May 21, 1957 J. D. CUMMINGS 2,792,807

PIPE INTERNAL COATING MACHINE

Filed Aug. 13, 1954 3 Sheets-Sheet 1

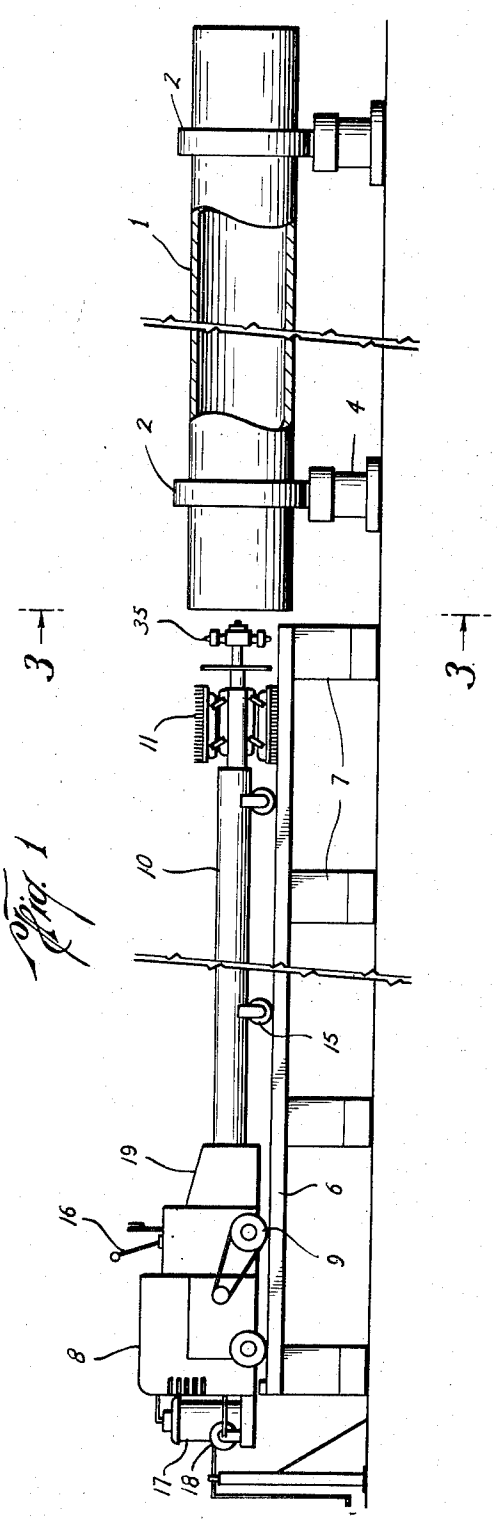

Fig. 1

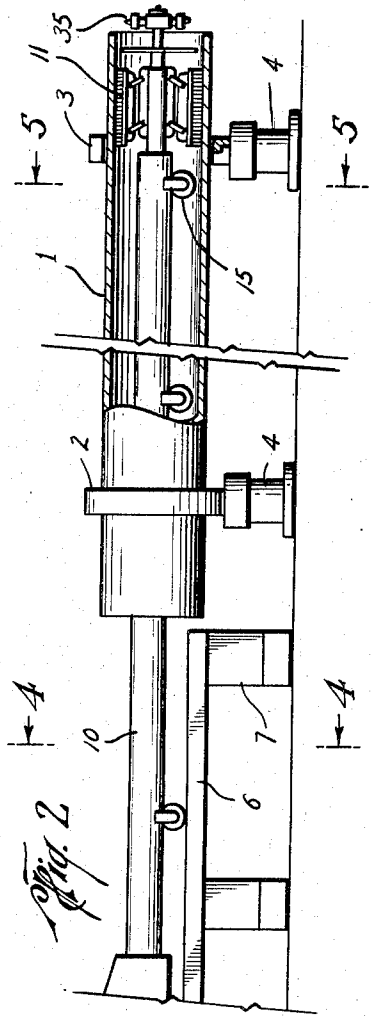

Fig. 2

James D. Cummings
INVENTOR.

