Sept. 21, 1971 M. P. HUFF ET AL 3,606,862

PIPE LINING APPARATUS

Filed Aug. 22, 1969 2 Sheets-Sheet 1

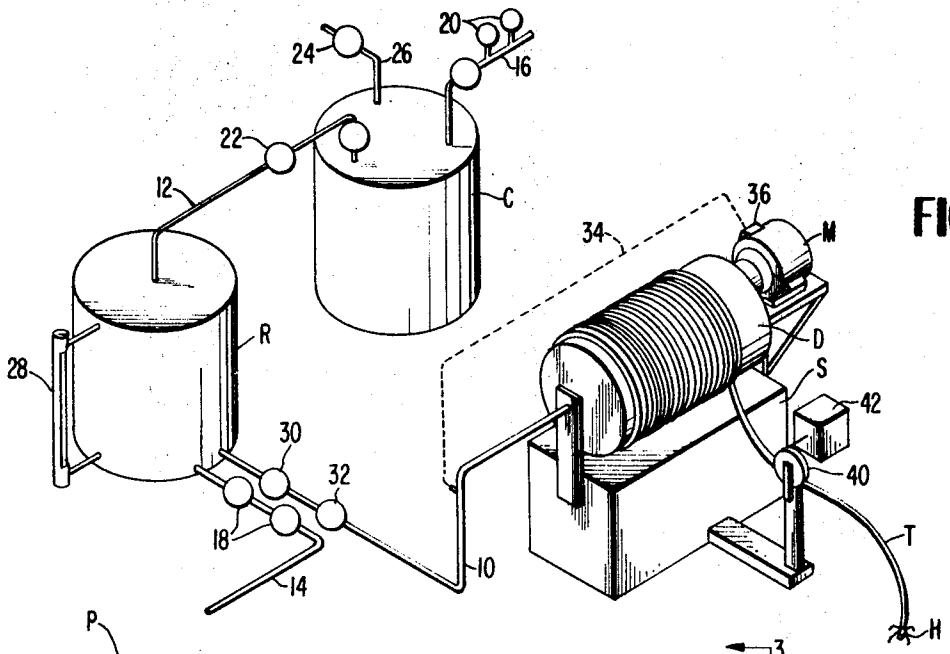

FIG. 1

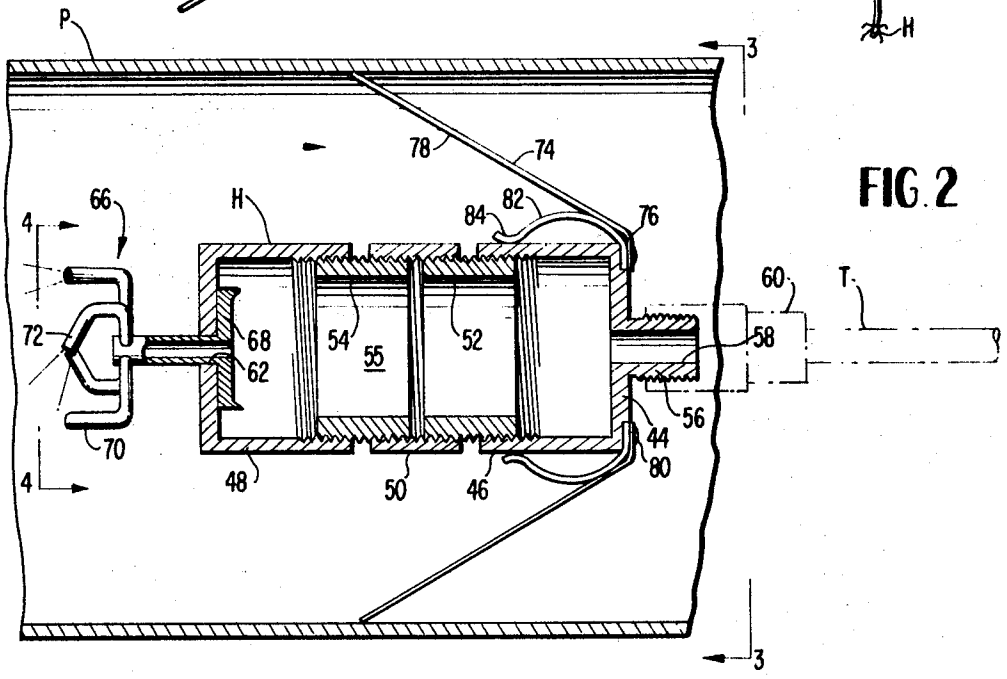

