April 21, 1964 H. C. BURDEN 3,130,077

COATING APPARATUS

Filed May 20, 1960 3 Sheets-Sheet 1

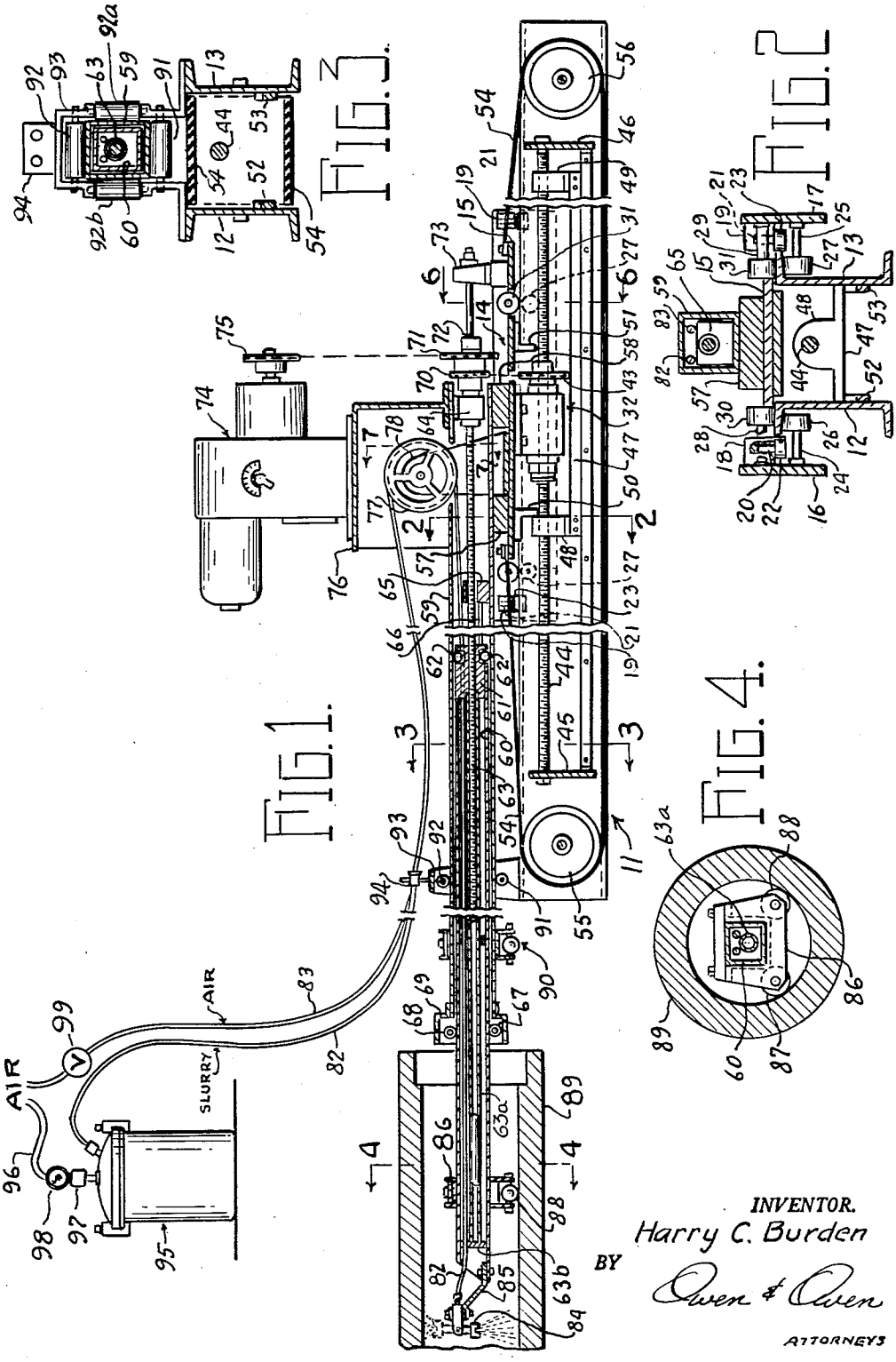


FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

INVENTOR.
Harry C. Burden
BY
Owen & Owen
ATTORNEYS

April 21, 1964 H. C. BURDEN 3,130,077

COATING APPARATUS

Filed May 20, 1960 3 Sheets-Sheet 2

FIG. 5.