BY G. C. Helwig

ATTORNEY

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Fig. 3

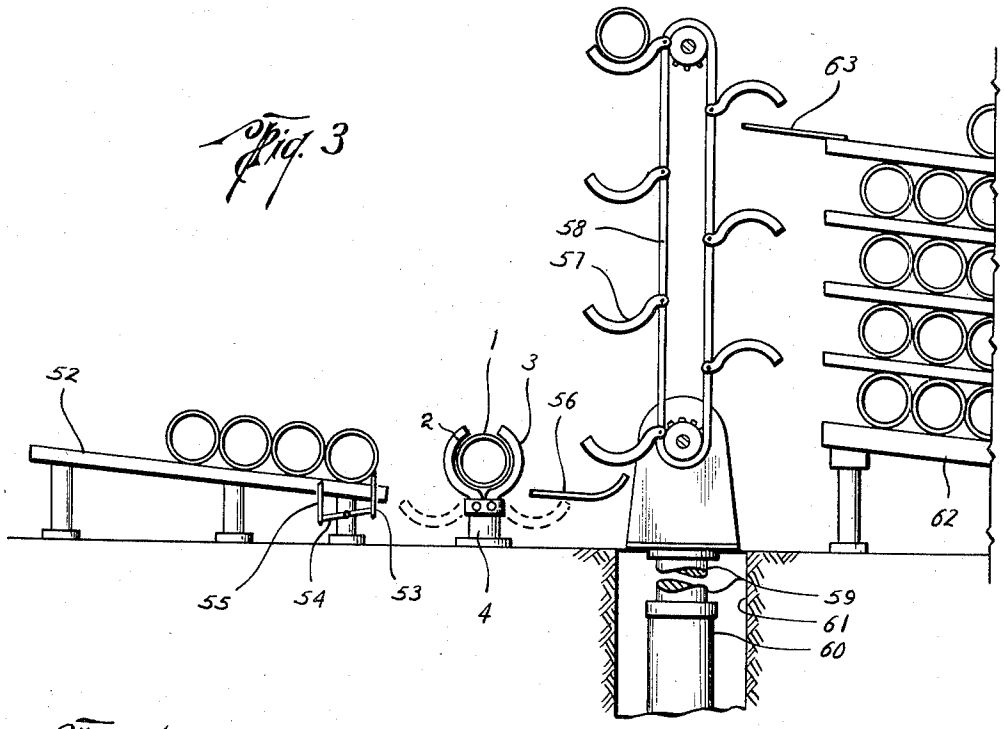


Fig. 4

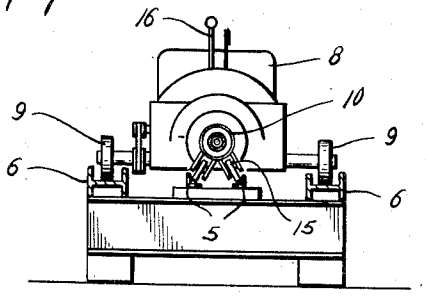


Fig. 5

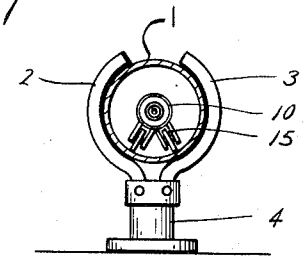
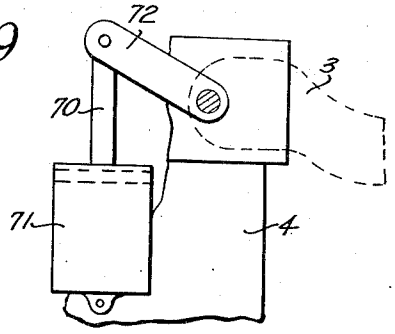


Fig. 9



James D. Cummings
INVENTOR.

