This invention relates generally to apparatus for applying a protective coating of mortar or like material to the inner walls of pipes, conduits and the like, and more particularly to apparatus for providing such a lining to pipes of relatively small diameter.

One type of apparatus for lining pipes available heretofore includes a coating material applying machine which is propelled through the pipe while progressively applying coating material to the interior surface of the pipe by centrifugal distributor means, the material being supplied from a source of material above ground through a hose drawn ahead of the machine. Apparatus of this type is described in U. S. Patents No. 2,108,319; 2,262,647 and others. A characteristic common to machines of this type has been a powered central rotating system extending longitudinally within the machine including screw-conveyor means for propelling the mortar or other coating material from a supply carried in a hopper or the like on the machine to the distributor head means, the supply at the machine being replenished periodically as needed through the hose from the above ground source. At the distributor head the material has been extruded through radially directed ports by blades of the screw-conveyor system within the ports means wiping across the ports to force the coating material radially therethrough at a rate determined by the screw-conveyor speed while at the same time preventing accumulation of coating material on the annular surfaces between the ports by the direct wiping action thereacross.

While this type of machine has proven highly successful in use, the aforesaid organization thereof results in a machine of considerable cross-sectional size, and accordingly the machines have been limited in use to the coating of pipes of fairly large interior diameter.

In accordance with the present invention means are provided whereby the coating material flow rate to the distributor head is regulated by operation of coating material supply means external to the pipe being lined, and whereby that flow is utilized to operate self-cleaning dispensing port means, so that the intermediate supply hopper within the pipe being lined and the powered rotating screw-conveyor system within the pipe lining machine are eliminated. This permits construction of a machine of much smaller cross-sectional dimensions for operation in pipes of smaller diameter than heretofore possible. According to one form of the invention, the axial rotating system within the lining machine is eliminated entirely, and a non-rotating trawl element of novel construction is provided whereby final smoothing of the applied lining may be effected without the necessity of a rotary power take-off. According to another form of the invention, the trawl means are provided comprising a rotary type trawl powered by the flow of coating material within the machine. In either event, it will be seen that the size of the motor means required on the machine are reduced. For further reducing the over-all dimensions of the machine, the motor means and power output transmission means are preferably of hollow center construction mounted annularly about the lining material supply conduit through the machine. This also permits disposition of the conduit in the machine in a compact manner with the flow there-through being essentially in a straight line for cooperation with the remote lining material feed source exterior of the conduit to be lined.

Accordingly a major object of the present invention is to provide improved pipe lining apparatus enabling the lining of conduits of small cross-sectional size.

Another object of the invention is to provide improved trawl means which is particularly adapted to use in the apparatus as aforesaid.

Another object of the invention is to provide an improved distributor device enabling the dispensing of pipe lining material through the ports of a device of the type described from a source external to the pipe being lined, in a self-cleaning distributor port means operable entirely by the force of that flow.

Still another object of the invention is to provide improved pipe lining material delivering means whereby application of a coat of material of predetermined thickness is facilitated while permitting disposition of the coating material feed pumping means at variably remote distances from the point of application of the material to a pipe being lined.

Another object of the invention is to provide an improved pipe lining apparatus as aforesaid which is compact cross-sectionally and yet is fully reliable in operation.

Other objects of the invention will be apparent from the following description and claims and from the drawings wherein:

Fig. 1 is a fragmentary general view, partly in section, showing pipe lining apparatus in accordance with the invention in use;

Fig. 2 is a schematic wiring diagram of the power and control circuits of the apparatus of Fig. 1;

Fig. 3 is an enlarged longitudinal section view of a portion of the apparatus of Fig. 1 in use in a pipe as in that figure;

Fig. 4 is a longitudinal sectional view of a second portion of the apparatus of Fig. 1 constituting a continuation of the showing of Fig. 3;

Fig. 5 is an enlarged cross-sectional view taken about on line V—V of Fig. 3 showing the arrangement of the distributor head parts of one form of the apparatus;

Fig. 6 is a perspective showing of the flow directing baffle shown in Figs. 3 and 5, with two of the lining material dispensing port-forming bars of the distributor head construction shown in phantom lines;

Fig. 7 is an enlarged cross-sectional view taken about on line VII—VII of Fig. 4;

Fig. 8 is an enlarged cross-sectional view taken about on line VIII—VIII of Fig. 4;

Fig. 9 is a cross-sectional view taken about on line IX—IX of Fig. 4;

Fig. 10 is a cross-sectional view of a modified form of the trawl of the invention.