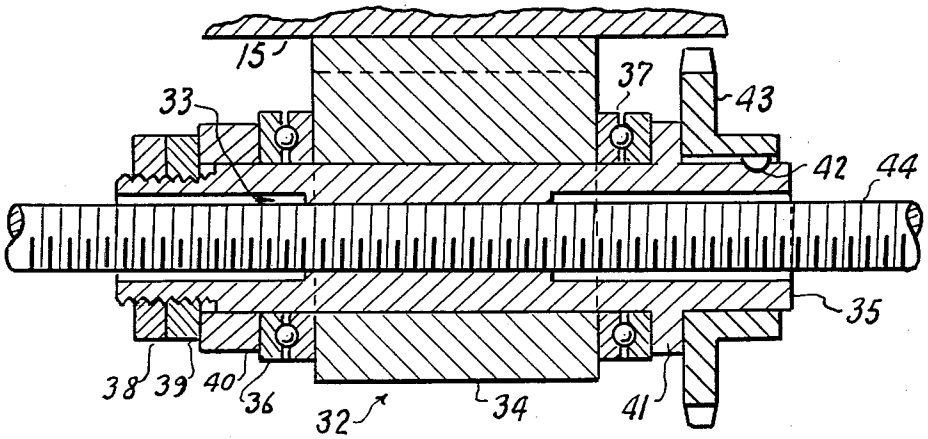


FIG. 6.

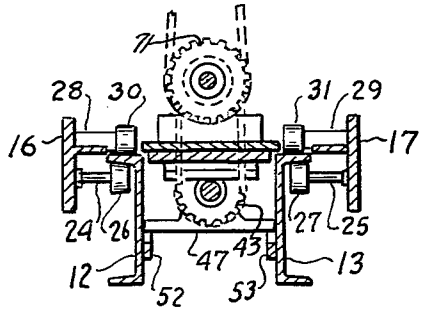
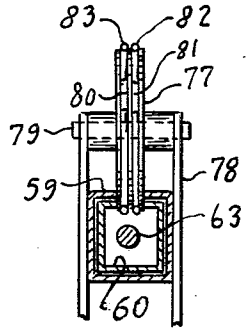


FIG. 7.



INVENTOR.
Harry C. Burden
BY
Owen & Owen
ATTORNEYS

April 21, 1964 H. C. BURDEN 3,130,077

COATING APPARATUS

Filed May 20, 1960 3 Sheets-Sheet 3

FIG. 8.

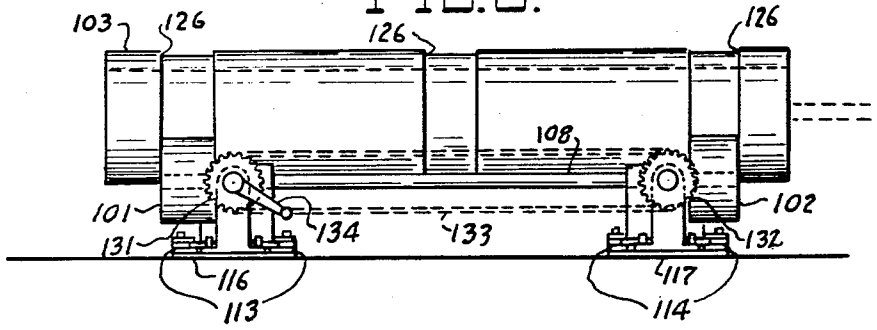


FIG. 9.

