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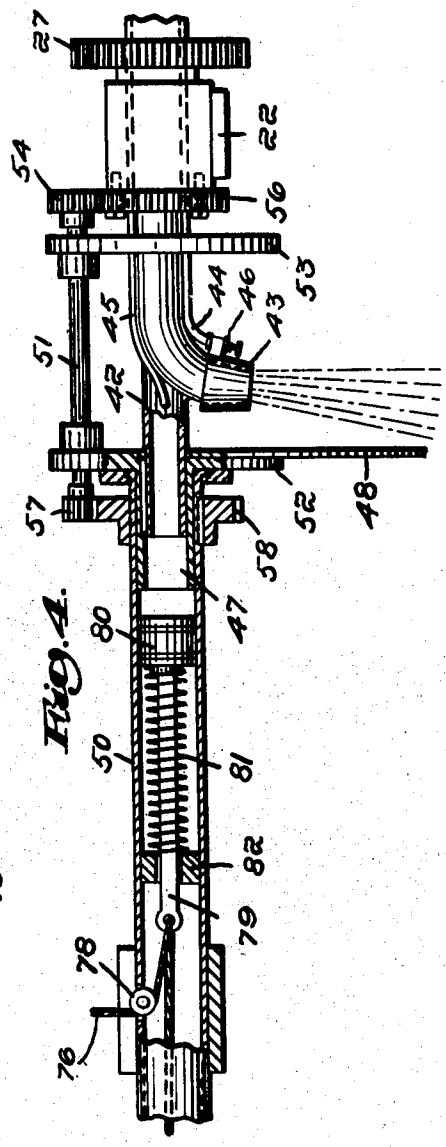
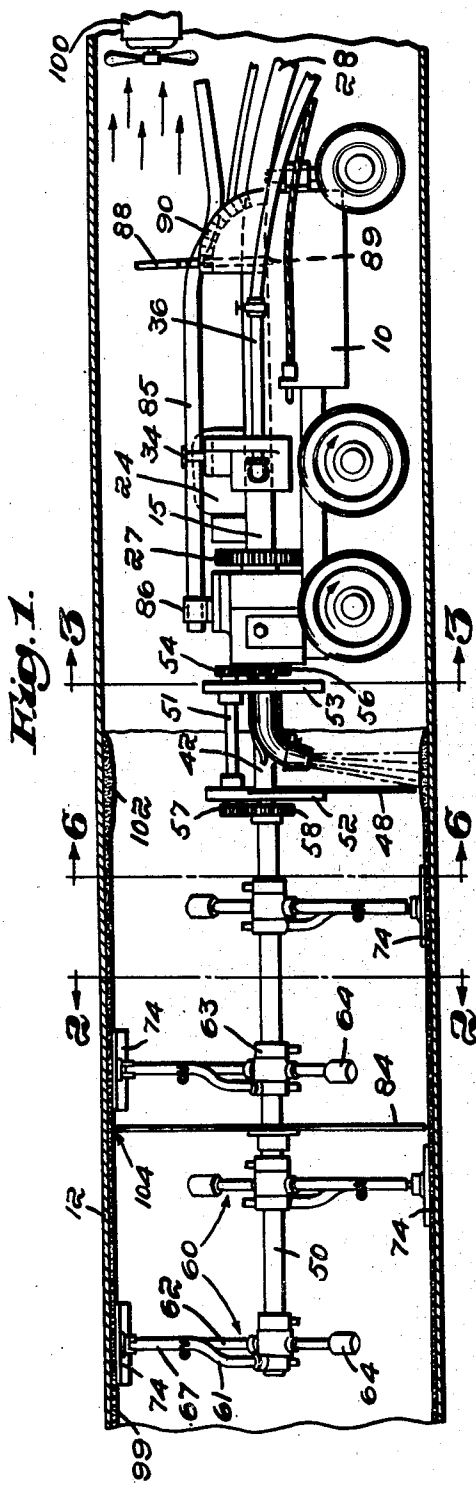
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2,484,018

