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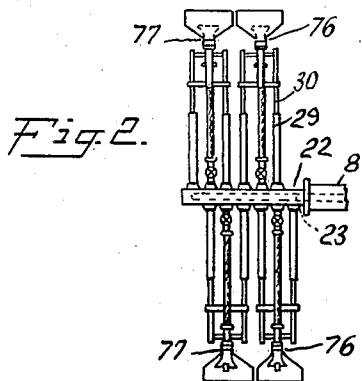
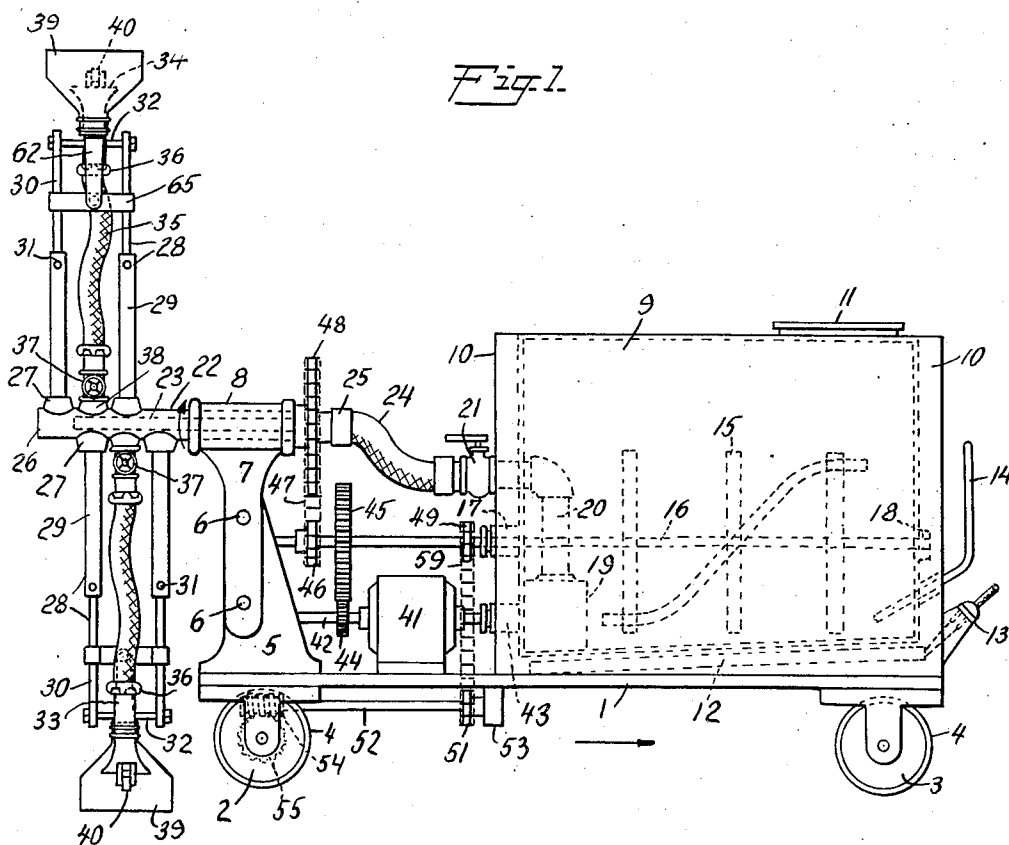
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2,140,298