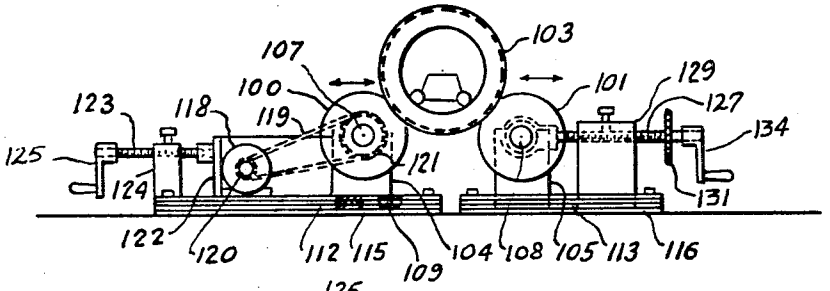
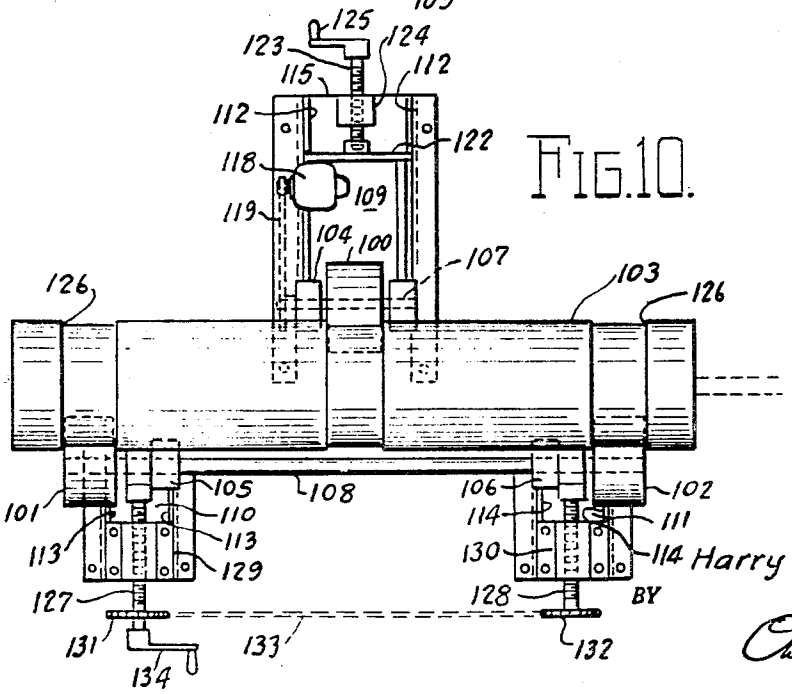


FIG. 10.



INVENTOR.
Harry C. Burden
BY
Owen & Owen
ATTORNEYS

United States Patent Office 3,130,077 Patented Apr. 21, 1964

3,130,077

COATING APPARATUS

Harry C. Burden, Sandusky, Ohio, assignor to Sandusky Foundry & Machine Company, Sandusky, Ohio, a corporation of Ohio

Filed May 20, 1960, Ser. No. 30,502
3 Claims. (Cl. 118—306)

This invention relates to an apparatus for coating or lining the interior of cylindrical articles, and, more particularly, relates to an apparatus for applying a refractory mold wash or temporary coating to the interior of tubular metal molds for use in centrifugal casting processes.

Permanent metal molds in which molten metal is to be centrifugally cast customarily are coated on their interior surface with a refractory material such as graphite, finely divided alumina, silica, flour and similar materials, such materials normally being applied as an aqueous suspension. Such a suspension is termed a "mold wash." The application of the mold wash eliminates the fusion or sticking of the casting to the molds, accelerates the pick-up of the molten metal for rotation with the mold, and enables the attainment of suitable surface characteristic on the outside surface of the particular article being cast.

It is usual to apply the mold wash to the mold interior by means of a lance or the like mounted at one end upon a reciprocating carriage and having a spray nozzle at the other end. The lance and spray nozzle mounted thereon are movable into and out of the interior of the mold, usually either the spray nozzle itself, the lance or the mold being rotated during such axial movement. Although such apparatus functions satisfactory when coating relatively short molds, it has been found that inaccuracies, such as the uneven buildup of the coating material within the mold which results in unequal heat extraction from the mold during casting, and eventually defective castings, occur in the coating surface when longer length molds, for example, over approximately 12 feet, are attempted to be coated. It is believed that such inaccuracies result, among other things, from vibration or sway of the lance and spray nozzle within the mold. In addition, due to the great length of the lance required for coating long molds, the space required for proper installation and operation of the prior art mechanisms is not usually available in the majority of foundries.

It is, therefore, the principal object of the invention to provide an improved apparatus or mechanism for coating the interior of hollow cylindrical articles.

It is a further object of the invention to provide an apparatus for coating permanent metal molds for use in centrifugal casting processes which overcomes the difficulties encountered in the use of the prior art devices and enables the production of substantially uniform coatings of the desired thickness and density over the entire interior surface of the mold.

Another object of the invention is to provide an apparatus for accurately and evenly coating permanent metal molds which are longer than those commonly used at the present time.

More particularly, it is a further object of the invention to provide an apparatus for coating the interior of hollow cylindrical articles in which a coating applying means is affixed to one end of a first tubular member, such first member being mounted for telescopic movement axially of the cylindrical article in a second tubular member supported by and affixed to a traveling carriage.