PIPE LINING MACHINE AND METHOD

Filed Feb. 21, 1946

4 Sheets-Sheet 1



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*Fig. 2.*

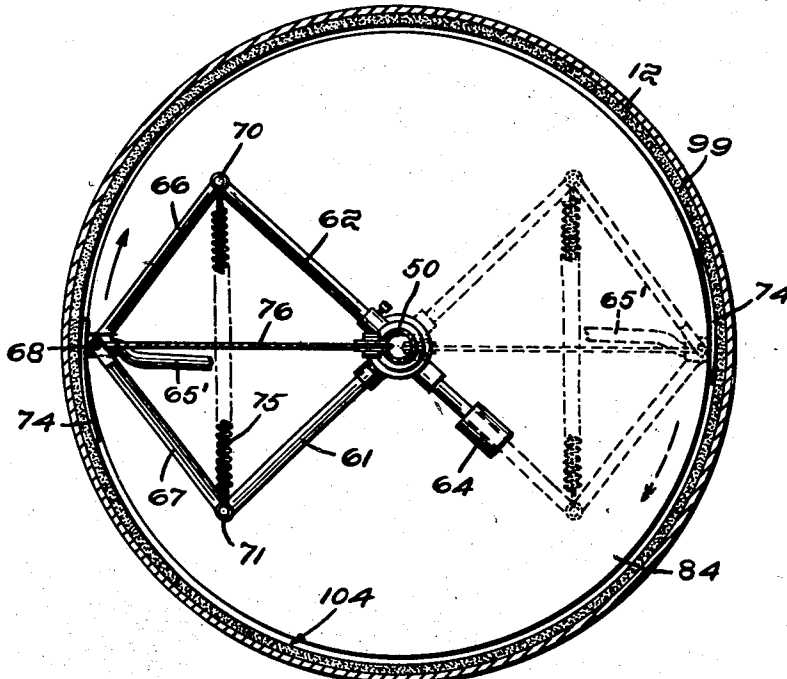
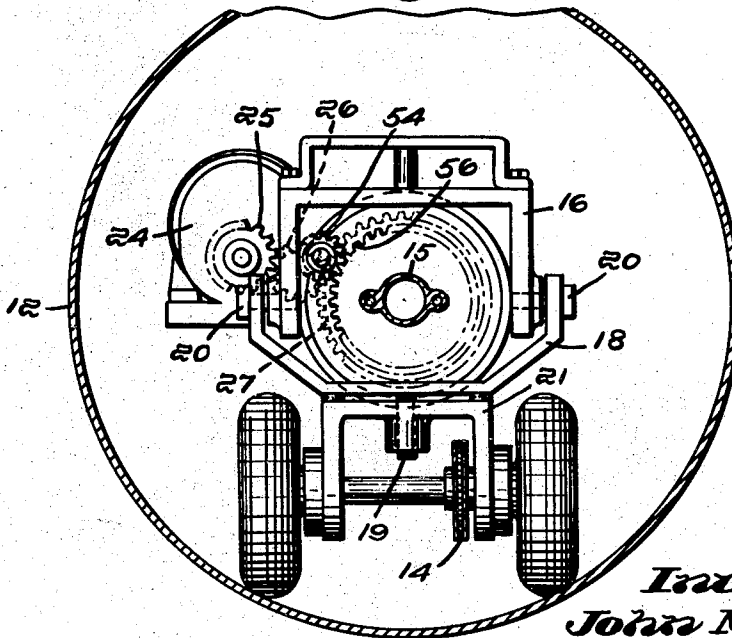


*Fig. 3.*



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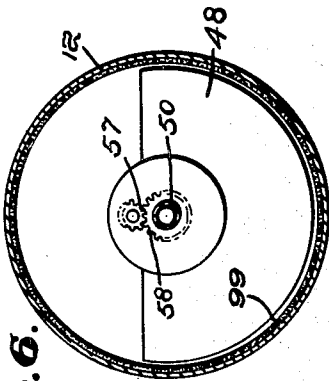


Fig. 6.