APPARATUS FOR COATING INTERIOR SURFACES OF TUBULAR STRUCTURES

Filed March 18, 1936

3 Sheets-Sheet 1



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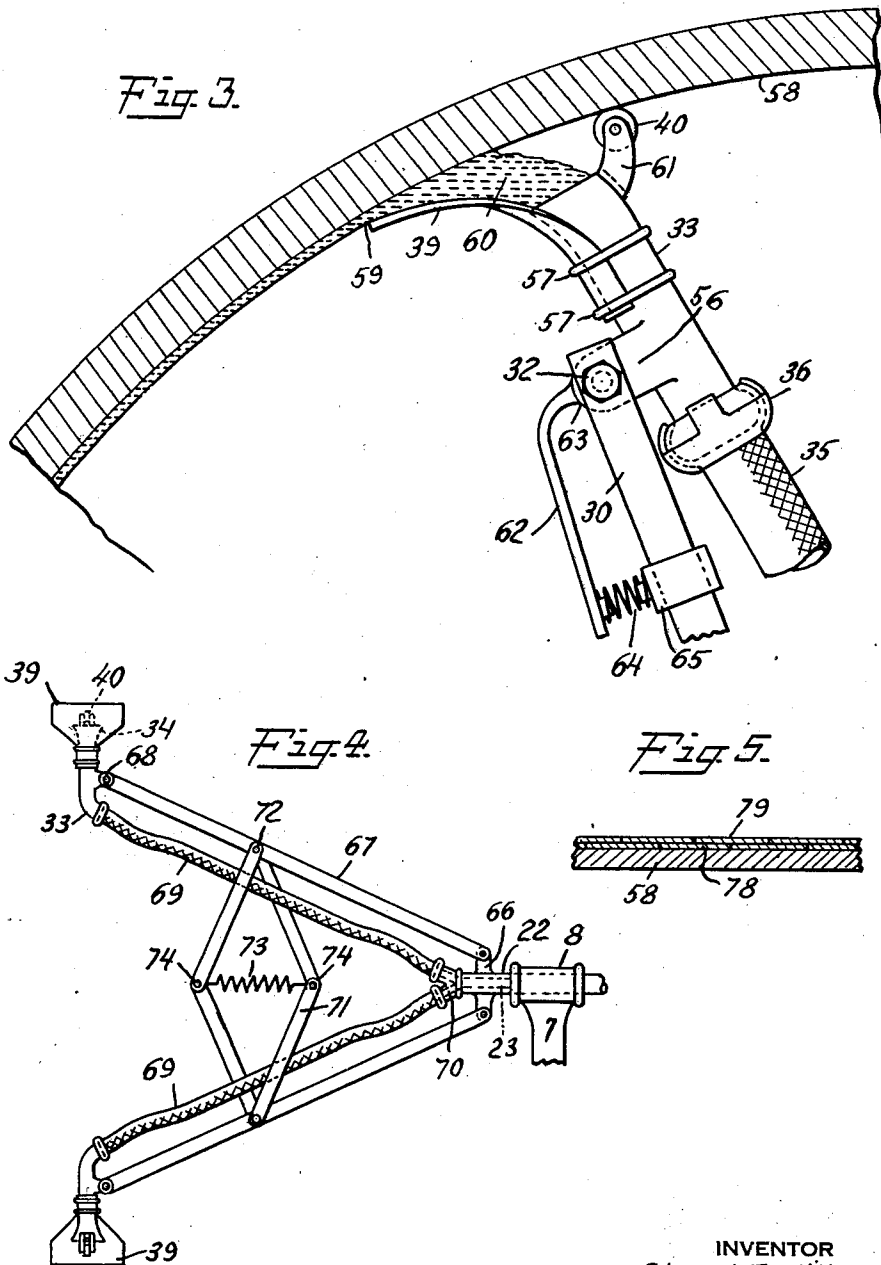
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APPARATUS FOR COATING INTERIOR SURFACES OF TUBULAR STRUCTURES

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3 Sheets-Sheet 2



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APPARATUS FOR COATING INTERIOR SURFACES OF TUBULAR STRUCTURES

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3 Sheets-Sheet 3

Fig. 6.

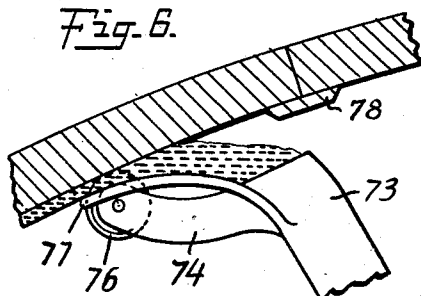


Fig. 7.

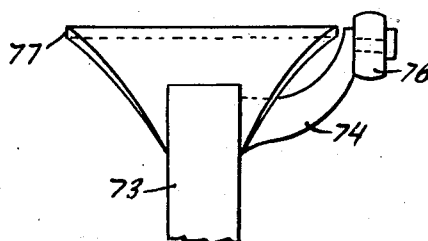


Fig. 8.

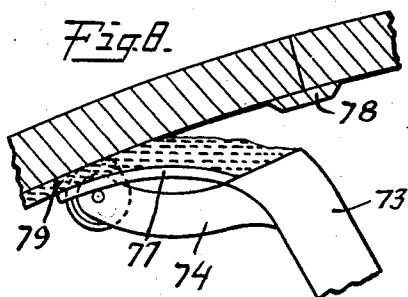


Fig. 9.