Still another object of the invention is to provide a novel apparatus for coating permanent molds, which apparatus is adjustable in order to enable its use with molds of various diameters and lengths.

Other objects and advantages will in part be apparent and will, in part, appear hereinafter. For a better understanding of the nature and objects of the invention, reference should be had to the following detailed description and accompanying drawings, in which:

FIG. 1 is a broken, fragmentary, side elevational view, with certain parts shown in cross section and certain parts shown schematically, of an apparatus for coating or lining metal molds in accordance with the present invention;

FIG. 2 is a cross-sectional view taken along the line 2—2 of FIG. 1 with certain parts broken away;

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 1;

FIG. 4 is a cross-sectional view taken along the line 4—4 of FIG. 1;

FIG. 5 is an enlarged, fragmentary detailed sectional view of a driving nut assembly located under the driving carriage;

FIG. 6 is a fragmentary, cross-sectional view taken along the line 6—6 of FIG. 1;

FIG. 7 is a fragmentary cross-sectional view taken along the line 7—7 of FIG. 1;

FIG. 8 is a diagrammatic side elevational view of a centrifugal casting mold and a mechanism for rotating same and showing a mold in position thereon;

FIG. 9 is a diagrammatic front elevational view of the mold rotating mechanism and showing a mold in position thereon; and

FIG. 10 is a top plan view of the mold rotating mechanism with a mold positioned thereon.

In general, the coating apparatus of the present invention includes a mold supporting mechanism; two tubular members having a common axis and geometrically similar cross sections which are movable axially into and out of the mold, one of such members having a smaller cross section than the other and being telescopingly mounted within the larger cross sectional member for reciprocal movement longitudinally or axially thereof, the larger cross sectional member being mounted on a carriage adapted for reciprocation on a pair of longitudinally extending rails; a spray nozzle affixed to the forward end of the inner telescoping member for applying mold coating material to the interior of the rotating molds; mechanism for simultaneously driving, in the same direction and at substantially the same speed, both the carriage and the inner telescoping member; and means for supplying coating material under pressure to the spray nozzle. It will be appreciated that, due to the novel telescoping construction of the present apparatus, a minimum of space need be utilized in the foundry for installation of the apparatus and performance of the process of coating molds of considerable length.

Inasmuch as the apparatus of the present invention is especially well suited for use in the coating of permanent molds for centrifugal casting processes, the following disclosure will be directed primarily to this particular application of the inventive concept. By so doing, however, it is not intended to limit the scope of the invention to apparatus for coating centrifugal casting molds, it being apparent in this respect that the apparatus also has utility in connection with the interior lining or coating of other tubular articles.

Referring now more particularly to the drawings, reference numeral 11 indicates generally the frame of the coating apparatus and essentially comprises a pair of heavy, spaced channel irons 12 and 13, the upper portions of which form rails upon which a carriage, indicated generally at 14, is mounted for reciprocation towards and away from one end of the rails 12 and 13. The carriage 14 comprises a base support 15 affixed along a portion of its length to a pair of side braces 16 and 17 (see FIGS. 2 and 6). Extending inwardly from the side braces 16 and 17 at either end thereof are a pair of support mem-

bers 18 and 19. Shafts 20 and 21 extend downwardly from the support members 18 and 19 and carry a pair of side rollers 22 and 23. The side rollers 22 and 23 cooperate with the side of the rails 12 and 13 to prevent lateral movement of the carriage during the longitudinal or axial movement thereof. Additionally, extending inwardly from the side braces 16 and 17 and affixed thereto adjacent either end of the braces are a pair of shafts 24 and 25 upon which bottom rollers 26 and 27 are journaled, and pair of shafts 28 and 29 extending parallel to and positioned directly above the shafts 24 and 25 upon which top rollers 30 and 31 are journaled. The upper, outwardly extending flanges of the channel shaped rails 12 and 13 are thus gripped between the respective upper and lower rollers 26 and 30, and 27 and 31 to steady the carriage for free rolling movements along the tracks.

An assembly 32 is secured to the underside of the base support 15 and includes a rotating nut mechanism indicated generally at 33 (see FIG. 5), which mechanism provides the driving connection for the carriage. The assembly 32 comprises a bearing block 34 affixed to the base support which in turn has a bore therethrough providing a bearing surface for a rotating nut 35. A pair of anti-friction thrust bearings 36 and 37 are provided and are held in place at either end of the bearing block 34 by a pair of adjustable lock nuts 38 and 39 and a spacer bushing 40 at one end thereof, and a circular flange 41 on the nut at the other end. The nut 35 is keyed, as indicated at 42, to a chain driven sprocket 43 and is engaged by and cooperates with a screw spindle 44, which spindle is affixed to the frame by spaced vertical members 45 and 46 at each end.