Fig. 11a is a fragmentary cross-sectional view show-
ing modified trowel means for employment with the apparatus of Fig. 11. Referring more particularly to Fig. 1, a preferred embodiment of the pipe lining apparatus of the invention is shown in the applying the pipe 22 in place below the ground level 24, the apparatus including a trowel element 26 drawn through a coating such as a draw bar 28 by a pipe lining machine 30 in trailing relation thereto. The pipe lining machine 30 comprises a lining material distributor section or portion 32 having a distributor head 34, and a machine propulsion section or portion 36 by which the machine is propelled through the pipe 22. Pipe lining or coating material is supplied to the machine 30 through a flexible conduit or hose 38 from a remote source 40 preferably exterior of the pipe being lined access to the pipe 22 for this purpose being had through a manhole 41 or the like. As shown the source 40 includes a lining material supply tank or hopper 42 and a pump 44 driven by an electric motor 46. Where the coating material is a viscous or semi-solid substance, such as mortar, the pump 44 is preferably of a screw-conveyor type as illustrated.

The lining machine 30 is self-propelled at an accurately determined speed for depositing a lining of a given thickness as will be more fully explained hereinafter, and to prevent disturbance of the travel of the machine the hose 38 is drawn ahead of the machine 30 by separate but coordinated propulsion means. To this end a winch device 50 is provided having a reel 52 driven by an electric motor 54 through suitable gearing 56 for winding a draw cable 58 together with a pump 50 supported by the winch device 50 through an arm 60. The cable 56 is detachably connected to the hose 38 at one or more points, such as a coupling 62 at the outlet end 64 of the hose and at spaced points (not shown) along the portion of the hose within the pipe 22, for drawing the hose through the pipe 22 ahead of the coating machine by operation of the winch. Preferably the hose 38 may be broken into sections at intermediate couplings, one of which is shown at 66, so that as hose accumulates above ground with progression of the machine 30 through the pipe 22, successive sections of hose adjacent the pump 44 may be removed at a coupling 66 on the pump discharge outlet. An electric cable 70 is provided for supplying power to electric motor means of the machine 30 below ground as well as for carrying control circuits for the motors 46 and 54 above ground as will be more fully described. This electric cable 70 may take over a companion sheave of the pulley means 58 and over a second pulley means 72 carried by the winch supported arm 60 to a reel 74 having suitable operator means such as a manual crank 76 and suitable electrical rotary control means indicated generally at 78 so that the cable 70 may be reeled in progressively as slack occurs therein with progressive operative movement of the machine 30.

The parts of the pipe lining apparatus of Fig. 1 located within the pipe 22 being lined are shown in greater detail in Figs. 2 and 3. Fig. 2 showing the trowel and distributor sections of the apparatus while Fig. 4 shows the machine propulsion and coating material hose connection portions of the device.

It will be seen that a dominant feature of the machine 20 is a continuous, substantially straight, coating material feed conduit or pipe 80 extending longitudinally through the machine and substantially coaxially with the pipe 22 being lined from the hose coupling 62 into the distributor head 34, and about which the major rotary elements of the machine are arranged annularly.

Referring more particularly to Fig. 4, the propulsion apparatus 36 of the machine includes a bottom frame 82 upon which are journaled the axes 84, 86 and 88, 90 of forward and rear wheel means tracking along the lower curved surface of the pipe 22 as best shown in Fig. 9. While in some cases single sets of forward and rear wheels would suffice, it is preferred to provide longitudinally spaced wheels at each wheel means, such as by the dual axled, quadruple wheel arrangement shown, for better negotiation of irregularities in the inner wall of the pipe 22 such as may be occasioned by a pipe joint or the like. Alternatively each wheel means could be of a tri-cycle or side-to-side longitudinally staggered wheel arrangement, to substantially the same effect.

The propulsion apparatus frame 82 supports the coating material feed pipe 80 by means of mount means including yoke brackets 102, 104 which receive and cradle double flanged mount brackets 106, 108 mounted on the pipe 80 as mounts. Preferably the yoke and mount brackets 102, 104 and 106, 108 are shaped to interlock for fixing the pipe 80 against rotation. The mount means includes also a cradle shaped roller device 110 journaled by a bracket mount 112 on the frame 82, the roller 110 giving vertical and lateral support to the inlet end of the feed pipe 80 while permitting longitudinal movement thereof as will be described more fully hereinafter.

Motor means are provided to supply tractive effort to the axles 84, 86, 88, 90 and the wheels mounted thereby, and to this end a hollow shaft electric motor 120 is mounted on the pipe 80 in a compact annularly arranged drive housing means 124 of the machine. The drive means are shown semi-diagrammatically to include a housing 122 embodying the motor stator 124 and mounted on the pipe 80 at its opposite ends by mounting flanges 126, 127. Cooperating with the motor stator 124, a motor rotor 128 is revolvably mounted within the stator as by bearings 129, 130 on the pipe 80 and includes an output shaft portion 132 in input relation to the motor output transmission indicated generally at 134. Preferably the motor output transmission 134 is also of annular hollow shaft construction, and may be of a planetary type having a hollow driving sun gear 136 formed on the output shaft portion 132 of the motor rotor 128 and driving planet gears 138, 138 in a ring gear 140 mounted in the housing 122, the planet gears 138 being journaled by a rotatable hollow center spider 142 carrying a hollow center bevel ring gear formation 144. The reduction gearing shown is for example only and any suitable hollow center planetary or other reduction gearing may be employed, whether of one or more stages.