FIG. 2

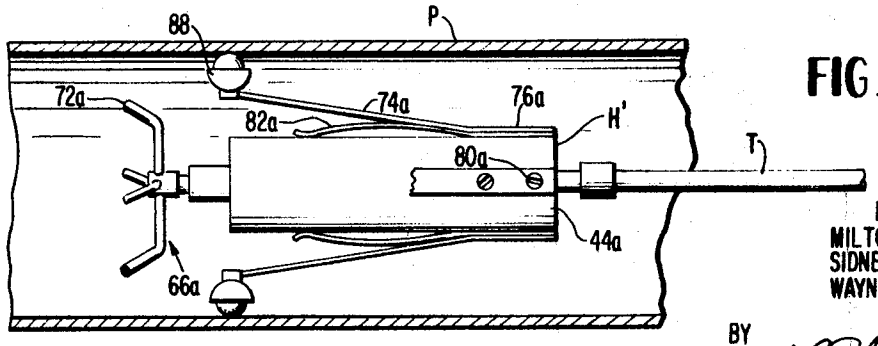

FIG. 7

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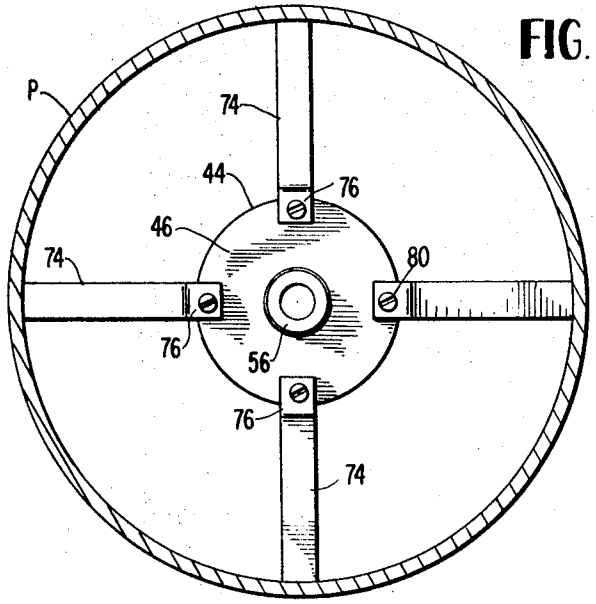
FIG. 3