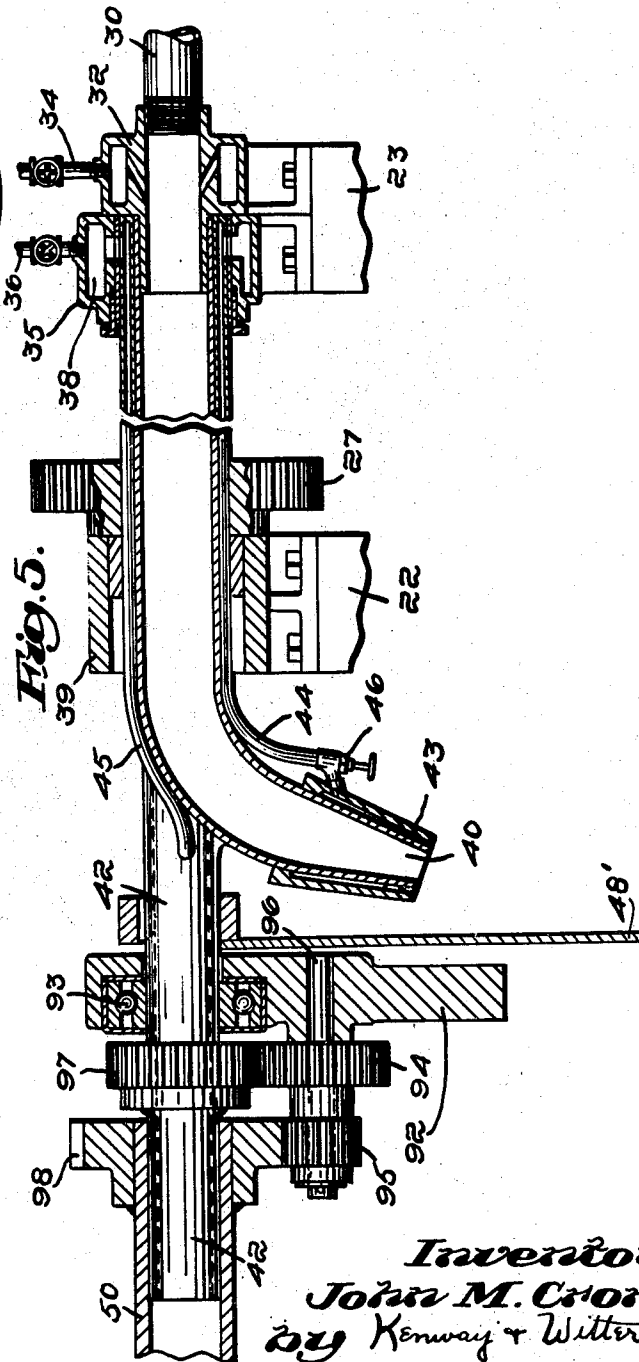


Fig. 5.