In the schematic arrangement shown, the bevel ring gear 144 drives a bevel pinion 146 which in turn drives a worm 148 cooperating with a worm wheel 150 to drive the output shaft 152 of the gearing. The shaft 152 extends through the far side of the housing 122 as seen in Fig. 4 and mounts a double sprocket 154 (Fig. 9) externally thereof at a confirming indentation 155 in the housing wall. Chain or other suitable drive elements 156, 157 interconnect the sprocket 154 with driving sprockets 158, 160 on axes 84, 90 of the tractor wheels for driving the same. Preferably the companion axles 86, 88 of each multiple wheel unit are driven also, as by chain connections 162, 164 taking about sprockets on the driven axles 84, 90 as shown at 162 (Fig. 9) and sprockets 166, 168 on the axes 86, 88 respectively.

As will be apparent from the description of the dispenser head 34 hereinafter, the rate at which coating material is distributed to the pipe 22 is dependent upon the rate at which it flows through the material feed pipe 80, and therefore in order to provide a pipe coating of predetermined thickness it is necessary to coordinate the rate of flow through the feed pipe 80 and the speed of travel of the machine 20 through the pipe. This rate of feed flow in the pipe 80 as motor speed is limited by frictional resistance within the supply hose 38 and the pressure supplied by the pump 44 and since the length of the hose 38 and its configuration as it is handled above ground continually vary as sections of the hose 38 are removed with progress of the machine 30 through the pipe 22, the rate of flow at the feed pipe tends to vary correspondingly. Accordingly, means are provided to supervise and restore the required relationship of feed flow and coating machine speed.
To this end, flow rate sensitive means are provided which in this case senses the flow rate primarily in terms of the pressure at the feed pipe 80 resulting in the flow from the dispensing head 34. This pressure sensing device comprises a flexible wall section 170 interposed in the feed pipe 80, in the form of a tube of rubberized fabric or other suitable flexible material interposed between flanged connections 172, 174 in the feed pipe line 80. Mounted by a shell portion 176 about the flexible section 170 between the flanged connections 172, 174, are resilient constricting means biasing the tube section 170 toward a transversely flattened position as shown in Figs. 4 and 8 against the pressure of the coating material flowing therethrough. In the construction shown this biasing means comprises cooperating roller members 180, 182 journals by corresponding axles 184, 186 carried by arms or links 188, 190 and 192, 194 pivoted on the shell 176 for movement toward and away from each other, the movement of the rollers toward each other being under the urge of tension springs 196, 198 mounted between extensions of the roller axles 184, 186 as shown, while the movement away from each other is under the forces of the static and dynamic pressure within the tube section 170. For sensing the position of the rollers 180, 182, one of the links 188 is provided with an extension 200 arranged to drive the movable part 202 of a transducer 204 pivotally mounted as at 206 on the casing 176, the sensing means and thus the thickness of the coating applied being adjustable as by a turnbuckle 202a in the transducer movable operator member 202.

The transducer 204 is connected in the electrical circuitry of the apparatus to adjust the relationship between the coating material flow rate and the travel rate of the coating machine to the desired predetermined relationship for maintaining the desired coating thickness applied to the pipe 22. Accordingly the transducer 204 is connected to increase the rate of travel of the pipe lining machine 30 or to decrease the output of the pump 44, or both, upon the sensing of an increase of coating material flow rate as sensed by dilatation of the flexible wall section 170, and vice-versa.

Referring to Fig. 2 the various motors of the apparatus are shown for simplicity of illustration as shunt field C.C. motors although it will be understood that any suitable types of motors may be used together with any suitable circuitry including appropriate control devices of known type performing speed control functions as described above. In the circuit arrangement shown, D.C. power for operation of the apparatus is supplied to terminals 210, 212 from which power is supplied under the control of a master switch 214 to the pump motor 46, the winch motor 54, the propulsion motor 120 and a motor 216 powering the rotary parts of the distributor head 34 as will be described hereinafter. If desired the several motors may be provided with individual switches 218, 220, 222, 224 as shown. In the illustrated arrangement the transducer 204 comprises a pair of rheostats 226, 228 ganged for opposite variation in value under the control of the mechanical input member 202 of the transducer as shown, the respective rheostats 226, 228 being connected in the shunt field circuits 230, 232 of the pump motor 46 and the tractor motor 120 so as to decrease the speed of the pump motor 46 and increase the speed of the tractor motor 20 so upon the sensing of an increase of flow through the feed pipe 80, and vice-versa.