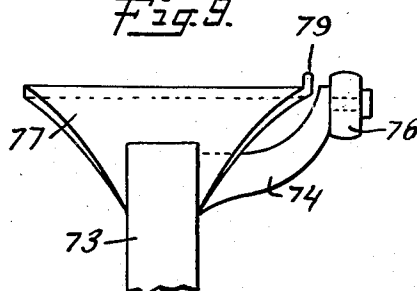


Fig. 10.

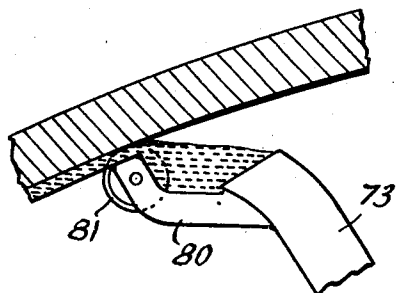
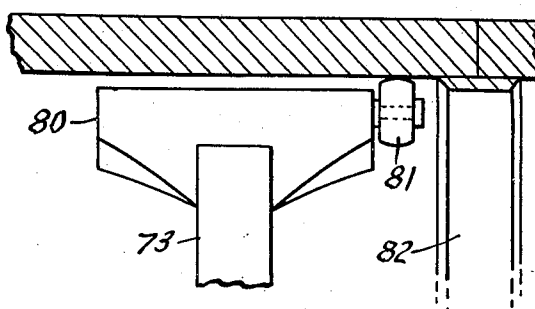


Fig. 11.



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## UNITED STATES PATENT OFFICE

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## APPARATUS FOR COATING INTERIOR SURFACES OF TUBULAR STRUCTURES

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2 Claims. (Cl. 91—30)

This invention relates to coating the interior surfaces of pipes, conduits or other tubular structures and more particularly to an apparatus for coating the interior surfaces of conduits of relatively large internal diameter, such as pen-

One object of this invention is to provide an apparatus and novel procedure for rapidly and efficiently applying protective material to the interior surfaces of large tubular structures.

A further object of this invention is to provide a coating machine provided with self-adjusting rotatable distributors designed to follow the interior surface of the tubular structure and apply and spread plastic coating material, such as heat liquefied bituminous material, uniformly thereover in bands or ribbons completely covering the interior surface of the tubular structure.

Briefly, the apparatus of this invention comprises a frame or carriage provided with wheels, and having mounted thereupon a tank or container adapted to contain hot liquid coating material. A hollow main shaft, which carries adjustable supporting members adapted to rotate in a plane perpendicular to the direction of motion of the carriage, is mounted thereon. One or more distributor nozzles are carried by the adjustable supporting members. Associated with each distributor is a pad or wiper for spreading the coating material over the surface of the pipe after it is fed thereon. A guide roller is also carried by each distributor and is arranged to travel on the surface of the pipe or conduit to insure substantially uniform clearance between the wall of the pipe or conduit and the distributor or applicator nozzles. The applicator nozzles are connected to the hollow main shaft by a flexible conduit, the shaft being communicably connected with the tank containing the coating material. As the apparatus moves longitudinally through the pipe, coating material is uniformly and rapidly spread over the interior walls thereof in the form of a helical ribbon or band which is simultaneously smoothed by the wiper to produce a uniform, smooth coating layer.

Alternatively the hollow main shaft may be sufficiently long to project within the pipe while the tank and operating mechanism remain outside the pipe but travel in line with the pipe to move the rotating applicators lengthwise in the pipe. This is advantageous in treating relatively short sections of pipe before assembly.

If desired the apparatus may be moved inter-

mittently through the pipe in order to apply successive circular bands of coating material instead of continuous helical bands. When operating in this manner, the apparatus is preferably moved a distance substantially equal to the width of a circular band of coating material applied after each complete revolution of the application nozzles.

In the accompanying drawings in which is depicted by way of illustration a preferred embodiment of this invention,

Figure 1 is a side elevational view, partly in section, of the coating apparatus embodying this invention;

Fig. 2 is an elevational view depicting a modification of the applicator mechanism of Fig. 1, in which two pairs of applicators are provided;

Fig. 3 is a fragmentary elevational detail depicting an applicator mechanism of the apparatus of Fig. 1;

Fig. 4 is an elevational view depicting an alternative form of applicator mechanism of the apparatus of Fig. 1;

Fig. 5 is an end elevational view depicting the way in which a double layer of coating material may be applied to the pipe surface by the use of the mechanism depicted in Fig. 2;

Figs. 6, 8, and 10, are detail views showing in side elevation modified forms of applicator nozzles; and

Figs. 7, 9, and 11 are end elevational views of the nozzles shown in Figs. 6, 8, and 10 respectively.