A sliding screw supporting assembly including a longitudinally extending member 47 and a pair of upstanding bearing brackets 48 and 49 fixed at either end thereof is provided to effectively eliminate sag of the screw spindle during movement of the carriage longitudinally therealong. The screw spindle extends through a bore provided in each of the brackets, the bores having a diameter slightly larger than the diameter of the threads of the screw spindle 44 and the supporting assembly is moved a limited distance in either direction with the carriage 14 by means of a pair of downwardly extending fingers 50 and 51 affixed to the under surface of the base member 15 on either side of the assembly 32. These fingers 50 and 51 engage the brackets 48 and 49 and cause reciprocation of the supporting assembly. The sliding supporting assembly is itself supported and guided in its movement by a pair of inwardly extending gib members 52 and 53, secured to the inner surfaces of the rails 12 and 13.

A strap of flexible material 54, having a width approximately equal to the width of the frame, is fixed at either end of the base member 15 and extends over a pair of idler pulleys 55 and 56 at either end of the frame. The flexible strap 54 serves to protect the screw spindle 44 and cooperating parts from dirt and other foreign materials collecting thereon.

Secured to the upper surface of the base member 15 by means of spacer blocks 57 and 58 is a longitudinal extending tubular member 59, which tubular member supports, for reciprocating axial movement therein, an inner telescoping tubular member 60. The tubular member 60 is supported at its inner end in the outer member 59 by means of a nut 61 suitably provided with rollers 62 which engage the inner surface of the outer tubular member. The nut 61 is engaged by a screw spindle 63 extending substantially through the inner tubular member 60, which screw spindle is journaled adjacent its rear end in a bearing block 64. For preventing sag of the spindle 63 rearwardly of the nut 61, a supporting block 65 is provided through which the spindle extends. The block 65 is moved longitudinally during operation as the nut 61 is moved. Preferably the following motion of the supporting block is accomplished by connecting it to the nut by a lost motion connection including a rod 66 which is fastened to the block and slidingly extends through the nut. The rod has an enlargement at its forward end so that the nut will carry the block along during forward movement, and will push the block back during rearward movement to any suitable position in the outer tubular member 59. A tube 63*a* supports the screw spindle 63 in the inner telescoping tubular member 60 between nut 61 and the forward end of the tubular member 60. The tube 63*a* is secured at its rear end by a counterbore in the end of the nut 61 and at its forward end by a plate 63*b* which closes the end of the tubular member 60. At the outer or forward end of the outer tubular member, the inner telescoping member 60 is supported by a roller 67 journaled in a suitable housing 69 fixed to the forward end of the outer tubular member 59, and guided by a top roller 68 and, if desired, by a pair of vertically extending side rollers (not shown) which may also be journaled in the housing 69.

The screw spindle 63 is suitably keyed at its rear end to a chain-driven sprocket 70 which in turn is fixed to and rotates with a chain sprocket 71, supporting shaft 72 being journaled in a pillow block 73 secured to the rear of the carriage. The screw spindle 63 and nut 35 are driven by a reversible motor and variable speed drive unit indicated generally at 74, through a sprocket 75 mounted on the shaft of the variable speed drive nut and the sprocket 71, chain drives being established between the sprocket 75 and the sprocket 71, and between the sprockets 70 and 43. The motor and variable speed drive unit 74 are mounted over the outer tubular member 59 by a housing 76 which is supported on the carriage 14. It will thus be appreciated that the carriage 14 and inner tubular member 60 are driven in synchronism to cause a telescopic extension or retraction of the inner tubular member relative to the outer tubular member 59.