Where, as in the illustrated form of the apparatus of the invention, the coating material feed rate-coating machine travel rate adjustment comprises variation of the machine travel rate rather than control of the machine travel rate, it is highly desirable to provide means correspondingly adjusting the rate at which the coating material supply hose 38 is drawn ahead of the machine. For this reason and in any case to provide synchronization of the movement of the hose 38 with the movement of the machine 30 for preventing disturbance of the speed of travel of the machine by the hose 38, motion disparity take-up means are provided in the feed conduit 88 generally, e.g. by which the same is connected to the hose 38. This motion disparity take-up device 233 comprises a telescoping section of the conduit 88 having interfitting portions 234, 236, internal surface continuity through which is provided by a rubber or other elastic liner 238 which is stretched between the interfitting connections 239, 240 at the opposite ends of the telescoping section to provide a smooth interior surface thereto at all times.

To prevent binding of the liner 238 on the interior walls of the telescoping conduit section under pressure, it is preferred that the liner 238 be relatively inelastic laterally, while having the described elasticity longitudinally. This may be provided by a spiral wire or the like embedded in the liner 238; the outer surface of this wire may project from the outer surface of the liner-sleeve to provide a metal to metal sliding bearing contact with the conduit wall, or the reinforcing element of the liner may be a separate part embracing the liner tube. Preferably the interior diameter provided by the telescoping sections 234, 236 is larger than that of the adjacent portions of a conduit 80 by the thickness of the elastic liner 238 so that smooth interior joints with the adjacent pipe surfaces are provided at the opposite ends of the liner. Biasing means are provided to urge the telescoping section to its fully retracted position; the longitudinal tension of the elastic sleeve 238 serves this purpose and if desired the biasing effect of the sleeve may be augmented by tension springs 242 interconnecting the two interfitting portions 234, 236 of the telescoping section as shown.

For synchronizing the speed of travel of the hose 38 with that of the machine 30 the longitudinally extensible take-up unit 233 functions as a relative speed sensing device, and to this end a transducer 244 is mounted as by a pivotal bracket 246 on one of the telescoping sections 236, the transducer including a mechanical input member 248 connected to the other of the telescoping sections 234 as by a pivotal connection 250. In the electric circuit example shown in Fig. 2 this transducer 244 is in the form of a rheostat connected in the shunt field circuit 252 of the winch motor 54 so that when the telescoping unit 233 is extended the rheostat 244 is changed in its setting to decrease the speed of the winch motor 54 and vice-versa. Accordingly the speed of take-up of the hose 38 is adjusted to match at all times the speed of travel of the coating machine 30, despite the changes in the speed of the coating machine 30 as may be effected by operation of the propulsion motor speed control 228 or any other cause.

As best shown in Fig. 3, the distributor section or portion 32 of the coating machine comprises the distributor head motor 216 having a stator portion or frame 260 which supports the conduit 80 by a flange portion 262, and a hollow shaft rotor 264 supported between the stator 250 and the feed conduit 80 by bearing means 266 and 268, 270, thereby giving further support to the conduit 80. The motor frame or stator 260 thus constitutes the frame of the distributor portion 32 of the machine and is supported at its trailing end by a pair of bearings 262, 272 journaled by a suitable axle mount 274 mounted by the motor stator or frame 260. Although a single axle, two wheel arrangement is shown it will be understood that a double axle, a quadruple, tri-cycle or otherwise longitudinally spaced wheel arrangement may be employed as in the case of the propulsion section wheels if desired.

It will be understood that the distributor and propulsion apparatus of the machine, as shown, would be mounted by single frame and carriage means having forward and aft wheel means of the type described and optionally employing a single electric motor arranged as dual motor means for powering both the distributor head rotor, as hereinafter described, and for driving the machine pro-
pelling wheel means, as hereinabove described. However in the illustrated form of the machine 30, the distributor and propulsion apparatus sections or facilities 32, 36 are embodied for convenience in flexibly detachably connected, interdependently working separate motor means 216, 129. In this construction, the forward end of the distributor portion 32 is supported by a tongue or draw bar 230 mounted by the stator flange 262 and having a detachable ball and socket connection 252 to the frame 82 of the machine propulsion portion 36 as shown in Fig. 4. This ball and socket permits at least some small amount of vertical as well as horizontal angular movement of the two portions 32, 36 of the machine relative to each other. Similarly the portions of the feed conduit 80 mounted by the respective propulsion and distributor portions of the machine are detachable from each other by a quick disconnect joint 284 such as may be provided by a pair of mating flanges 286, 288 on the respective sections of the conduit 89, which flanges are fastened together by cam type removable clamps 290, 292. For imparting flexibility to the conduit 80 between the two portions of the machine a rubber or other suitably flexible conduit section 256 is also provided in the connecting conduit 80 at the longitudinal position of the ball and socket draw bar connection 252. As shown this conduit section 294 is stepped or feathered at its opposite ends to provide a smooth interior surface at its joints with the adjacent portions of the conduit 80, the overlapping portions of the flexible conduit section 294 being held in place by ring clamps 296, 298.