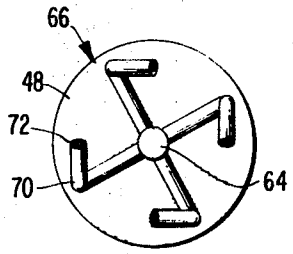


FIG. 4

FIG. 5

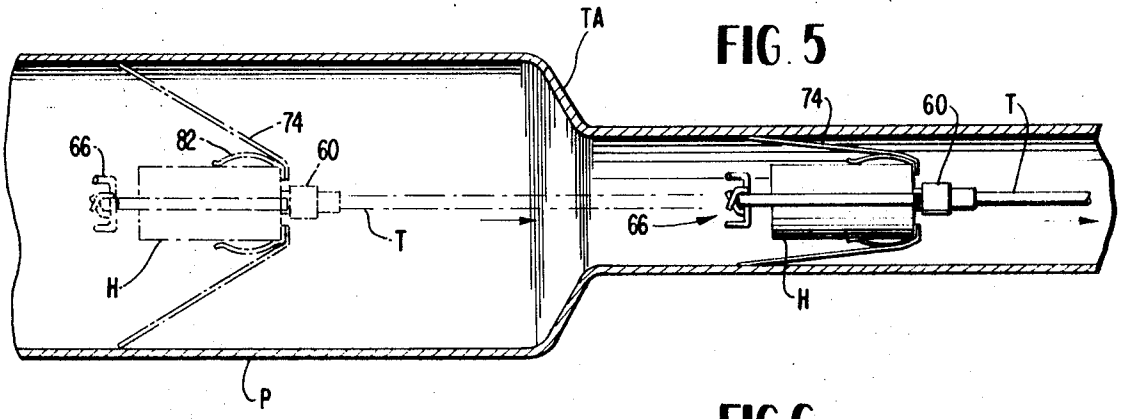
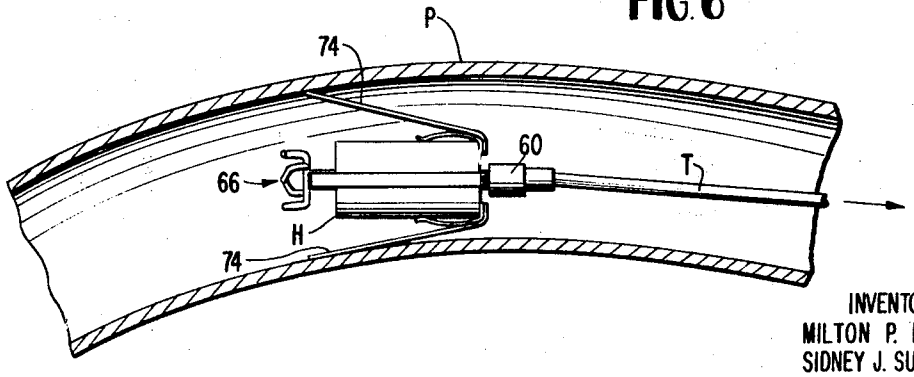


FIG. 6



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PIPE LINING APPARATUS

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ABSTRACT OF THE DISCLOSURE

Disclosed is a motor driven drum for drawing a supply hose and an applicator head through a pipe. The hose communicates through the drum with a reservoir containing coating material and supplies the latter to the applicator head for coating the wall of a pipe. The applicator head has a plurality of nozzles mounted for rotation under centrifugal force to provide a conical spray for applying the coating to the wall as the head is drawn through the pipe. A plurality of centering vanes are carried at circumferentially spaced positions about the head and are spring biased to engage the inner wall forwardly of the spray whereby the head is maintained in a coaxial position relative to the pipe as it is drawn through the latter.

The present invention relates to pipe lining apparatus and particularly relates to simplified and improved apparatus for applying a coating to the interior walls of pipes, tubes and the like having various diameters.

Applicator machines of the general type for applying a lining material, for example, cement, silicates and the like, to the interior wall of a pipe are known and have been used for many years. Conventional pipe lining apparatus of this type often comprises a carriage or dolly mounted on wheels for movement along the interior of the pipe, the carriage carrying an applicator head. The head includes one or more nozzles which may be of centrifugally operated type for spraying the coating onto the wall. The dolly or carriage may be self-propelled and a hose usually connects with a reservoir externally of the pipe for communicating coating material to the applicator head carried by the dolly as the head and dolly traverse the length of the pipe. Alternatively, the carriage or dolly of certain pipe lining apparatus is drawn through the pipe by a cable or the like connected to a motor driven reel with a separate hose supplying the coating material from a reservoir to the applicator head on the carriage.