An idler pulley or sheave 77 is supported on the carriage by means of a generally U-shaped bracket 78 and a shaft 79 journaled therein, and is protected by the housing 76. The pulley 77 is formed with two side-by-side grooves 80 and 81 on its periphery, which grooves are adapted to receive and support a pair of hoses 82 and 83. The hose 82 provides delivery means for the desired refractory mixture or slurry for coating the inner surface of the molds while the hose 83 serves as the delivery means for compressed air for atomizing such slurry. The pulley 77 is mounted at a height such that the lower extent of its periphery lies in a horizontal plane at approximately the same vertical height as the upper surface of the outer tubular member 59. The hoses extend through the outer and inner tubular members 59 and 60, suitable bores being provided through the nut 61 and plate 63*b*, and terminate at a spray nozzle 84 secured to the forward end of the inner tubular member by a bracket 85. The nozzle 84 is pivotally mounted by the bracket 85 so as to enable its adjustment in a vertical plane to any desired position between the solid and dotted line positions whereby the coating slurry may be discharged radially or axially of the mold as is well known in the art. A supporting member 86 is fixed to the inner tubular member adjacent its forward end and provided with rollers 87 and 88 which contact the inner cylindrical surface of a mold 89 and support such inner member when the same is received in a mold. In a similar manner, the outer tubular member 59 is provided with roller support means indicated generally at 90 adjacent the forward end thereof.

The outer tubular member 59 is supported for axial movement on the frame 11 by a roller 91 suitably journaled in a housing 93, and guided by a top roller 92 and a pair of vertically extending side rollers 92*a* and 92*b* also journaled in the housing 93. In addition, the housing 93 supports a clamp 94 for rigidly holding the hoses 82 and 83 against movement.

A suitable pressurized feed tank is indicated generally

at 95 and contains the desired refractory coating slurry for application to the inner surface of the mold. The tank 95 is provided with a compressed air inlet 96, a suitable valve being provided at 97 for controlling the pressure on the slurry and, thereby, its rate of flow through the hose 82. The feed tank also includes a conventional agitator (not shown) which extends downwardly therein and is driven by an air motor 98 for maintaining a substantially homogeneous slurry. In addition, the air hose 83 leads from a suitable compressed air source and is provided with a valve 99 for maintaining the desired atomizing pressure in such hose and at the spray nozzle. One type of mold supporting and rotating apparatus which may be successfully employed with the coating mechanism in accordance with the invention is shown somewhat diagrammatically in FIGS. 7–10 and includes laterally adjustable rollers 110, 101 and 102. These rollers are adapted to receive molds such as that indicated at 103 and support and rotate them during the coating operation. Each of the rollers are mounted on bearing standards 104, 105 and 106, the roller 100 being keyed to a shaft 107 journaled in the bearing standard 104, while rollers 101 and 102 are mounted on a common shaft 108 journaled in standards 105 and 106. The bearing standards are secured to base plates 109, 110 and 111, which in turn are slidably mounted on bearing gibs 112, 113 and 114 fixed to floor plates 115, 116 and 117, respectively.

A mechanism is included for driving the roller 100 and comprises a variable speed motor 118 mounted on the base plate 109. A continuous belt 119 extends from the drive shaft pulley 120 of the motor 118 to a pulley 121 keyed on the shaft 107 thereby providing a driving connection therebetween.

An upstanding member 122 is provided at the rear of the base plate 109 and is secured to the inner end of a screw 123 which is in turn threaded through a support block 124. The outer end of the screw 123 is squared to receive a wrench or crank 125 whereby on rotation of the screw 123, the base plate 109, motor 118, bearing standard 104, and roller 100 are adjusted laterally along the bearing gibs 112 to permit the roller 100 to be positioned properly with reference to the rollers 101 and 102 in order to accommodate molds of different diameters. The rollers are engaged in longitudinally spaced grooves 126 suitably provided in the outer surface of the mold in order to prevent end play thereof during high speed rotation. It should also be noted that although in the particular embodiment illustrated the mold itself is rotated during the coating operation, it is also possible to mount the mold in a fixed position and employ a rotating spray nozzle or one which emits a 360° spray to assure the entire inner surface of the mold is coated.

In a like manner, the rollers 101 and 102 are laterally adjustable by connection of screws 127 and 128 to the bearing standards 105 and 106 respectively. The screws are threaded through support blocks 129 and 130 secured to the base plates 110 and 111 and are provided with sprockets 131 and 132 respectively adjacent their outer ends between which an endless chain 133 is connected. The screw 127 is squared at its free end to receive a wrench or crank 134 whereby upon rotation of the crank, screws 127 and 128 are rotated together and rollers 101 and 102 move laterally. It will thus be appreciated that any size mold can be positioned with its longitudinal axis in the same vertical plane and at the desired height relative to the tubular members 59 and 60. It will be apparent that the adjustable roller mechanism described above constitutes only one manner of obtaining alignment between the axis of the mold and the axis of the coating applicator. Such alignment may also be maintained by raising or lowering the plane of movement of the carriage 14.