Referring again to Fig. 3 the rotor of the distributor head motor 216 includes a hollow output shaft portion 300 which mounts the revolving portion or rotor 302 of the distributor head 34, as by screws 304, 306. As shown in Figs. 3 and 5 the distributor head rotor comprises a plurality of radial distributor blades or vanes 308, 309 mounted by an annular end plate 310, 312. This structure is shown somewhat diagrammatically herein, and the actual details of construction may be as shown in U.S. Patent No. 2,262,647, and may include replaceable wear plate portions 314 as shown in that patent. Further as shown in that patent, the discharge end of the feed conduit 80 is provided with an annular row of discharge ports 316 disposed for registration with the vanes 308 of the distributor head rotor, these ports 316 being bounded by bar members 318 constituting extensions of the wall of the feed conduit 80 at its discharge end.

However in the case of the present invention, means are provided to direct the flow of coating material from the conduit 80 out through the ports 316 solely under the pressure of the material in the conduit 80 as supplied by the remote pump 44. To this end the port defining bars of Fig. 3 (318) are formed with angularly related side portions 320 providing a relatively sharp leading edge 322 to each of the bars at the inner or upstream side of the bars relative to the flow of coating material therearound. For cooperating with the aforesaid port construction, the end wall 324 of the feed conduit 89 is provided with or shaped to form a baffle device or surface 326 adapted to direct the flowing coating material radially through the ports. In the illustrated construction the baffle surface 326 is provided by the forward surface of the end wall 324, this surface being conical with an apex 328 in the order of 90° extending into the ported discharge portion 330 of the feed pipe 80. Preferably the outer or base portion 332 of the conical surface extends to the outer diameter of the discharge portion 330, and the surfaces at the joining lines of the baffle surface and the bar side surfaces 320 are rounded or filleted as shown at 334 in Fig. 6. To provide this configuration the ends of the port forming bars 318 are tapered in conformity with the baffle surface 326 to mate smoothly therewith and the end wall members 324 is mounted in the end of the conduit 80 by brazed, welded or other suitable connection to the ends of the bars 316 at this tapered joint, with the brazed or weld metal providing the smooth fillets 334. Accordingly the coating material is directed in a smoothly flowing pattern by the baffle surface 326 radially out through the ports 316 in the proper opportunity to lodge and disperse in the discharge or dispensing assembly, the coating material directing surfaces of the ported dispenser construction being streamlined with respect to the flow for functioning in a self-cleaning manner by operation of that flow as induced by the remote pump 44.

From the foregoing it will be understood that the coating material will be fed from the feed conduit 80 through the metering ports 316 whereupon it will be picked up and thrown centrifugally as shown at 336 by the vanes 308 of the dispersing head rotor to form a coating 338 on the interior of the pipe 22 being lined. For greater clarity of illustration, the coating material within the feed pipe 80 and the distributor head 34 has not been shown. While the coating or lining 338 so applied to the interior surface of the pipe 22 is quite smooth, it is sometimes desired to trawl the surface thereof lightly for further smoothing the surface. For this reason a trawling device is provided as shown in Figs. 1 and 3 of the drawing. In the construction shown, the trawl comprises an annularly symmetrical, forwardly disposed disc shaped member 340 of rubber or other resilient material having a forwardly disposed hub portion 342 and an annularly continuous trailing edge portion 344. The trawl is provided with a tapered portion at its hub portion with attachment means such as the draw bar 28 for drawing the trawl through the pipe 22 in trailing relation to the pipe coating machine 30, as by attachment of the bar 28 to a clevis 348 attached to the end wall member 324 of the conduit 80. As shown the bar 358 may be attached to the hub conduit 342 by upset flanges 350, 352 on a stud portion 354 of the bar 28. Members are provided to bias or urge the trailing annular portion 344 of the trawl into bearing relation with the surface of the coating 26, this biasing means being preferably adjustable to vary the trawling pressure. For this purpose the stud 354 is extended rearwardly beyond the hub 342 of the trawl and mounts a circular pressure plate 356 bearing against the resilient walls 340 between the hub 342 and the trailing portions 344 for cooperation with the resilient character of the wall 340 to urge the trailing portion 344 outwardly. To provide the preferred trawling pressure adjustment, the position of the pressure plate longitudinally on the trawl may be varied by tightening or loosening a nut 358 by which the plate 356 is fastened on the stud 354. Preferably the lining contacting or trawling outer surface of the portion 344 of the trawl wall terminates in a substantially cylindrical extended trawling portion as shown at 360.

As shown in Fig. 10 pneumatic means may be utilized in lieu of the pressure plate 356 to resiliently bias the lining bearing or trawling surfaces of the trawl element. In the construction shown in that figure, the trawl 26 comprises an annularly symmetrical body 346 of rubber or other resilient material having a forwardly extending central hub portion 3422 and a rearwardly extending annularly continuous trailing edge portion 344. As in the trawl of Figs. 1 and 3 the hub portion 342 mounts a draw 28 or other attachment means for connection of the trawl to a pipe coating machine in trailing relation thereto.