Referring to Fig. 1 of the drawings, in which like numerals refer to like parts, the apparatus of this invention comprises a carriage 1, provided with a plurality of wheels 2, rotatably disposed on an axle attached to the under side of the floor plate of the carriage. A carriage having three wheels may be utilized, namely a guide wheel 3 situated at approximately the mid-point of the front end (with respect to direction of travel of the carriage when in operation, which direction is indicated by the arrow in Fig. 1) of the carriage and a pair of drive wheels 2 at the rear corners thereof. Guide wheel 3 is preferably mounted on a swivel which permits free rotation thereof in the horizontal plane, and, as will be more fully explained hereinafter, serves to keep the apparatus traveling along the desired path. Drive wheels 2 are mounted on an axle at the rear of the truck, which axle, as will be more fully described hereinafter, is driven so that the wheels are caused to rotate to cause the carriage to move longitudinally through the tubular con-

duit. The wheels 2 and 3 are advantageously provided with rubber tires or other suitable tread to prevent damage to primer or other coating previously applied to inside pipe surface.

5 Mounted on the carriage is a tank 9 adapted to contain hot liquid coating material, such as coal tar pitch or other bituminous material. Tank 9 is provided with heat insulated walls 10 adapted to prevent radiation of heat therefrom. 10 A charging inlet 11 at the top thereof serves as an inlet for fresh coating material, which is maintained in the molten state therein by a heating unit, preferably an electrical heating unit 12 situated at the base thereof and connecting 15 with a source of current by means of connection 13. The temperature of the liquid mass within the container may be determined by a thermometer 14 which is preferably so placed that the bulb thereof is below the surface of the hot material and the scale thereof is on the outside 20 of the container, thus facilitating easy reading. Situated within the container and adapted to maintain the liquid material therein in a state of agitation is a stirring device 15 mounted on 25 and rotatably actuated by shaft 16. Shaft 16 is supported within the container by bearings 17 and 18 disposed on the walls of the container and extends through bearing 17 to the exterior of the container.

30 A pump 19 of any well known type having an outlet communicating with the pipe 20 is provided for forcing coating material through the pipe. While in the illustrated embodiment of the invention pump 19 is shown disposed within 35 the tank 9, it will be appreciated that this pump could readily be disposed exteriorly of the tank. If the pump is located outside of the tank it is provided with an inlet projecting into the tank below the level of the coating material therein.

40 A regulating valve 21 disposed in pipe 20 serves to regulate the flow of coating material through the pipe.

A standard 5 is mounted on the rear end of the carriage and has adjustably secured thereto by 45 bolts 6 a bearing member 7 providing a bearing 8 extending in a direction parallel to the surface of the carriage. By suitably adjusting member 7 the bearing 8 may be raised or lowered until it is approximately in line with the axis of the pipe which is being coated. Rotatably mounted 50 in bearing 8 is a main shaft 22 extending outwardly beyond the rear of the carriage. The shaft 22 is hollow providing a duct 23 through which coating material flows from the container 55 to the distributing mechanism hereinafter described. Main shaft 22 is connected to pipe 20 by flexible conduit 24 which is affixed to the main shaft 22 by a gland member 25 adapted to permit free rotation of the main shaft independently of 60 the connecting conduit 24.

Extending at right angles to the main shaft 22 and rigidly affixed thereto by sockets 27 are a plurality of extensible supporting members 28 adapted to rotate in a plane perpendicular to the 65 direction of motion of the truck or carriage. Each supporting member 28 comprises a pair of spaced parallel tubular members 29, preferably of cylindrical shape, having telescopically mounted therein solid extension members 30 70 which are held in position within the hollow members 29 by means of set screws 31 and which are connected together at the outermost ends thereof by cross bars 32. By adjusting the set screws 31 the rod members 30 may be extended 75 or retracted to accommodate the distributing

mechanism to the diameter of the pipe under treatment.

