passages 40 and 41, which is expelled by the after blast of air, no liquid is left in the nozzle or beyond the point of fluid cut-off to clog the nozzle or cause waste of fluid or evaporation and loss of solvent, so that a higher volatile solvent may be safely used.

This process of lining tubular goods by pneumatic pressure through an extended spray gun produces a continuous lining on the internal surface of tubular goods, that is free of runs, sags, and homogeneous pin hole imperfections. The materials are atomized at 70-pound to 100-pound pressure and shot into the internal surfaces of the pipe through a 360° nozzle, in one or a series of coats, by a manually operated spray gun that is extended through the interior of the pipe to reach all surfaces of pipes 1 inch to 24 inches in diameter and 60 feet or less in length. On thread and coupling type pipe the lining is extended out on the coupling to the point of makeup and on the male thread end a return of materials is made around the end of pipe to the first thread. On plain end pipe lining is carried to inner edge of pipe only, and any materials extending over the edge of pipe are removed.

The completed lining fulfills the following requisites:

- Resistance to corrosion and contamination;
- Reduction of friction losses and wall turbulence;
- Reduction of solid deposits on walls of pipe;
- Resistance to abrasion;
- Minimum loss of volume;
- Minimum increase in weight through lining;
- Withstands rough handling;
- Protection of all exposed surfaces.

The success of vinyl or phenolic resin coatings as a protective coating is dependent to a large extent on the tenacity with which they adhere to the surface on which they are applied, evenness of film, free of sags, runs and/or rifling, a minimum of solvents or carrying agents to place the film on the surface. This is especially true in connection with the lining of internal surfaces of tubular goods where the coating film must not only withstand the chemical attack of acids, salts, alkalies, organics, etc., but also physical conditions of pressure, velocity and abrasion causing erosion, which accelerate deterioration.

The coating must be applied with enough pressure to drive the initial coating into the pores of the surface to which it is applied, and succeeding coats into the prime or basecoats in a continuous manner so as to bind the resins into one film. To permit this on any commercial length of pipe and of varying diameters the spray nozzle and control gun have been connected by sectional extension and operating needle tubes, which in turn are centered to the pipe by adjustable centering rollers. These sections are constructed to permit handling the materials without loss of efficiency through the extended length and with sufficient pressure to properly atomize the materials in the right consistency to produce a uniform unbroken film. By this method of application, pipe or tubular goods may be coated with the resin film without handling or moving on the pipe racks. No follow up is necessary to remove excess materials from the bottom of the pipe. In fact, either rolling of pipe after film has been placed on the surface, or brushing to remove excess as would result from improper application or excessive thinning, would rifle

and trap solvents, in turn causing pin hole breaks in the film if rolled and rupture if brushed.

The present process results in a completed film that is of uniform even thickness, free of homogeneous pin hole fractures, entrapped solvents, which, dependent on the solution of synthetic resins used and sufficient thickness, is highly resistant to either chemical or physical breakdown, thereby retarding corrosion of materials lined and contamination of materials carried.

From the foregoing description, taken in connection with the drawings, the advantages of my invention in internally coating pipes or tubes with a protective material of the character described will be readily understood and appreciated by those familiar with the practical problems involved in the handling and application of these vinyl resins, or like thermoplastic or phenolic type resin compounds, and it will be readily apparent to such persons that my invention provides a method and apparatus whereby prior difficulties are overcome and an effective coating operation secured. While the apparatus and steps of the method described are preferred, it is to be understood that changes, falling within the scope of the appended claims, may be made without departing from the spirit of the invention.

Having thus described my invention, I claim:

1. An apparatus adapted to be moved axially within a pipe or tube for coating the internal surface of the pipe or tube with spray of a thermoplastic or phenolic type resinous solution having a rapidly evaporable solvent, for forming on the evaporation of the solvent a protective coating on said surface, comprising an induction head, an eduction head including a sprayer axially supported coincident with the axis of the pipe, conductors connecting the heads for respectively supplying the fluid and a propellant solution to the sprayer for issuance therefrom to form an annular spray directed against the surface of the pipe as the device is progressively moved therein from end to end of the pipe, each conductor comprising a plurality of detachable sections engageable with each other and with other like sections to vary its length and the distance between the heads, a valve in the induction head for controlling the flow of fluid to the fluid conductor, a valve in the eduction head controlling the flow of solution thereto from the solution conductor, a controlling rod connected to the second named valve and extending there-
to through the solution conductor from the in-

duction head, means for coordinately operating the first named valve and the valve rod, and means for supporting the device for travel in the pipe and centering the device therein.

2. An apparatus adapted to be moved axially within a pipe or tube for coating the internal surface of the pipe or tube with spray of a thermoplastic or phenolic type resinous solution having a rapidly evaporable solvent, for forming on the evaporation of the solvent a protective coating on said surface, comprising an induction head including a coupling sleeve having fluid passages, an eduction head including an inner member having a solution passage and fluid passage, an outer sleeve member connected therewith, and a nozzle connected to the inner member and forming with the nozzle a sprayer having a discharge outlet connected with said passages, conductors connecting the heads for respectively supplying the fluid and a propellant solution to the sprayer for issuance therefrom to form an annular spray directed against the surface of the pipe as the device is progressively moved therein from end to end of the pipe, each of said conductors comprising a plurality of detachable sections having interfitting telescopic end portions, the forward sections of said conductors being connected with the inner member of the eduction head and the rear section of the solution conductor being connected with the induction head and extending outward therefrom through the coupling sleeve, an adjusting sleeve adjustably connected with the coupling sleeve and telescopically engaging the rear section of the fluid conductor, and means for supporting the device for travel in the pipe and centering the device therein.

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