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*Fig. 7.*

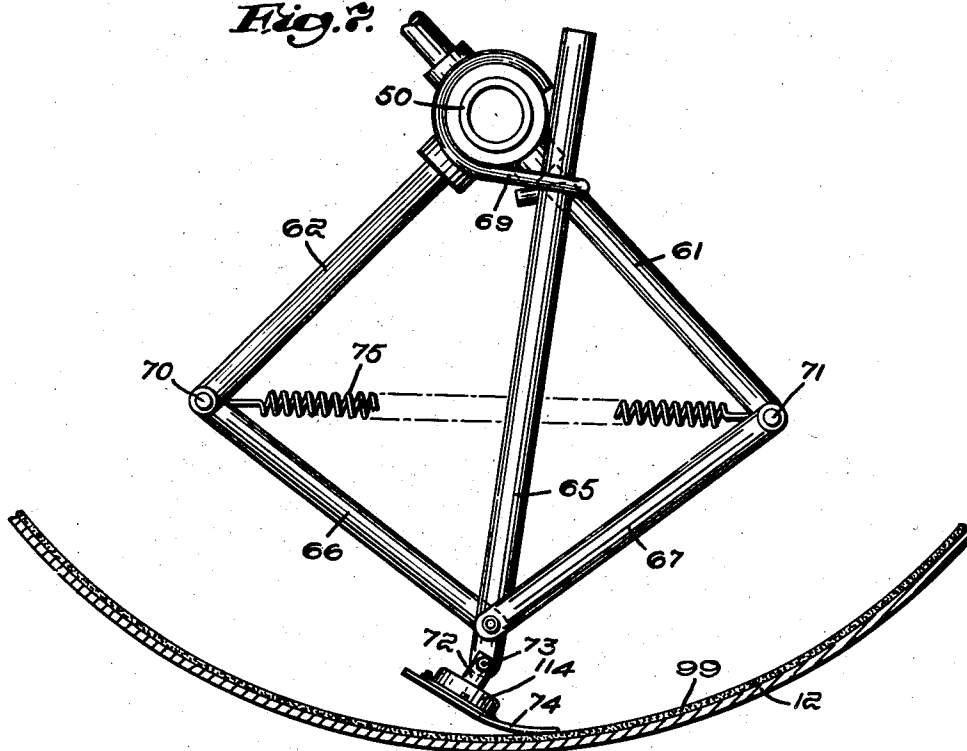


*Fig. 8.*

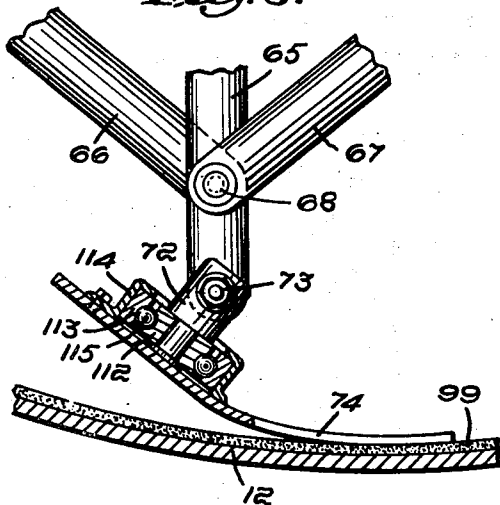
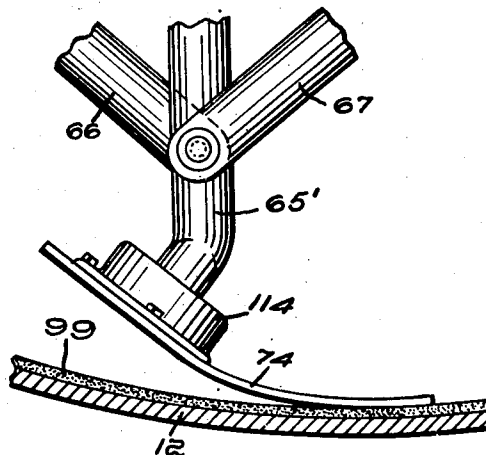


*Fig. 9.*



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## UNITED STATES PATENT OFFICE

2,484,018

## PIPE LINING MACHINE AND METHOD

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Application February 21, 1946, Serial No. 649,330

21 Claims. (Cl. 25—38)

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This invention relates to the lining of large pipes, irrigation ditches, etc., with cementitious composition as shown in my Patents 2,176,891 and 2,297,099 and the primary object of the invention resides in the production of improved mechanism and method for performing this operation more effectively and producing superior, more uniform and smoother linings that will serve more efficiently the conductive flow of liquids.

The invention particularly contemplates improved mechanism embodying a carriage adapted to be moved longitudinally along a ditch or through a pipe to be lined and having associated therewith novel grout projecting apparatus, new and improved troweling mechanism, protective shields for largely eliminating rebound of grouting materials, and other features adapted to produce a superior and smoother lining. The troweling mechanism is carried on a shaft projecting rearwardly beyond the carriage and mounted for universal adjustment thereon permitting proper and accurate centering of the shaft and troweling mechanism within the pipe being lined. The grout projecting apparatus includes a novel air jacketed nozzle particularly adapted to keep the nozzle clean, prevent loss of the projected material outside of the nozzle zone and aid in maintaining uniformity in the flow of grout. Other features of the invention include novel driving mechanism for the trowel shaft, novel suction means in association with one of the protective shields for preventing accumulation of dust and grit particles on the finished trowelled surface, and further improved features hereinafter more specifically described.

These and other features of the invention will be best understood and appreciated from the following description of certain embodiments thereof selected for purposes of illustration and shown in the accompanying drawings, in which

Fig. 1 is a side elevation of the machine, illustrated as placing a lining on and within a pipe,

Fig. 2 is a cross-sectional view taken on line 2—2 of Fig. 1,

Fig. 3 is a cross-sectional view taken on line 3—3 of Fig. 1,

Fig. 4 is an enlarged fragmentary view illustrating a portion of the apparatus in longitudinal section,

Fig. 5 is an enlarged fragmentary longitudinal sectional view through the grout conduit and nozzle, and illustrates a modified gearing arrangement associated therewith,

Fig. 6 is a cross-sectional view taken on line 6—6 of Fig. 1,

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Fig. 7 is an elevation of the trowel supporting frame,

Fig. 8 is an enlarged fragmentary sectional view of the trowel supporting unit, and

Fig. 9 is a like elevation of a modified construction.

The apparatus comprising the invention is particularly adapted to the lining of large pipes or conduits with a cementitious grout. Such pipes are ordinarily used to convey water or other liquid and it is highly important that the lining shall present a smooth and uniform surface to the liquid flow. Any roughness or lack of uniformity offers resistance to the flow and presents a surface that will accumulate foreign matter and retard the flow. A primary object of the invention therefore resides in the production of means for constructing a uniform lining having a smooth and unbroken flow surface. Such means primarily comprises the improved apparatus herein described and illustrated and embodying various novel features which mutually contribute to the object of the invention.

In the drawings 10 indicates a wheeled carriage adapted to pass through a pipe 12 to be lined. The carriage is driven from a motor through a driving chain 14 as in my Patent 2,297,099.

A grout conducting conduit 15 and cooperating mechanism are supported on a frame 16 (Fig. 3) pivotally mounted within and to the arms of a yoke 18 having a vertical stud 19 disposed within the chassis 21 of the carriage. The yoke is movable in a horizontal plane about the vertical axis of the stud and the frame 16 is movable in a vertical plane about the two horizontal studs 20 which support the frame in the yoke, thus providing a universal joint support for the frame and conduit.