Cross bars 32 have pivotally mounted thereon an applicator or distributor nozzle. Each applicator comprises a nozzle member 33 preferably 5 of metal having a fan-shaped mouthpiece 34 at the end thereof and connected to the main shaft 22 by a flexible conduit 35. A valve 37 is disposed on the line 38 joining flexible conduit 35 to the duct 23 in main shaft 22. Flexible joints 36 are 10 preferably employed at the points of jointure between conduit 35 with nozzle member 33 and conduit 38.

Pipes and fittings between the tank 9 and nozzles 33 may, if desired, be heated, e. g. by means 15 of electric heating coils.

Fig. 3 shows in detail, the construction of an applicator and shows how plastic coating material is spread uniformly over the interior surface 20 58 of a conduit by means of the spreading member 39. Each applicator is attached to the cross-bar 32 of the supporting member which, as shown in Fig. 3 passes through a hole piercing a lug member 56 formed integral with or attached to the applicator nozzle 33. Thus the applicator is 25 pivotally mounted on bar 32 and can move in the plane of rotation of the distributing mechanism independently of the rotary motion imparted thereto. In this way the applicators adjust themselves to compensate for any unevenness 30 in the surface of the pipe and for slight off-center position of the main shaft with respect to the longitudinal axis of the pipe. The applicator nozzle 33 is maintained at a suitable predetermined distance from the surface of the pipe 35 by means of a guide roll 40 rotatably mounted on an extension arm 61 secured to the applicator nozzle. A spreader 39 is attached to each applicator 33 by rings 57. These spreaders are made of semi-flexible material such as reinforced asbestos pads, sheet metal or the like; adapted to 40 permit bending or flexing thereof under tension when forced against the pipe surface. This length may be varied to give a desired wiping effect, depending on the viscosity of the coating material used, the thickness of coating required, 45 etc. In order to maintain spreaders 39 under suitable tension against the pipe surface, a lever arm 62 is provided either integral with or attached to lug 56, as indicated by reference numeral 63. Tension is applied to the lever arm 50 near the free end thereof by means of a compressed spring 64, one end of which is positioned against the lever arm and the other positioned against a rod member 65 suitably attached to extension members 30. As coating material 60 is discharged from the orifice of applicator 33, spreading member 39 comes into contact therewith and spreads it evenly over the interior surface of the pipe, as indicated by reference numeral 59.

A motor 41, preferably an electric motor, is disposed on carriage 1 and is in driving engagement with pump 19 and is also adapted to actuate 65 the other moving parts of the apparatus. The motor 41 is provided with a drive shaft 42 which has one end journaled in bearing 43 disposed in wall 10 of tank 9 and the other end journaled in a bearing, not shown carried by the standard 5. Keyed to the shaft 42 is a gear 44 which 70 meshes with a gear 45, keyed to shaft 16 thus rotating this shaft and the stirrer 15 carried thereby. A sprocket wheel 46 keyed to shaft 16 has a chain 47 passing thereover which also passes over a sprocket 48 keyed to the main shaft 75

22. The main shaft is thus rotated. Rotary motion is imparted to the shaft 52 journaled in suitable bearings, one of which is indicated by reference numeral 53, by means of a drive chain 59 traveling over sprocket wheel 49 keyed to shaft 16 and sprocket 51 keyed to shaft 52. A worm-gear 54 on shaft 52 is disposed to mesh with a gear 55 keyed to the axle carrying wheels 2. Motor 41 thus drives wheels 2 which cause the apparatus to move. A clutch may be disposed between worm-gear 54 and shaft 52 to permit placing the worm out of driving engagement with shaft 52 so that the motor may operate to agitate the contents of the tank without propelling the apparatus. The gear ratios of the various gear systems used in the apparatus are so arranged that the rate of progress of the carriage through the pipe is slow enough to permit the surface of the pipe to be completely coated with protective material. It will be understood that instead of the drive described above other suitable drives may be employed.

Before applying coating material to the interior surface of a conduit, the surface is preferably cleaned by the removal therefrom of any dirt or other materials adhering thereto, and is then primed with a suitable primer to furnish a bond for the coating compound. The cleaning may be accomplished by sand blasting the interior or passing a wire brush thereover.