In order to fully disclose the functioning of the invention, a complete cycle of the operation carried out by the apparatus illustrated in the drawings will now be described and explained. At the beginning of an operation, the carriage 14 and the inner tubular member 60 will be fully retracted and the feed tank will contain sufficient coating or lining material therein to cover the full length of the mold being processed. A properly preheated mold is then lowered upon the rollers 100, 101 and 102, and such rollers laterally adjusted so that the axis of the mold is in end-to-end alignment with the telescoping members 59 and 60, and at a vertical height such that the members may be moved axially therethrough.

When the mold has been properly positioned on the supporting rollers, the motor 74 is started in the proper direction to move the carriage 14 and the inner telesoping member 60 simultaneously through the mold until the spray nozzle 84 is adjacent the remote end thereof. In this respect, it will be noted that due to the chain and sprocket connections, the movement of the carriage 14 together with the outer tubular member 59, and the inner tubular member 60 is cumulative. Preferably this movement is geared through the sprockets so that the effective lineal motion of the end of the inner tubular member 60 is at twice the speed of the end of the outer tubular member 59 whereby the inner tubular member moves approximately twice the distance that the carriage and outer tubular member move. Further in this connection it should be noted that a limit switch (not shown) is preferably provided on the carriage and actuated by contact with suitable trips located at any desired position adjacent either end of the frame, whereby the motor 74 is automatically cut off on such contact, thereby eliminating any possibility of the carriage overrunning its track or the inner tubular member 60 advancing beyond the end of the screw spindle 44.

It will also be noted that the hoses 82 and 83 are rigidly held by the hose clamp 94. Neither hose, therefore, travels in either direction through this clamp whereby their lengths are fixed through the telescoping tubes, both these hoses terminating at the spray nozzle. Of course any travel of the hose within the small diameter tube is at twice the speed at which the hose pulley 77 will travel. However, this greater hose speed within the inner tube is compensated for by the double reeving of hose between the clamp 94 and the nozzle 84. This is an important feature since it enables the air and slurry to be delivered to the spray nozzle through hoses that are constant in length and constant in the number of bends and thus of constant resistance to flow. When coating a long mold, this feature eliminates the hose friction variable which would be high when the hose was reeled, for example, on a drum, and low when the hose is extended. The pulley 77, in other words, serves merely to change the direction of the hoses and provide the entrance for the hoses through the hole in the top of the outer tube 59. Of course, this operation is reversed when retracting the tubes, a constant length of hose being maintained.

When the spray nozzle has been positioned as described above, with the nozzle slightly beyond the far end of the mold length, the rollers 100, 101 and 102 may again be adjusted, if necessary, to bring the roller supports 88 and 90 into contact with the inner surface of the mold. The motor 118 is then started and drives the roller 100 thereby rotating the mold about its longitudinal axis. As the mold rotates, the rollers 88 and 90 revolve on the interior of the mold.

The motor 74 is then reversed and again started in order to retract both the outer and inner tubular members 59 and 60 from the mold at a predetermined speed. At the same time, the compressed air valves 97 and 99 are opened to the desired extent whereby the slurry is forced through the hose 82 causing the spray nozzle 84 to discharge a plurality of jets of the coating slurry at high velocity.

With the mold rotating about its longitudinal axis, the spray nozzle discharging jets of coating slurry, and the

motor operating to cause retraction of the carriage **14** and inner tubular member **60**, the nozzle delivers the coating material onto the interior of the mold length, the rotation of the mold insuring thorough coating of the entire interior surface. It will be appreciated that the air pressure, the speed of rotation of the mold, and the speed of withdrawal or retraction of the telescoping members are all suitably predetermined to enable the desired coating thickness to be applied to the interior of the mold surface. Preferably, these variables are so chosen as to enable the desired coating thickness to be applied during one pass of the spray nozzle.

When the spray nozzle **84** reaches the rear end of the mold, valves **97** and **99** are closed, thereby terminating the application of the coating slurry. The operation of the motor **118**, however, is continued to maintain rotation of the mold for a short time after the completion of the actual operation of applying the coating to enable settling or solidification of the same. In this respect, by rotating the mold for a short time after the completion of the application of the coating, a uniform distribution thereof is assured by the resulting centrifugal action, and any accumulation of an excess of coating slurry at the bottom of the mold is avoided. Similarly, the motor **74** is also permitted to operate for a short time after application of the coating slurry has been discontinued so that the spray nozzle **84** and inner telescoping member **60** are withdrawn rearwardly a sufficient distance to permit the next mold to be coated to be suitably positioned on the rotating apparatus.