There are, however, various problems associated with such prior pipe lining apparatus. Specifically, the devices of such prior apparatus are not particularly adaptable for lining the interior walls of pipes of different diameters. The applicator head is normally fixed on the carriage and its position relative to the pipe is determined by the foregoing consideration rather than the particular diameter of the pipe to be coated. Generally, a smooth, even and uniform coating about the inner wall of the pipe is not possible when the applicator head is radially offset from the axis of the pipe. For example, if the applicator head, or specifically the spray nozzles, is positioned by its dolly below the axis of the pipe, it will be seen that the coating applied to the upper wall portions of the pipe will vary in thickness and uniformity as compared with the coating applied to the lower portions of the pipe wall. Thus, to apply a uniform coating about the wall of a pipe employing this conventional apparatus, the applicator or spray head must be adjusted relative to the carriage such that the spray head will be coaxial with the pipe. Often, a different sized applicator and carriage arrangement must be provided.

Moreover, carriage carried applicator heads are not particularly adapted for movement through pipes having varying diameters or through pipes having bends or turns therein. For example, it will be seen from the foregoing considerations that an applicator head fixed to a carriage will move radially relative to the axis of the pipe upon encountering different diameters in the same pipe as it is drawn therethrough. This results in a non-uniform coating on certain wall portions of the pipe. Moreover, when making the transition from smaller to larger diameter portions in a pipe or from larger to smaller diameter portions, the possibility of fouling the supply lines as well as getting the carriage stuck in the pipe is always present. Additionally, certain carriage-carrying applicator heads are unable to negotiate sharp turns or bends in the pipe and this increases the possibility that the carriage will become stuck in the pipe.

The present invention provides an improved pipe lining apparatus which overcomes or minimizes the above-discussed problems associated with prior pipe lining apparatus and provides a novel improved pipe lining apparatus. Particularly, the present invention provides an improved pipe lining apparatus having an applicator head drawn through the pipe to be coated by a hose which supplies the coating material from a reservoir to the applicator head. The coating material is supplied to the head under pressure and rotates a plurality of nozzles carried by the head. Particularly, the nozzles angle laterally and rearwardly from the applicator head and the reaction force of the coating material supplied under pressure on the nozzles rotates the latter to apply the coating material completely about the inner walls of the pipe. Specifically, a conical spray is provided.

To provide a uniform coating about the circumference of the pipe as the applicator head is drawn through the pipe, it is a particular feature of the present invention that a plurality of vanes are spaced circumferentially about and extend radially outwardly from the applicator head to maintain the head substantially coaxially of the pipe. The vanes are spring biased outwardly and their outer tip portions engage the inner wall of the pipe forwardly of the wall portions being coated by the nozzles thereby centralizing the head relative to the pipe. Additionally, the vanes automatically self adjust to maintain the applicator head centered with respect to the pipe throughout a wide range of pipe diameters. Thus the same applicator head can be utilized without adjustment for coating the interior walls of pipes having different diameters. Moreover the spring-biased vanes automatically self adjust to center the applicator head with respect to a pipe at transition areas along the pipe wherein the pipe diameter substantially instantaneously increases or decreases. The vanes also maintain the applicator head coaxial with a pipe having a constant gradual increase or decrease in diameter as the head traverses the length of the pipe.

The applicator head is drawn through the pipe by a motor driven take-up drum assembly. The supply hose is wound about the drum and communicates through the drum with a reservoir containing the coating material. The coating material is conveyed through the hose at a selected rate and the supply hose is threaded through an indicator whereby the rate of travel of the applicator head through the pipe can be determined. The thickness of the coating applied to the wall can thus be preselected.

The present invention is particularly adapted for the coating of a plastic material, such as Teflon, to the interior walls of pipes, tubes or the like. By coating the interior walls of pipes, tubes and the like with Teflon or any of the materials comprising the Teflon family or any other corrosion resistant, low adhesion and low friction material, it is possible to decrease resistance to flow, prevent

cohesion of flowing materials to the coated surface and increase the life of the pipe unit by preventing corrosion. The pipe lining apparatus is particularly useful in pipes, tubes and the like utilized in remote systems wherein accessability thereto is difficult and often unobtainable.