In the operation of the apparatus of this invention, tank 9 is filled to a suitable level with coating material, such as bitumen, asphalt or pitch, which is maintained in molten condition, by heat applied thereto from the heater 12. The material is agitated during the use of the apparatus by stirrer 15, thus insuring uniform heating of the coating material. The apparatus is inserted in one end of the pipe or other tubular structure with the pivoted guide wheel 3 in front. Guide wheel 3 functions to automatically guide the apparatus along the center of the pipe. The main shaft is adjusted by means of bolts 6 until it is approximately in line with axis of the pipe. Applicator arms 28 are positioned by loosening set screws 31 so that guide roll 40 contacts with the interior surface of the pipe and the set screws 31 are then tightened to maintain the arms in this position.

The motor 41 is then started and the apparatus moved through the pipe. Pump 19 forces the heat liquefied material to pass through pipe 20, conduit 24, duct 23, and through the distributor nozzles which apply the material in a helical ribbon onto the surface of the pipe. The coating material may be caused to extrude from as many of the applicators as desired by suitably adjusting valves 37. The spreading pads 39, during the operation of the apparatus, may be bent under tension against the pipe surface or may be spaced a desired distance from the surface, e. g.,  $\frac{1}{8}$  or  $\frac{1}{4}$  inch etc. to apply a desired thickness of coating to the interior wall of the pipe. Thus, as the coating material leaves the nozzle it is spread uniformly and evenly over the surface of the pipe by the pressure exerted by the spreaders and spring 64. With the arrangement of the applicator shown in Fig. 1, upon movement of the carriage longitudinally of the pipe, the coating material from each nozzle or applicator is applied to the interior surface of the pipe in the form of a helix, the bands of which may overlap to form a continuous substantially uniform coating thereon. If the pipe surface is uneven the guide rolls 40 follow the surface and

the applicator nozzle 33 pivots about the cross-bar 32 to compensate for the irregularities and to maintain the nozzle at a definite distance from the pipe surface. Hence, damage to the apparatus is minimized and frequent adjustments of the apparatus obviated, as irregularities encountered are compensated for.

The apparatus of Fig. 2 differs from that of Fig. 1 in that two sets of applicators or coating distributors 76 and 77 are employed instead of the single set shown in Fig. 1. Upon movement through the pipe at a suitable rate, the apparatus of Fig. 2 will produce a double layer of coating material. The rate of application of the coating material applied by the apparatus of Fig. 2 is so regulated as to permit the first coat applied by the applicators 76 to set before the second coat is applied to the applicators 77. With bituminous coating applied in the heat liquefied condition at a temperature somewhat above the setting point thereof, e. g. about 300 to 400° F., the coating sets quickly upon contact with a cold metal surface, thus permitting relatively rapid movement of the applicators longitudinally along the pipe with application of a double layer of coating material thereto. Each layer is constituted of a helical band of bituminous material so arranged that the respective layers overlap as shown in Fig. 5 wherein reference numeral 78 depicts the bands of coating material applied by nozzles 76 and reference numeral 79 depicts the superposed bands of coating material applied by coating nozzles 77. It will be noted the meeting lines of the superposed bands 79 represented by the dark lines on Fig. 5, defining the width of a ribbon or band applied by the applicator, are out of alignment with those of bands 78. It is desirable to control the rate of movement of the applicators so as to provide the necessary time interval to permit the coating applied by applicators 76 to set before the coating from applicators 77 is superimposed thereon.

If desired the apparatus may be operated to apply the coating material in circular instead of helical bands by connecting the clutch between shaft 52 and worm-gear 54 to move the apparatus forward through the pipe only after each complete revolution of the applicator nozzles. Suitable clutches (not shown) may be provided between motor 41 and pump 19 and between gear 45 and shaft 22 to stop the operation of the pump and the revolution of the applicator nozzles while the apparatus is moving forward through the pipe.

Fig. 4 shows an alternative form of applicator mechanism. Referring to the drawings, in which the parts corresponding to those of Fig. 1 have been indicated by like reference numerals, main shaft 22 extends a short distance beyond bearing 8 and has pivoted thereto, as indicated by the reference numeral 66, angularly extending supporting members 67. Applicator members 33 are fixed at the end of the supporting member 67, as indicated by reference numeral 68. Coating material is conveyed to the applicators 33 by means of flexible pipes 69 communicating with the main shaft 22 by means of a hollow Y-joint 70. A toggle member 71 has the ends 72 pivoted to supporting members 67 and is provided with a spring 73 extending across the pivoted joints 74 of the toggle. The spring 73 tends to force the toggle arms closer together whereby the supporting members 67 carrying the applicators are moved against the wall of the pipe. Thus, the spreaders 39 on the applicators are maintained

under tension against the coating material applied to the pipe. When in use, the applicator mechanism may be inserted into the pipe while the supporting members are drawn together and when in position the supporting members may be permitted to spread so as to move the spreaders on the applicators against the walls of the pipe under tension provided by spring 73.