BY

G. C. Helmig

ATTORNEY

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Fig. 6

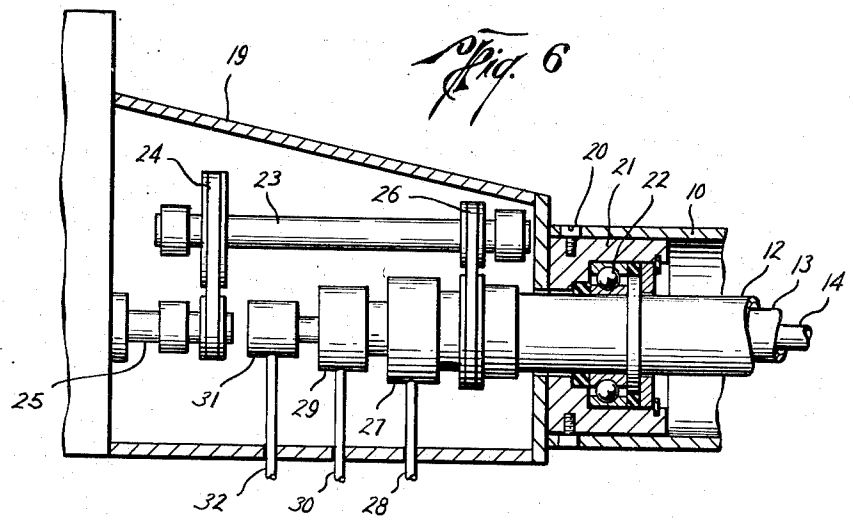


Fig. 7

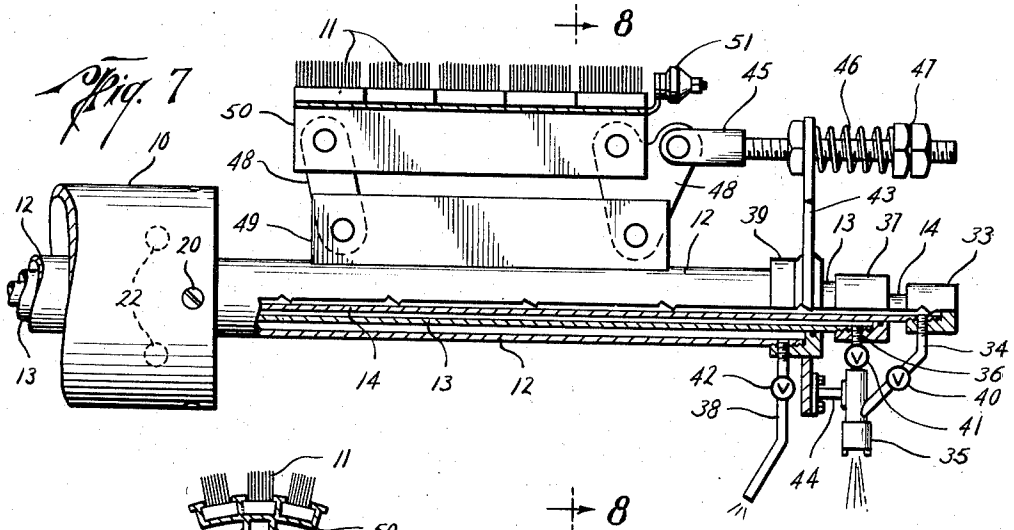
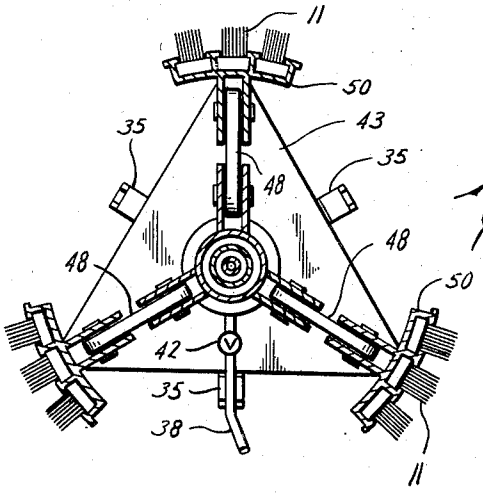


Fig. 8



James D. Cummings
INVENTOR.

BY G. C. Helmig

ATTORNEY

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PIPE INTERNAL COATING MACHINE

James D. Cummings, Houston, Tex., assignor to Crutcher-Rolfs-Cummings, Inc., Houston, Tex., a corporation of Texas

Application August 13, 1954, Serial No. 449,722

12 Claims. (Cl. 118—72)

This invention relates to apparatus for treating large diameter pipe commonly employed for cross-country fluid conduits, and more particularly to improved equipment for applying protective coating on the inside surface of individual joints or lengths of pipe.

Pipe lines for transporting petroleum fluids are assembled or made up of sheet iron sections externally coated with a corrosion resistant covering, and generally no serious thought has been given heretofore to interior surface protection. The rate of oxidation during storage and transportation from mill to useage is fairly rapid, and the dirt, rust, and scale picked up by fluid flowing through a line of pipe whose inside was not precleaned and smoothly coated, has dictated the use of line filters at intervals, and these filters need periodic attention for cleaning and replacement. Roughness of dirty surfaces increases frictional resistance to flow, and reduces pump station efficiency, whereas a clean, smooth surface having a protective coating not only resists corrosion for prolonging life, but also minimizes power flow requirements, the number of filter installations, and costly attention.