Within the body of the trawl, a pneumatic pressure chamber 356 is disposed in position to provide air pressure bearing outwardly against the resilient wall 340 for biasing the trailing portion 344 thereof into bearing relation with the coating 26 in the pipe 22 being lined. Conveniently this pressure chamber 356 is in the form of a hollow rubber ball seated in a hollow shaped socket configuration 360 provided by the interior surface of the wall 340 and inflatable through a valve 358 to a pressure providing the desired trawling pres-
As in the trowel 26, the lining contacting or troweling outer surface portion 344 of the trowel wall preferably terminates in a substantially cylindrical portion 360°. In the case of either of the trowel means of Figs. 1 and 3, or 10, respectively, it is preferred to provide carriage means supporting the trowel in addition to such support as may be provided by the troweling surface 360 or 360°. This carriage means desirably carries the entire weight of the trowel element, so as to permit application of an evenly distributed troweling pressure thereby about its annular surface. To this end, a wheeled trowel carriage is provided comprising a pair of angularly related leg ports 352 or 352' of a bracket assembly clamped to the draw bar 28 or 28' as by a clamp screw 364 or 364' and rotatably mounting a pair of wheels 366 or 366'. As best shown in Fig. 3, the wheels are provided with thin, tapered knife edges cutting through the applied coating 338 and running on the inner wall of the pipe 22 for supporting the trowel thereon. These knife edges make thin cuts in the soft mortar, one of which is shown greatly exaggerated at 368 in Fig. 3 as made by the trowel carriage wheel in the background of that figure, these cuts being so thin as to nearly or fully reseal in and any event being eliminated by the subsequently passing trowel.

In Fig. 11, a modification of the coating material flow actuated ported dispensing means of the invention is illustrated. In this embodiment of that facility, a coating material driven turbine element is provided which is preferably in the form of a screw device 370 having spiral blade means 372 resecting to turn the screw upon flow of coating material therewithin to feed within the conduit 80°. One end of the screw or turbine shaft 374 is supported by a loosely fitted seating bearing 376 supported in the conduit by a thin web 378 therein, while the other end of the shaft is journaled at 380 in the end wall 324'

In registry with the dispensing ports 316' of the conduit 80° outlet portion, the turbine shaft 374 is enlarged to provide a flaring or conical baffle port 326' forming in effect the interior end wall of the conduit 80° and mounting a plurality of blades 382 extending into contiguity with the inner surface of the ported discharge portion of the conduit 80° so as to wipe that surface at and between the ports 316' as the shaft 374 is revolved. These blades keep the material within the ported discharge device agitated and prevent accumulation of mortar on the interior wall surfaces between the ports. Preferably the dispenser blades 382 are set at an angle less than that of the turbine blades 372 so as to aid in the conduction of the coating material outwardly along the flared surface of the conical baffle port 326' and out through the ports 316'.

In all other respects the apparatus of Fig. 11 is identical to the corresponding parts of that shown in Fig. 3, except that the V formation of the dispenser ports would ordinarily be arranged so as to provide a source of coating material separate from said machine and adapted to be located exterior of the pipe being lined, and self-propelled supply conduit means interconnecting said source and said machine, said machine comprising a coating material distributor head 34' and an essentially straight feed conduit interconnecting said head with said head for supplying coating material thereto entirely under the pressure of said source, said distributor head comprising a feed discharge port at the discharge end of said feed conduit, said discharge port comprising an annularly arranged radially directed port means and generally conical baffle means directing flow from said feed conduit therethrough, said port means comprising a plurality of ports having relatively angularly related adjacent walls merging to present a streamlined configuration in the direction of the discharge flow therethrough, and fluid flow rate sensitive means at said feed conduit connected in control relation to at least one of said pressure source and the propelling means of said machine, said feed conduit comprising a longitudinally extensible motion disparity take-up means adjacent said supply conduit comprising speed coordinating control means connected in control relation to the propelling means of said supply conduit means.

2. In an apparatus for lining pipe lines, a self-propelled pipe lining machine adapted to move through the pipe for applying coating material to the same, a pressure source of coating material separate from said machine and adapted to be located exterior of the pipe being lined, and self-propelled supply conduit means interconnecting said source and said machine, said machine comprising a coating material distributor head and an essentially straight feed conduit interconnecting said supply conduit means.
duit with said head for supplying coating material thereto entirely under the pressure of said source, said distributor head comprising a feed discharge part comprising an annular wall continuous with the discharge end of said feed conduit and an end wall transverse thereto, said annular wall being formed with annularly arranged radially directed port means contiguous with said end wall, said end wall comprising baffle means providing a generally conical baffle surface having an apex extending into said discharge part coaxially therewith and a base extending to the outer surface of said annular wall, said port means comprising a plurality of slots through said annular wall, the longitudinally extending walls of said slots being angularly related to merge at the inner side of said annular wall, and fluid flow rate sensitive means at said feed conduit connected in control relation to at least one of said pressure source and the propelling means of said machine, said feed conduit comprising a longitudinally extensible motion disparity take-up means comprising speed coordinating control means connected in control relation to the propelling means of said supply conduit means.