Accordingly, it is a primary object of the present invention to provide an improved apparatus for coating the interior walls of pipes, tubes and the like.

It is another object of the present invention to provide an improved pipe lining apparatus having an applicator head which is automatically maintained in a coaxial position within the pipe.

It is still another object of the present invention to provide an improved applicator head for pipe lining apparatus wherein the head can be employed in pipes having different diameters and without adjustment when utilized successively in two different diameter pipes.

It is a related object of the present invention to provide an improved applicator head for pipe lining apparatus capable of traversing pipes having bends or sharp turns and without substantially affecting the uniformity of the coating applied to the pipe.

It is a further object of the present invention to provide an improved pipe lining apparatus having an applicator head which is drawn through the pipe solely by the hose conveying the coating material to the supply nozzle.

It is a still further object of the present invention to provide an apparatus for coating the interior of cylindrical pipes which provides a substantially uniform coating of selected thickness about the entire interior surface of the pipe.

It is a still further object of the present invention to provide a coating apparatus for lining the interior walls of pipes or the like including an applicator head carrying improved and self adjusting means for maintaining the head centered with respect to pipes having changing diameters as the applicator head is drawn through the pipes.

It is a further related object of the present invention to provide a system for applying a coating to the interior walls of pipes or the like which is simple in construction and use and which can be inexpensively manufactured.

These and further objects and advantages of the present invention will become more apparent upon reference to the following specification, appended claims and drawings, wherein:

FIG. 1 is a schematic perspective view of a pipe lining apparatus constructed in accordance with the present invention;

FIG. 2 is a fragmentary cross-sectional view of a pipe illustrating the applicator head of the pipe lining apparatus hereof located within the pipe;

FIG. 3 is a cross-sectional view thereof taken about on line 3—3 in FIG. 2;

FIG. 4 is a cross-sectional view thereof taken about on line 4—4 in FIG. 2;

FIG. 5 is a fragmentary cross-sectional view of a pipe having a transition area and illustrating the movement of the applicator head from a larger diameter portion through the transition area to a smaller diameter portion;

FIG. 6 is a fragmentary cross-sectional view of a pipe illustrating the applicator head hereof as it traverses a bend or turn in the pipe; and

FIG. 7 is a fragmentary cross-sectional view of a pipe and another form of applicator head hereof.

Referring now to the drawings, particularly to FIG. 1, there is schematically illustrated an improved pipe lining apparatus constructed in accordance with the present invention and comprising an applicator head H adapted to be drawn through a pipe P (FIG. 2) by a flexible tubing or hose T wound about a drum or reel D. The drum is pivotally mounted on a stand S and driven by a motor M in any suitable manner such that the hose T and head H can be drawn through the pipe with the hose T being wound about drum D. The opposite end of the hose T is fixed to drum D and communicates with a reservoir R containing coating material via a conduit **10**. Any suitable connection between conduit **10** and hose T may be provided and the details of this connection are not set forth herein as they are conventional. In the preferred form of the invention, the coating material in reservoir R is pneumatically conveyed through conduit **10** and hose T by a pressurized gas in container C which communicates with tank R via a conduit **12**. The coating material in tank R is thus conveyed under pressure through conduit **10** and hose T to applicator head H.