The embodiment of the invention illustrated in Fig. 4 is particularly adapted for uniformly coating the interiors of out of round pipes, i. e. pipes of oval or other non-cylindrical shape. It will be observed that the spring-tensioned toggle mounting of the applicator nozzles resiliently presses the rolls 40 into contact with the pipe and allows the nozzles to move inwardly and outwardly so that they follow the non-cylindrical contour of the pipe.

In Figs. 6 and 7 there is illustrated a modified applicator nozzle 73 provided with an arm 74 extending along the forward side thereof (with respect to the direction of movement of the machine through the pipe), a roller 76 journaled in the free end of the arm, and a flexible spreading pad 77. The roller 76 contacts the interior surface of the pipe at a point behind the outlet of the applicator nozzle (with respect to the direction of rotation of the nozzle), but somewhat in advance of the free end of flexible pad 77. This embodiment of the invention is particularly adapted for coating pipes having longitudinal welds or other ridges 78 therein. It will be observed that roller 76 and spreader ride over such ridges simultaneously and apply thereto a layer of coating material of substantially the same thickness as the layer applied to the remainder of the pipe.

The applicator nozzle of Figs. 8 and 9 differs from that shown in Figs. 6 and 7 in that flexible pad 77 is provided with a projection 79 extending from the forward side of the pad adjacent the free end thereof. The projection 79 rides in contact with the interior of the pipe and gauges the thickness of the coating layer applied.

In Figs. 10 and 11 there is shown an applicator nozzle provided with a rigid doctor member 80 extending rearwardly therefrom in lieu of the flexible spreading pads shown in Figs. 1 to 9. The free end of the doctor may be spaced the desired distance from the interior of the pipe to gauge the thickness of the coating layer applied to the pipe by means of a roller 81 mounted thereon and contacting the pipe. Alternatively, roller 81 may be mounted on an arm extending beside the doctor member analogous to the arm illustrated in Fig. 6. The rollers 76 and 81 of Figs. 6 to 11 are preferably bevelled to enable them to ride readily over circumferential welds 82 or other circumferential ridges in the pipe.

It will be understood the apparatus of this invention is not limited to the embodiments herein disclosed and changes may be made in the details of construction thereof without departing from the scope of this invention. For example, in place of electrical heating unit 12, indicated above, other suitable heaters may be provided. Instead of an electric motor a compressed air or other motor may be employed, or if desired the apparatus may be pulled through the pipe by cable actuated from a source of power exterior of the pipe. In lieu of two distributing members, any desired number of such members may be employed.

I claim:

1. Apparatus for applying coating material to the interior of tubular structures comprising a carriage, a tank for coating material on said carriage, a vertically adjustable bearing on said carriage disposed near one end thereof exteriorly of said tank, a hollow shaft rotatably mounted in said bearing and having one end communicably connected with said tank and the other end extending beyond the carriage, an applicator rotatably mounted on the said other end of said shaft and communicating therewith and means for sending coating material from said tank through said hollow shaft into and through said applicator.

2. An apparatus for coating the interior surfaces of tubular structures comprising a carriage adapted to move through the interior of the tubular structure, a guide wheel supported at the front end of said carriage near the mid point thereof, a pair of driven wheels at the rear end of said carriage, a container supported on said carriage, an agitator within said container, a pump, a bearing on said carriage exteriorly of said container, a hollow shaft rotatably mounted in said bearing and communicably connected with said container, extensible supports on said hollow shaft, flexible applicators carried by said extensible supports, discharge nozzles on said applicators, a flexible spreader associated with each discharge nozzle and adapted to uniformly distribute coating material discharged by the nozzle over the interior surface of the tubular structure, a guide roll carried by the nozzle and adapted to contact with the interior of the tubular structure to maintain a constant clearance between the discharge nozzle and the interior wall of the tubular structure, flexible connections between said applicator and said pump, means for rotating said applicator over the interior of said tubular structure, said means being constructed and arranged to drive said agitator, said pump, and to move said carriage through the interior of said tubular structure.

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