The frame 16 embodies uprights 22 and 23 within which are bearings for rotatably supporting the conduit and the frame furthermore supports a motor 24 with gears 25 and 26 in mesh with and adapted to drive a gear 27 fixed to the conduit. Grouting material is fed to the conduit through a hose 28 connected to a pipe 30 threaded into a housing 32 on the upright 23. The grouting material is forced through the hose and pipe and into the conduit by air pressure. Water is admitted to the conduit from a pipe 34 through the housing 32 as illustrated in Fig. 5. A second housing 35 is supported on the upright 23 and the conduit is rotatably mounted on the housing 32 and within the housing 35. Air is conducted from a pipe 36 through the housing 35 to an annular chamber 38 disposed about the conduit.

The conduit extends rearwardly of the carriage through and is rotatably mounted within a bearing 39 on the upright 22 and from thence extends laterally in the form of a nozzle 40. A tubular shaft 42 coaxial with the conduit extends rearwardly beyond and is an integral part of the conduit. An important feature of the invention comprises an air jacket 43 on and extending about the nozzle and open at the nozzle exit. Air is conducted from the chamber 38 to the jacket and to the tubular shaft 42 through pipes 44 and 45 and a valve 46 controls the flow of air to the jacket 43. A sleeve 47 (Fig. 4) having an integral flange 52 is non-rotatably mounted on the shaft 42 and supports a segmental shield 48 disposed in opposed relation to the nozzle and serving to prevent splashing of the grout rearwardly of the nozzle.

The troweling mechanism 50 illustrated in Fig. 1 is rotatably mounted on and extends rearwardly of the sleeve 47. As illustrated in Figs. 1, 3, 4 and 6, this mechanism is adapted to be rotated as follows: A shaft 51 is mounted to rotate in bearings on flanges 52 and 53 fixed to the conduit. A pinion 54 on the shaft is in mesh with a gear 56 fixed non-rotatably to the upright 22. A pinion 57 on the other end of the shaft is in mesh with a gear 58 fixed to the trowel shaft 50. As will be apparent, the shaft 50 will be rotated as the conduit is rotated and its relative speed of rotation can be varied by employing gears of varying size.

The troweling shaft 50 extends a considerable distance rearwardly of the carriage 10 and has a plurality of troweling mechanisms 60 mounted thereon, four such mechanisms being illustrated in Fig. 1. Each troweling mechanism illustrated comprises a polygonal frame (Fig. 2) carried by the shaft 50 and embodying relatively angular arms 61 and 62 mounted on and radiating from the shaft. The arm 61 is fixed to the shaft and the arm 62 is loose on the shaft between the arm 61 and a collar 63 and is counterbalanced by a weight 64. The frame also embodies two links 66 and 67 hinged together and to a rod 65 at their outer ends at 68 and having their inner ends pivotally connected to the outer ends of the arms at 70 and 71. The rod 65 extends inwardly of the frame substantially radially of the shaft 50 and is supported by a bracket 69 for longitudinal movement on and relative to the shaft 50. A trowel 74 is mounted on the outer end of the rod for free swiveling movement about an axis extending outwardly of the shaft 50. A spring 75 is connected to the frame at 70 and 71 and normally functions to pull the arms toward each other and move the trowel outwardly.

It will be noted that the trowel carrying frame (Fig. 2) is in the form of a pantograph and is located at one side of a diameter extending through the shaft 50. It will be apparent that such construction, under the action of the spring 75 maintains the trowel in constant functioning contact with the pipe surface being troweled even though the shaft 50 is slightly off center or the pipe slightly out of round.

The axis about which the trowel 74 is mounted to swivel is preferably made adjustable as by the means illustrated in Figs. 7 and 8, and anti-friction means is also preferably provided for swiveling the trowel. As illustrated, a trowel supporting block 72 is mounted for pivotal adjustment on the outer end of the rod and can be secured in adjusted position by tightening a nut 73. The inner ring 112 of a ball bearing race unit is car-

ried on the outer end of the block and the outer ring 113 of the unit is attached to the trowel by brackets 114 riveted or otherwise secured to the trowel. A ball race 115 between the rings provides relatively free rotation of the trowel on and about the longitudinal axis of the block. The rod and block maintain the trowel at the proper angle relative to the surface being troweled and the rod is free to move inwardly and outwardly to compensate for any lack of uniformity in the surface being troweled at 99. It will be apparent that adjustment of the block 72 to an angular position relative to the rod 65, as illustrated in Figs. 7 and 8, permits such mounting of the trowel that its rear portion bears resiliently against the surface being troweled and is dragged rearwardly of its free pivotal mounting on the block 72.