In the illustrated form, tank R is supplied from a main reservoir, not shown, via a conduit **14** and the pressure fluid in container C is likewise supplied from a main pressure source, not shown, via a conduit **16**. Suitable valves indicated at **18** and **20** are provided in conduits **14** and **16** respectively as desired and a pressure regulator **22** is provided in conduit **12** whereby the pressure in tank R and hence the driving force behind the coating material can be predetermined. A pressure relief valve **24** also communicates with pressure fluid reservoir C via a conduit **26**. An indicator for indicating the level of the coating material in tank R may be provided as desired. A suitable valve **30** for regulating the flow rate of the coating material and a check valve **32** for preventing backflow of coating material from the hose T to the tank R are provided in conduit **10**. A pressure actuated switch **36**, in communication with the coating material under pressure in conduit **10** via a line **34**, is operable to shut down the motor M and stop the reel R in response to pressures in line **10** exceeding or below a predetermined range of pressures. The hose T is fed through and drives a reel **40**. Reel **40**, in turn, drives a conventional velocity meter and a distance measuring gauge whereby the rate of travel of the hose T through the pipe and the length of hose outstanding from reel D can be displaced.

Referring now to FIG. 2, there is illustrated an applicator head H including a cylindrical body **44** comprised of a pair of end couplings **46** and **48** and an intermediate coupling **50**. Couplings **46** and **48** comprise generally cup-shaped members having internally threaded portions adjacent their open ends. The intermediate coupling **50** comprises an internally threaded sleeve. Couplings **46**, **48** and **50** are joined to form cylindrical body **44** by a pair of externally threaded interior sleeves **52** and **54**. Specifically, end couplings **46** and **48** are respectively threaded about sleeves **52** and **54** and coupling **50** joins the opposite ends of the sleeves one to the other. A closed cylindrical chamber **55** is thus formed and the foregoing construction provides an applicator head which can be readily disassembled for cleaning purposes.

Coupling **46** terminates at its forward end in an externally threaded nipple **56** having a central bore **58**. The distal end of hose T carries a conventional coupler **60** for threaded securement with nipple **58** whereby hose T and applicator head H are secured one to the other. The opposite end coupling **48** is provided with a central bore **62** through which a tube **64** is mounted on suitable bearings, not shown, the tube **64** comprising part of a nozzle assembly generally indicated at **66**. The inner end of tube **64** carries a large diameter section **68** for retaining the nozle assembly **66** on applicator body **44**. A plurality of nozzles **70** are disposed circumferentially about the outer end of and in communication with tube **64** and terminate in obliquely extending nozzle heads **72**. With the foregoing arrangement, it will be appreciated that the coating material under pressure is supplied through hose T into the cylindrical body **44** and through chamber **55** for distribution about the interior walls of pipe P by means of the nozzle assembly **66**. Specifically, the pressurized coating material communicates through tube **64** into the nozzles **70** and heads **72** whereupon the reaction of the pressurized coating material on the rearwardly and laterally extending nozzle heads **72** cause the nozzle assembly **66** to rotate and provide a truncated conical

shaped spray supplying coating material against the interior walls of pipe P.

To maintain the applicator head H in coaxial relation with pipe P a plurality of leaf springs or vanes **74** are carried by body **44** at circumferentially spaced positions thereabout. preferably, four springs **74** are spaced circumferentially about 90 degrees apart such that the applicator head H can be supported in coaxial alignment with pipe P for all angular orientations of applicator head H relative to pipe P. Specifically, leaf springs **74** comprise a base portion **76** bent to form an obtuse angle with the leg **78** of spring **74**. The base portion **76** is secured against the front face of coupling **46** by screws **80** with the leg portion **78** diverging rearwardly from body **44**.

Vanes **74** are biased outwardly by arcuate spring, preferably steel, bands **82** secured at like circumferentially spaced positions about body **44** in underlying relation to vanes **74**. Particularly, the bands **80** are secured between the base portions **76** of vanes **74** and end coupling **46** by the screws **80** and extend arcuately between vanes **74** and body **44** to bias the vanes **74** outwardly. The opposite ends **84** of bands **82** are free for sliding movement along the sides of end coupling **46** and inward movement of vanes **74** is thus resisted by the outward bias of spring bands **82**. It will be appreciated that the free ends of vane **74** are adapted to engage the interior walls of a pipe P and automatically center head H along the axis of pipe P. Should the head H become radially offset from the axis of pipe P, the bias of the spring band **80** on the side of head H which lies closest to the wall urges the associated vane **74** outwardly relative to head H with a force greater than the spring band **82** on the opposite side urges its associated vane **72** outwardly. The result of this differential force is to displace the head relative to the pipe back to a position in axial alignment with the pipe P whereby the spring forces of bands **82** are balanced.