3. In an apparatus for lining the inner walls of pipe lines with a self-propelled pipe lining machine adapted to move through the pipe for applying coating material to the same, a pressure source of coating material separate from said machine and adapted to be located exterior of the pipe being lined, and self-propelled flexible supply conduit means interconnecting said source and said machine, said machine comprising a coating material distributor head and an essentially straight feed conduit interconnecting said flexible conduit with said head for supplying coating material thereto entirely under the pressure of said source, said distributor head comprising a feed discharge part and a rotary distributor part coaxial therewith, said discharge part comprising an annular wall continuous with the discharge end of said feed pipe and an end wall transverse thereto, said annular wall being formed with annularly arranged radially directed port means contiguous with said end wall, said end wall comprising baffle means providing a generally conical baffle surface having an apex extending into said discharge part coaxially therewith and a base extending to the outer surface of said annular wall, said port means comprising a plurality of slots through said annular wall, the longitudinally extending walls of said slots being angularly related to merge at the inner side of said annular wall, and fluid flow rate sensitive means at said feed conduit connected in control relation to at least one of said pressure source and the propelling means of said machine, said feed conduit comprising a longitudinally extensible motion disparity take-up means adjacent said flexible supply conduit comprising speed coordinating control means connected in control relation to the propelling means of said flexible conduit means.

4. In a pipe lining apparatus, a pipe lining machine adapted to be propelled through a pipe to apply a coating thereto, said machine comprising a distributor head and a substantially straight feed conduit for supplying coating material thereto, a pressure source of coating material separate from said machine, and supply conduit means connecting said source with said feed conduit, said supply conduit means being adapted to be propelled in advance of said machine, said feed conduit comprising telescoping means to take up motion disparity between said machine and said supply conduit means.

5. In combination with a machine adapted to apply a lining of plastic material to a pipe while traveling therethrough, a trowel means connected to said machine to trail therebehind to smooth the surface of the previously applied lining, said trowel means comprising annular means comprising a rubber-like resilient material arranged to provide a continuous troweling surface about the outer periphery of said annular means, said trowel means comprising bias means adapted to urge said troweling surface uniformly outwardly radially of said annular means against the interior pipe lining surface to be troweled, the rubber-like resilience of said material providing for change in circumferential size of said annular means in response to said bias means and the opposing supply bias means at said lining without discontinuity in said troweling surface.

6. In combination with a machine adapted to apply a lining of plastic material to a pipe while traveling therethrough, trowel means connected to said machine to trail therebehind to smooth the surface of the previously applied lining, said trowel means comprising annular means comprising a rubber-like resilient material arranged to provide a continuous troweling surface about the outer periphery of said annular means, said trowel means comprising bias means adapted to urge said troweling surface uniformly outwardly radially of said annular means against the interior pipe lining surface to be troweled, the rubber-like resilience of said material providing for change in circumferential size of said annular means in response to said bias means and the opposing surface of said lining being troweled, and carriage means connected to support said annular means for relieving said troweling surface of weight of said trowel means and comprising wheel means located to track on the lower half of the pipe in advance of said troweling surface, said wheel means having knife-like tracking edges adapted to cut through the applied lining material to bear directly on the pipe wall, whereby the disturbance of the lining by said wheel means is of such minimal character as to be erased by the subsequently passing troweling surface.

7. In a pipe lining apparatus, means for progressively depositing a predetermined thickness layer of the lining material on a pipe, said means comprising traveling lining material depositing means including a rotary material depositing head and travel speed control means, remote lining means comprising bias means at said feed conduit including pressure control means, conduit means including a variable length flexible hose connecting said pump means with said head and arranged for supplying said head with lining material at a rate in accordance with operation of said pump means, and flow rate responsive means adapted and located to sense the flow rate from said pump through said conduit means to said depositing means, said responsive means being connected in control relation to said speed control and said pressure control means.

8. In a pipe lining apparatus, means for progressively depositing a predetermined thickness layer of the lining material on a pipe, said means comprising traveling lining material depositing means including a rotary material depositing head, remote lining material supply pump means including pressure control means, conduit means including a variable length flexible hose connecting said pump means with said head and arranged for supplying said head with lining material at a rate in accordance with operation of said pump means, and flow rate responsive means adapted and located to sense the flow rate from said pump through said conduit means to said depositing means, said responsive means being connected in control relation to said speed control and said pressure control means.