An object of the present invention is to provide mechanism for economically applying a protective coating on the pipe interior surface, and for effectively cleaning the surface preparatory to and as a part of the coating operation. The operation can be performed just prior to the installation of sections at the final pipe line location, but performance at the mill and soon after fabrication of the pipe joints will require less cleaning and eliminate the problem of corrosion build-up during prolonged storage.

A further object of the invention is to provide a trackway for a power driven reciprocatory carriage and a pipe handling device to locate a pipe section in end to end succession with the trackway for receiving within the pipe section, the working head of the carriage, including a rotary scrubbing brush or wall scraper which acts first to clean the surface thoroughly, and which cleanings simultaneously are blown out of the pipe in a pressure air stream, together with a surface coater for applying a protective paint on the cleaned surface, as the carriage travels in its final retracting stroke from inside of the pipe.

Another object of the invention is to provide a traveling carriage of a longitudinal dimension to enable its cleaning head to traverse the entire length of a pipe joint in one stroke for completion of the cleaning operation before any paint is applied in a single return stroke, and a brush whose working face diameter can be easily varied to fit the size of the pipe being operated upon and whose pressure contact with the surface is controlled by a pipe engaging roller pre-set to limit outward spring force on the brushes.

Other objects and advantages will become apparent during the course of the following specification having reference to the accompanying drawings wherein Figs. 1 and 2 are side elevations partly in section of the operating mechanism in two different positions, in one of

which the traveling carriage is fully retracted and in the other of which the carriage is in a position approaching its fully projected relation; Fig. 3 is an end elevation of a pipe cleaning and handling arrangement as viewed on line 3—3 of Fig. 1; Figs. 4 and 5 are transverse sectional views taken on lines 4—4 and 5—5, respectively, of Fig. 2; Figs. 6 and 7 are longitudinal sectional views at the rear end and the front end respectively of the traveling carriage; Fig. 8 is a transverse section as on line 8—8 of Fig. 7, and Fig. 9 is a diagrammatic representation of an operating motor linkage.

In the drawings the pipe 1 to be cleaned is clamped near its opposite ends between two pairs of jaws 2 and 3 pivotally mounted on pedestals 4. This clamped position alines it longitudinally in end to end relation with and as a continuation or extension of a fixed trackway including a pair of angle irons 5, and also a pair of more widely spaced apart channels 6. Standards or posts 7 support the trackways above the ground on a horizontal level for to and fro travel of a power driven carriage including a power unit 8 having wheels 9 riding in the channels 6 and a forwardly projecting frame 10 which conveniently may be a long tube for telescopic reception within the pipe 1 and whose length corresponds substantially to the length of the pipe 1. The length referred to is to impart a longitudinal stroke from end to end of the pipe to a rotary brush 11 at the front of the carrier tube within which is rotatably supported a brush driving shaft constituted by a series of three concentrically nested and radially spaced tubes 12, 13 and 14. Tubular frame weight and supported load are transferred to the angle irons 5 by rollers or wheels 15 arranged in pairs on divergently related axes, as shown in Fig. 4, normal to radii from the axis of the rotary brush so that the wheel rims will be guided within the angular legs of the angle irons and will ride easily, as seen in Figs. 2 and 5, on the interior circular wall of the pipe 1 for support and tracking guidance whenever the wheels extend beyond the forward end of the angle irons during reciprocation of the traveling carriage.

The power unit 8 has either an internal combustion engine or an electric motor geared to one or more of the wheels 9 under control of a hand lever 16 at the operator's station. A conventional pressurized container 17 is mounted for travel on the power unit and provides for storage of a supply of liquid paint of a type suitable for a corrosion retarding covering on an iron surface. Beside the paint storage container there may be mounted a spring wound reel 18 for a flexible hose leading from an air compressor or other source of air under high pressure. The reel pays out and winds up the flexible hose during carriage travel, but it need not be mobile with the carriage and will serve just as well in a stationary location at the rear end of the trackway. In either event the front end of the hose is connected to a distribution manifold on the traveling carriage. One branch of the manifold is for connection through a pressure regulator with the paint container 17 for forcing the paint through a conduit to the forward end of the carriage as will later be described in more detail.