The construction illustrated in Fig. 9 is the same as that of Figs. 7 and 8 except that the outer end of the arm 65' is bent to provide a swivel support for the trowel in lieu of the pivoted block 72.

The following described means is provided for automatically retracting the trowels inwardly toward the shaft and against the action of the springs 75. A cable 76 is connected to each hinge joint 68 and extends therefrom inwardly of the shaft and over a sheave 78. The cables are connected to a piston rod 79 carrying a piston 80 operative within the shaft. A spring 81 disposed on the rod between an abutment 82 and the piston is of a strength normally operative to retract the trowels. However when the machine is in operation air enters the shaft through the pipe 45 and forces the piston to the left (Fig. 4) whereby compressing the spring 81 and permitting the springs 75 resiliently to move the trowels outwardly into contact with the pipe coating being troweled.

One or more circular shields are mounted on the troweling shaft 50 for shielding the troweled surface against grouting splash, one such shield 84 being illustrated in Fig. 1 between the two final trowels and the preceding leveling trowels. The shield is of a size substantially commensurate with the interior of the pipe 12 and provides only a relatively narrow annular gap between the periphery of the shield and the troweled surface.

The universal joint mounting at 19 and 20 together with the following mechanism provides means for properly centering the troweling mechanism within the pipe. A rigid controlling arm 85 is rigidly affixed to the frame 16 at 86 and extends forwardly therefrom. Movement of the arm horizontally and vertically is adapted to adjust and center the shaft 50 within the pipe. The arm passes beneath a yoke 88 pivoted to the carriage at 89 and cooperating with the yoke is a toothed segment 90 for holding the yoke in any pivotally adjusted position. When the arm is adjusted to a position properly centering the shaft within the pipe, the yoke is moved into holding contact therewith and serves to hold the shaft properly centered during operation of the machine.

In Fig. 5 I have illustrated an alternative form of mechanism for rotating the troweling shaft 50 from the conduit 15. A relatively heavy bracket 92 is hung loosely on a ball bearing 93 on the shaft 42 and normally retains its downwardly extending position by the gravity force of its own weight. A shield 48', like the shield 48, is supported on the shaft 42. Two integrally connected gears 94 and 95 are mounted to rotate on a stub shaft 96 supported in the bracket. The gear 94 is in mesh with a gear 97 fixed to the

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shaft 42 and the gear 95 is in mesh with a gear 98 fixed to the shaft 50. It will be apparent that rotation of the shaft 42 will cause rotation of the shaft 50 and that the relative speeds of rotation can be varied by employing gears of varying size.

The function of the machine is to coat the inside surface of the pipe 12 with a uniform layer 99 of grouting material and to leave the entire flow surface of the coating uniform and smooth. This latter is extremely important since any lack of uniformity and any roughness on the surface very substantially interferes with the flow of liquid through the pipe and thus lowers its efficiency. The shields 48, 48' and 84 are provided for the purpose of preventing grout splash rearwardly onto the troweled surface of the coating and this feature of the invention is further improved by creating a suction in the pipe forwardly of the shields and a continuous current of air forwardly through the space 104 between the shield 84 and the lining 99. In Fig. 1 I have illustrated a fan 100 for creating this current of air. The fan is located forwardly of the shields and can be mounted on the carriage or in any convenient manner.

The use and operation of my improved apparatus as herein described will now be apparent. The carriage is continuously moved forwardly through the pipe 12 at a rate predetermined to produce the desired lining and is under the control of an operator on the carriage. Grouting material, mixed with the proper amount of water, is forced through the conduit 15 which is rotated and projects the grout outwardly of its nozzle 40. The shield 48 or 48' rotates with the nozzle and is always disposed in opposed relation thereto and prevents rearward splash of grout to the troweling mechanism and troweled surface. The segmental shape of this shield, as illustrated in Fig. 6 permits the operator to view the troweling mechanism and its functioning during operation of the machine.

The dry grouting material mixture is air-conveyed to the housing 32. Water is added to this mixture at 32 and the resulting liquid grout is projected outwardly of the rotating nozzle 40 on and about the pipe to be lined. The liquid grout is somewhat plastic and is inclined to slobber at the nozzle tip and wad or ball within the hose and such action has resulted in a portion of the grout departing from the air stream at the nozzle and becoming improperly projected onto the lining. Some of it may be blown back along the interior of the conduit and finally come to rest on the finished troweled surfaces whereby requiring further work to smooth such portions of the lining. The air jacket 43 around the nozzle eliminates this trouble and not only keeps the nozzle clean but furthermore maintains the entire charge within the air stream of the jacket and results in maintaining a continuous and uniform projection of the charge outwardly onto the pipe.