It will now be appreciated that the present invention is characterized by important advantages and provides an apparatus for uniformly coating the interior surfaces of tubular articles thoroughly and rapidly. By providing the telescoping movement of the tubular members **59** and **60** as described above, the accurate coating of relatively long molds may be accomplished without necessitating a great amount of foundry space to be appropriated for the operation. In addition, the invention provides means for easily adjusting the apparatus to accommodate molds of various sizes, the construction of the various elements being simple and readily accessible so that no serious maintenance problem is involved.

While what has been described is considered to be the most advantageous embodiments of the invention, it is apparent that many modifications and variations can be made in the specific details, construction and arrangement of the parts without departing from the spirit and scope of the present invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention as defined by the appended claims.

I claim:

1. In apparatus for applying a coating on the interior of a cylindrical article, the combination comprising a frame, a first tubular member supported by said frame, said first tubular member having an opening near a rear end thereof, a second tubular member mounted for telescoping movement relative to said first tubular member and including coating applying means mounted on the forward end thereof, means positioned forwardly of said frame for rotatably mounting the cylindrical article in end-to-end relationship with said first and second tubular members for reception thereof, first driving means to cause telescopic extension and retraction of said second tubular member relative to said first tubular member, second driving means of rotating said cylindrical article to aid in the distribution of the coating, a hose extending from a source of coating material through said rear opening in said first tubular member and through said first tubular member to supply coating material to said coating applying means, and holding means associated with said frame for supporting said hose with the portion of the hose between said holding means and said coating applying means being substantially free of slack when said coating applying means is in an extreme forward position.

2. In apparatus for applying a refractory coating, deposited from a slurry, on the interior of a tubular mold, the combination comprising a frame, a first tubular member supported by said frame, said first tubular member having an opening near a rear end thereof, a second tubular member mounted for telescoping movement relative to said first tubular member and including coating applying means mounted on the forward end thereof, means positioned forwardly of said frame for rotatably mounting the tubular metal mold in end-to-end alignment with said first and second tubular members for reception thereof, first driving means to cause telescopic extension and retraction of said second tubular member relative to said first tubular member, second driving means for rotating said mold to aid in the distribution of the coating, two hoses extending from a source of the slurry and a source of air through said rear opening in said first tubular member and through said first tubular member to supply air and the slurry to said coating applying means, and holding means associated with said frame for supporting said hoses with the portions of the hoses between said holding means and said coating applying means being substantially free of slack when said coating applying means is in an extreme forward position.

3. In apparatus for applying a coating on the interior of a cylindrical article, the combination comprising a frame including a longitudinally extending track, a traveling carriage mounted for reciprocating movement on said track, a first tubular member fixed to said carriage and extending forwardly thereof, said first tubular member having an opening near a rear end thereof, a second tubular member mounted for telescoping movement in said first tubular member and including coating applying means mounted on the forward end thereof, means positioned forwardly of said frame for mounting a cylindrical article in end-to-end alignment with said first and second tubular members for reception thereof, first means for driving said carriage to advance and retract said coating applying means, second driving means actuated with said first driving means to cause telescopic extension and retraction of said second tubular member relative to said first tubular member at a rate equal to the rate of said carriage and said first tubular member relative to said track, hose means extending from a source of coating material and air through said rear opening in said first tubular member and through said first tubular member to supply coating material to said coating applying means, holding means fixed relative to said track in a position at least as close to the position of the cylindrical article to be coated as the rear opening of said first tubular member when said first member is in its extreme forward position, said means holding said hose means at a fixed point with the hose means between said holding means and said coating applying means being substantially free of slack when said coating applying means is in an extreme forward position whereby said hose means will remain substantially free of slack and kinking for all positions of said first and second tubular members.

References Cited in the file of this patent

UNITED STATES PATENTS

2,249,741	Bowers et al.	July 22, 1941
2,348,714	Defiore	May 16, 1944
2,612,070	Hoelcher	Sept. 30, 1952
2,693,736	Schumacher	Nov. 9, 1954
2,885,711	De Mart	May 12, 1959
2,885,920	Livingston	May 12, 1959
2,929,564	Stone et al.	Mar. 22, 1960