Referring now to FIG. 5, it will be seen that applicator head H may be drawn through a pipe P having a transition area TA wherein the diameter of the pipe either increases or decreases. In the illustrated form, the applicator head H is moving from left to right, from the larger to the smaller diameter portion of the pipe, through the transition area TA. The angle of divergence of vanes **74** from body H is accordingly greater in the larger diameter pipe with the head H being centered within the pipe in the manner previously described by the springs **82**. When the head H is drawn through the transition area TA into the smaller diameter portion of the pipe, the vanes move inwardly against the bias of bands **82** with the head H being automatically maintained in a centered position relative to the smaller diameter portion of the pipe. It will thus be appreciated that vanes **74** move inwardly or outwardly automatically relative to the head H depending upon the diameter of the particular pipe. Accordingly, for those pipes having variable diameters through their length, the applicator head H is automatically maintained in a coaxial position relative to the pipe by the self adjusting cooperation between vanes **74** and spring bands **82** regardless of the diameter of the pipe at the particular longitudinal position of the head H along the pipe.

Referring now to FIG. 6, the applicator head H is illustrated as it traverses through a bend or turn in a pipe. By supporting the head H on the vanes **74**, the spray assembly **66** is maintained substantially coincident with the axis of the pipe as the head H traverses the pipe bend.

The operation of the pipe lining apparatus will now be described. The hose T is threaded through the pipe P to be coated in any suitable conventional manner and coupled to the drum D in communication with conduit **10**. The applicator head H thus lies at one end of the pipe while the hose H extends from head H through the full length of the pipe to the drum D located at the opposite end of the pipe. The coating material in tank R is pressurized by admission of the pressure fluid from container C via conduit **12**. The valve **30** is then opened and the pressurized coating material is conveyed through conduit **10** and hose T to head H. The motor M is actuated and drum D begins to wind in hose T thereby drawing applicator head H through pipe P. As head H is drawn through the pipe, the pressurized coating material supplied to head H is distributed uniformly about the interior walls of pipe P by the centrifugally operated nozzle assembly **66**. Note that the nozzle assembly **66** is maintained substantially coaxially of pipe P by the vanes **74** as the head H traverses the pipe whereby a substantially truncated conical spray is provided and a uniform coating is applied to the interior wall of the pipe. As the head H is drawn through the pipe by the hose T, the vanes **74** continuously and automatically adjust the position of head H relative to the axis of pipe P to maintain the head H in coaxial alignment with the pipe notwithstanding differences in diameter of the pipe as head H traverses the length of the pipe. The thickness of the coating applied to the pipe wall can be adjusted by regulating valve **30** in accordance with the rate of travel of the applicator head H through the pipe as indicated by the velocity meter **42**. For remote applications, the total footage of the pipe traversed by the applicator head H is determined by the distance meter and the flow of coating material can be shut off when the length of hose corresponding to the length of the pipe to be coated has been drawn through the pipe.

The present invention is particularly adapted for coating the interior wall of the pipe with a plastic material such as Teflon. Where any of the Teflon family of coating materials are applied, an inert gas, such as nitrogen, is supplied to container C for driving the coating material through the hose T onto the wall of the pipe. Moreover, it will be appreciated that the thickness of the coating can be selected in accordance with the particular application. Such thickness can be controlled by varying the rate of withdrawal of the applicator head as it is drawn through the pipe and by varying the pressure behind the coating material by adjusting the pressure regulator **22** to provide the desired thickness. It will be further appreciated that the size of the nozzle openings through the spray head can be selected for particular applications. Thus, the wide range of coating thicknesses that can be applied by the pipe lining apparatus hereof permits a wide variety of different coating materials to be used.