Following the projecting of a layer 102 of grout material onto the pipe, the first troweling mechanism 60 engages this material and performs a preliminary distributing and smoothing action, and this operation is continued and the grout further distributed by the second troweling mechanism. The two final troweling mechanisms finish the distributing and troweling functions and leave a smooth and uniform surface. Particular attention is directed to the shield 84 disposed between the leveling trowels and the final finishing trowels. The shield prevents rear-

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ward splash onto the finished surface and the continuous passage of air through the gap 104 at the periphery of the shield aids in preventing the passage of dust and light weight particles rearwardly and settling on the completed surface.

Particular attention is directed to the troweling mechanisms which maintain the trowels in uniformly resilient contact with the coated surface. The pipes 12 to be lined are frequently considerably out of round and require a considerable variation in the radial position of the trowel relative to and during rotation of the shaft 50. An important feature of the invention resides in my novel trowel supporting frame of pentograph construction together with the spring 75 by which the trowel is maintained at uniform pressure contact with the coated surface regardless of the radial trowel distance from the shaft 50 when the spring is properly adjusted to length and to give the required tension.

Having thus disclosed my invention what I claim as new and desire to secure by Letters Patent is:

1. A machine for troweling the inside surface of pipes, comprising a carriage adapted to be moved through the pipe, a shaft carried by and projecting beyond the carriage, means for rotating the shaft, a polygonal frame carried by the shaft and including two relatively angular arms radiating from the shaft and pivotally connected at their ends to the outer portion of the frame, said frame being disposed in a plane normal to the shaft, a trowel attached to the outer portion of the frame, and a spring associated with the frame and normally operative to pull said arms toward each other and move the trowel outwardly.

2. The machine defined in claim 1 plus means including a second spring normally operative to retract the trowel and frame inwardly toward the shaft, and fluid operated means operative against the second spring for rendering the first named means inoperative on the trowel.

3. A machine for troweling the inside surface of pipes, comprising a carriage adapted to be moved through the pipe, a shaft carried by and projecting beyond the carriage, means for rotating the shaft, a rectangular frame carried by the shaft and including two relatively angular arms radiating from the shaft and two links hinged together at their outer ends, remotely from the shaft and having their inner ends pivotally connected to the arms, a trowel attached to the hinged portion of the frame, and a spring associated with the frame and normally operative to pull said arms toward each other and move the trowel outwardly from the shaft.

4. The machine defined in claim 3 in which one of said arms is fixed to the shaft and the other is mounted for rotation thereon, and a counterweight for counterbalancing the rotatably mounted arm on and about the shaft.

5. The machine defined in claim 3 in which one of said arms is fixed to the shaft and the other is mounted for rotation thereon and in which the spring is connected to the outer ends of the arms.

6. A machine for troweling the inside surface of pipes, comprising a carriage adapted to be moved through the pipe, a shaft carried by and projecting beyond the carriage, means for rotating the shaft, trowel carrying means carried by and disposed radially outward of the shaft and including an arm extending outwardly from the shaft, a trowel, and means mounting the trowel

on the outer end of the arm for free swiveling movement about an axis extending outwardly of the shaft.

7. A pipe lining machine comprising a carriage adapted to be moved longitudinally through a pipe, a shaft embodying a grout conducting conduit carried by and projecting rearwardly beyond the carriage and having an outwardly directed nozzle at the rearward end of the conduit, means for rotating the conduit about its longitudinal axis, a second shaft carried by the carriage and projecting longitudinally and rearwardly beyond the conduit shaft, means for rotating the second shaft from the conduit shaft, pipe lining trowels carried by the second shaft, means for resiliently moving the trowels outwardly into contact with the pipe lining, and means including a plunger within the second shaft for retracting the trowels inwardly.

8. The machine defined in claim 7 in which the last named means includes flexible connections between the plunger and trowels and includes a spring operative against the plunger for retracting the trowels, and means for pneumatically operating the plunger in a direction opposed to the spring.

9. A pipe lining machine comprising a carriage adapted to be moved longitudinally through a pipe, a shaft carried by and projecting longitudinally and rearwardly beyond the carriage, pipe lining trowels carried by the shaft, means for rotating the shaft, and means supporting the shaft on the carriage for universal movement about horizontal and vertical axes.

10. The machine defined in claim 9 plus a guiding bar attached rigidly to the shaft supporting portion and extending forwardly of the carriage, and means cooperating with the bar for holding said portion of the carriage in adjusted position about said axes.