9. In an apparatus for lining pipe lines, a self-propelled pipe lining machine adapted to travel longitudinally through the pipe to be lined, said apparatus comprising a non-rotating system arranged to extend longitudinally of the pipe comprising a distributor head feed discharge part on said machine and a substantially straight conduit connecting said discharge part, and a non-rotating trowel connected to said machine to trail therebehind and having a continuous resilient annular troweling surface, said trowel comprising adjustable force resilient means adapted to bias said troweling surface against the lining applied to the pipe, said machine comprising a hollow shaft power system annularly embracing said feed conduit, said power system comprising distributor head rotor and machine propulsion drive means comprising
an electric motor having hollow power shaft means and a machine propulsion hollow center speed reducer transmission having hollow input shaft means connected to said power shaft having thin said feed conduit passing through said motor and said transmission within said hollow shaft means of each, pump means for supplying coating material under pressure, and adjustable length supply conduit means connecting said pump means to said feed conduit, said feed conduit comprising flow rate sensitive means connected in control relation to at least one of said propulsion drive means and said pump means.

10. In an apparatus for lining pipe lines, a self-propelled pipe lining machine adapted to travel longitudinally through the pipe to be lined, said machine comprising a coating material conveying system arranged to extend longitudinally of the pipe comprising a distributor head feed discharge part on said machine and a continuous coating material feed conduit extending longitudinally through said machine to said discharge part, said machine comprising distributor means comprising a distributor head rotor cooperating with said discharge part, and machine propulsion means comprising motor means therefor, said motormeans comprising a hollow center electric motor having a central hollow output shaft means and a hollow center speed reducer transmission having a generally central hollow center input shaft means connected to said output shaft, said feed conduit being disposed to pass through said motor and said transmission within said hollow shaft means.

11. In an apparatus for lining pipe lines, a self-propelled pipe lining machine adapted to travel longitudinally through the pipe to be lined, said machine comprising a coating material conveying system arranged to extend longitudinally of the pipe comprising a distributor head feed discharge part on said machine and a continuous coating material feed conduit extending longitudinally through said machine to said discharge part, said machine comprising distributor means comprising a distributor head rotor cooperating with said discharge part, and machine propulsion means comprising motor means therefor, said motor means comprising a hollow center electric motor having a central hollow output shaft means and a hollow center speed reducer transmission having a generally central hollow center input shaft means connected to said output shaft, said feed conduit being disposed to pass through said motor and said transmission within said hollow shaft means, said transmission having annularly disposed output and torque reaction elements passing said feed conduit.

12. In combination with a machine adapted to apply a lining of plastic material to a pipe while traveling there through, trowel means connected to said machine to trail there behind to smooth the surface of the previously applied lining, said trowel means comprising a body member of rubber-like resilient material comprising a hub portion and an annular troweling portion extending outwardly and backwardly therefrom, said troweling portion having a substantially cylindrical continuous outer troweling surface of a circumference variable without discontinuity by reason of the resilience of said rubber-like material, said trowel means comprising resilient bias means adapted to urge said troweling portion outwardly against the lining surface to be troweled, and carriage means connected to said body member through said hub portion and bias means adapting said bias means to be cut through soft lining material to bear directly on the inner wall of a pipe being lined in advance of said troweling surface to thereby relieve said troweling surface of weight of said troweling means, said wheel means being arranged to track on the lower half of the pipe wall only.

13. The combination of claim 12 wherein said bias means comprises adjustable mechanical spreader means acting on said body intermediate of said hub and troweling portions to urge said troweling portion outwardly with a force variable by adjustment of said spreader means.

14. The combination of claim 12 wherein said bias means comprises a variably inflatable pneumatic pressure chamber acting within said body member to urge said troweling portion outwardly.

15. In a pipe lining apparatus, a pipe lining machine adapted to travel through a pipe to apply a coating thereon, said machine comprising a distributor head and a generally longitudinal feed conduit for supplying coating material thereto, a pressure source of coating material separate from said machine, and supply conduit means connecting said source with said feed conduit, said supply conduit means being adapted to be propelled in advance of said machine, said feed conduit comprising longitudinally resiliently extensible section means to take up motion disparity between said machine and said supply conduit means.

16. In a pipe lining apparatus, means for progressively depositing a predetermined thickness layer of the lining material on a pipe, said means comprising traveling lining material depositing means including a rotary material depositing head and travel speed control means, remote lining material supply pump means, conduit means including a variable length flexible hose connecting said pump means with said head and arranged for supplying said head with lining material at a rate in accordance with operation of said pump means, and flow rate responsive means adapted and located to sense the flow rate from said pump through said conduit means to said depositing means, said responsive means being connected in control relation to said speed control means.

17. In an apparatus for lining pipe lines, a pipe lining machine adapted to travel longitudinally through the pipe to be lined, said machine comprising a coating material conveying system arranged to extend longitudinally of the pipe comprising a distributor head feed discharge part on said machine and coating material feed conduit means extending longitudinally through said machine to said discharge part, said machine comprising distributor means comprising a distributor head rotor cooperating with said discharge part, and machine propulsion means comprising motor means therefor, said motor means comprising a hollow center electric motor having a central hollow output shaft means and a hollow center speed reducer transmission having a generally central hollow center input shaft means connected to said output shaft, said feed conduit being disposed to pass through said motor and said transmission within said hollow shaft means.

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