Another embodiment of the applicator head hereof is illustrated in FIG. 7. In this form, a cylindrical body **44*a*** is provided which at one end is coupled to the hose T as in the previous embodiment. The opposite end of body **44*a*** carries a nozzle assembly **66*a*** having similar rearwardly and laterally extending nozzle heads **72*a*** which are rotated by the centrifugal force of the pressurized coating material flowing through hose T, body **44*a*** and outwardly through the nozzles **72*a***. In this form, the vanes **74*a*** and spring bands **82*a*** are secured as by screws **80*a*** along the side of body **44*a*** adjacent its forward end. Particularly, the screws **80*a*** are inserted through the leg portion **76*a*** of vanes **74*a*** and the forward leg portions of outwardly biased arcuate spring bands **82*a***. The bands **82*a*** bias vanes **74*a*** outwardly as before and the latter carry housings **86** at their distal ends mounting ball bearings **88**. Ball bearings **88** are provided to afford a substantially friction free movement of the applicator head H along the pipe P without scraping along or otherwise damage the interior wall of the pipe.

What is claimed and desired to be secured by United States Letters Patent is:

1. Apparatus for applying a coating maerial to the interior wall of a pipe comprising:

a generally cylindrical applicator head for applying the coating material to the pipe wall, having a diameter smaller than the internal diameter of the pipe, said applicator head being adapted to traverse the length of the pipe in one direction and to receive

the coating material under pressure through a supply hose connected thereto;

a plurality of rearwardly diverging, biased, centering vanes spaced circumferentially about said head, an end of each vane attached to the forward portion of said head, said ends being disposed about the circumference of said head in transverse alignment;

a plurality of arcuate leaf springs disposed circumferentially about said head adjacent and biasing said vanes, each spring having a fixed end and a free end, the fixed end of each of said springs being attached to the forward portion of said head adjacent the end of each vane attached to said head, the free end of each spring being disposed to ride on the outer surface of said head as said spring biases said vane, urging said vane outwardly;

a rotatable nozzle assembly coaxially mounted at the rear end of said head and in communication with said head, said assembly comprising a plurality of rearwardly and laterally directed jets,

so that as said head is drawn through a pipe and coating material is admitted under pressure into said head, said liquid is dispensed through said nozzle assembly causing said assembly to rotate, the material being dispensed therefrom in a truncated conical pattern to coat the interior walls of said pipe.

2. The coating apparatus of claim **1** wherein the end of said vane mounted on said head and the fixed end of said spring are interconnected to said head at a common point with said spring in underlying engagement with said vane, the free end of said spring being disposed for axial sliding movement relative to said head.

3. The coating apparatus of claim **2** wherein said head includes a pair of cylindrical end caps, the forward end cap having an axial opening therethrough; means about said opening for coupling said head to the coating material supply hose; the rear end cap mounting said nozzle assembly.

4. The coating apparatus of claim **3** wherein the end of said vanes mounted on said head and the fixed end of said spring are mounted on the forward cylindrical end cap.

5. The coating apparatus of claim **4** wherein the end of each vane opposite the end attached to said head mounts a roller for rolling engagement along the interior pipe walls to facilitate movement of said head through the pipe.

6. The apparatus of claim **2** further comprising a hose coupled to the forward end of said head, said hose connecting said head and a reservoir of coating material; a take-up reel on said hose for rolling up said hose to draw said head through said pipe while said nozzle assembly dispenses coating material from said reservoir to uniformly coat the interior walls of said pipe

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JOHN P. McINTOSH, Primary Examiner

U.S. Cl. X.R.

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