11. A pipe lining machine comprising a carriage adapted to be moved longitudinally through a pipe, a grout conducting conduit carried by and projecting rearwardly beyond the carriage and having an outwardly directed nozzle at its rearward end, means for rotating the conduit, a shaft carried by the carriage and projecting longitudinally and rearwardly beyond the conduit, pipe lining trowels carried by the shaft, a gear fixed against rotation on the carriage, and means rotatable with the conduit and including a pinion in mesh with the gear for rotating the shaft.

12. A pipe lining machine comprising a carriage adapted to be moved longitudinally through a pipe, a shaft embodying a grout conducting conduit carried by and projecting rearwardly beyond the carriage and having an outwardly directed nozzle at the rearward end of the conduit, means for rotating the conduit, a second shaft carried by the carriage and projecting longitudinally and rearwardly beyond the conduit shaft, pipe lining trowels carried by the second shaft, a gear fixed to the conduit shaft, a weighted member hung for free rotation on the conduit shaft, a second gear carried by the member and in mesh with the first gear, and means including a gear fixed to the second shaft and in mesh with a gear fixed to rotate with said second gear for rotating the second shaft from the conduit shaft.

13. A pipe lining machine comprising a carriage adapted to be moved longitudinally through a pipe, a grout conducting conduit carried by and projecting rearwardly beyond the carriage and having an outwardly directed nozzle at its rearward end, a shaft aligned with and projecting

rearwardly of the conduit, means for rotating the conduit and shaft, leveling and finishing trowels on the shaft rearwardly of the conduit nozzle, a segmental shield disposed in longitudinal alignment and rotatable with the nozzle between the nozzle and leveling trowel, and a disk-like shield on the shaft between the leveling trowel and the finishing trowel.

14. A method of lining and finishing pipe with a cementitious coating, which consists in projecting plastic cementitious material radially outward onto, around and progressively along the inner wall of a pipe, troweling the cementitious material in place on said wall progressively around and along the pipe following the projecting of said material, and preventing the accumulation of dust and grit particles on the troweled surface by providing a protective shield between the troweling and projecting locations to an annular position adjacent to but spaced from the lining and creating a suction forwardly of the shield and the continuous passage of a current of air forwardly through the space between the shield and the lining.

15. The method defined in claim 14 in which said material is first rough troweled following its projection onto said wall and is thereafter finish troweled, and in which a protective shield is located between the roughing and finishing trowel positions.

16. The machine defined in claim 1 plus a rod extending inwardly from the trowel to a point adjacent to said shaft, means supporting the rod for longitudinal movement on and relative to the shaft, and means mounting the trowel on the outer end of the rod for free rotation about an axis disposed transversely of said shaft and extending outwardly in the general direction of the rod.

17. The machine defined in claim 1 plus a rod extending inwardly from the trowel to a point adjacent to said shaft, means supporting the rod for longitudinal movement on and relative to the shaft, a block pivotally adjustable on the outer end of the rod about an axis parallel to the shaft, and means mounting the trowel for free swiveling movement on the outer end of the block.

18. A pipe lining machine comprising a carriage adapted to be moved longitudinally through a pipe, a grout conducting conduit carried by and projecting rearwardly beyond the carriage and having its rear end portion curved outwardly and formed into an outwardly directed nozzle, means for rotating the conduit about its longitudinal axis, a segmental shield rotatable with and disposed adjacent to and rearwardly of the nozzle and in alignment therewith longitudinally of the conduit, a shaft carried by the carriage coaxial with and projecting longitudinally and rearwardly beyond the conduit, pipe lining trowels carried by the shaft rearwardly of the shield, and means for rotating the shaft relative and proportional to the conduit rotation.

19. A pipe lining machine comprising a carriage adapted to be moved longitudinally through a pipe, a grout conducting conduit carried by and projecting rearwardly beyond the carriage and having an outwardly directed nozzle at its rear end, a segmental shield rotatable with and disposed adjacent to and rearwardly of the nozzle and in alignment therewith longitudinally of the conduit, a shaft carried by the carriage coaxial with and projecting longitudinally and rearwardly beyond the conduit, a pipe lining trowel carried by the shaft, and means for rotating the

conduit and shaft about their longitudinal axis, the shield providing an anti-splash wall rearwardly of the nozzle and forwardly of the trowel at the nozzle side of said axis, the space in the plane of the shield being open at the other side of the axis.

20. The machine defined in claim 1 in which said polygonal frame is located at one side of a diameter extending through said shaft.

21. The machine defined in claim 1 in which said polygonal frame is of pantograph construction and is located at one side of a diameter extending through said shaft.

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