Fig. 6 shows the rear end of the carrier tube 10 secured to the power unit 8 through a housing 19 which encloses drive gearing for the nested tube drive shaft assembly. Detachable studs 20 locate a spacer ring 21 inside the tube 10 for supporting an anti-friction ball bearing assembly 22 by which the outermost shaft tube 12 is rotatably mounted. Similar bearings are provided at the opposite end of the carrier tube, as indicated by dotted lines in Fig. 7, and at several spaced intermediate points. Spacing spiders or blocks may be employed to key together the nested tubes for their unit rotation. Shaft rotation preferably is transmitted from a power take-off device clutch-

able to the motive power source which also is clutchable with the traction wheels 9 of the power unit 8. Optionally separate motors can be used to power the traction wheels 9 and the projecting drive shaft. In either event, the housing 19, as seen in Fig. 6, encloses a counter-shaft 23 geared through a chain 24 with the engine output shaft 25 and drive connected by a chain 26 with a sprocket fixed on the torque transmitting tube 12.

The use of the countershaft 23 enables selection of drive ratio either up or down, depending on power output in relation to speed at which the drive shaft assembly is to be rotated. Additionally the offset counter-shaft affords space for swivel coupling boxes on the rear ends of the nested tubes. Thus a stuffing box 27 seals the intervening conduit space between neighboring tubes 12 and 13 and a fixed tube 28 connects the sealed off annular conduit through a pressure regulator with the hose connected manifold leading from the supply of compressed air. The end of the tube 13 projects slightly beyond the outermost tube 12 and is sealed to the innermost tube 14 by a stuffing box 29 having a supply conduit 30 connected with the compressed air manifold distributor through another pressure regulator for maintaining pressure within the annular conduit 13 at a somewhat lesser level than that in the outermost conduit 12. A third stuffing box 31 is swiveled on the projected end of the innermost tube 14 and has a conduit connection 32 leading from the discharge outlet of the paint container 17.

The paint under relatively low pressure and the air delivered at two different pressure levels, in accordance with working requirements of each fluid, passes through the nested tubes for emission at their forward ends. Fig. 7 shows a closure cap 33 over the forward end of the innermost paint delivery tube 14 with a branch conduit 34 leading to an air pressure or spray gun 35 for discharge in applying a paint coating on the interior surface of the pipe 1 under the atomizing force of pressure air fed to the gun applier 35 through a conduit 36 leading from a closure cap 37 over the forward end of the conduit 13. More than one atomizing spray gun may be employed in circumferentially spaced relation to one another as seen in Fig. 8. Immediately rearwardly of the spray gun location and in the axial space between the guns 35 and the pipe wall scraper brush 11, there is positioned an outwardly extending tube 38 whose inner end connects with the high pressure tube 12 and is mounted on a tube end closure 39. Near its outer end the tube 38 is bent rearwardly as seen in Fig. 7, and also circumferentially as seen in Fig. 8, so that its discharge nozzle is directed away from the gun and outwardly toward the wall surface. There results a high velocity current blast following a substantially helical path to entrain and sweep dirt in a swirling cloud through the pipe for ejection at the rearwardly open end through which the cleaning brush entered upon carriage projection. Control valves 40, 41 and 42 are inserted in the conduits 34, 36 and 38, respectively, and each valve may be simple hand cock for manual manipulation or incorporate a pneumatic or electrical remotely controlled motor with a control device located at the driver's station on the power unit 8.

A triangular plate 43 is welded or otherwise fixed to the end closure cap 39 and affords a detachably bolted mounting for a supporting arm 44 for each paint applier gun 35. Each apex of the plate 43 is apertured to slidably receive the stud of a clevice 45 and also seats one end of a coil spring 46 surrounding the outer end of the clevice stud and being held in adjustable compression by lock nuts 47 threaded on the stud. The clevice head is pivotally pinned to an adjacent one of a pair of radially disposed swinging shackles or parallel links 48, whose inner ends are hinged between two longitudinal extending ears or wings 49 welded on the outermost tube 12 just ahead of the forward terminal of the carrier tube 10. Pivot pins connect the other end of the links 48 to dependent attachment ears of holders 50 for detachably mounting the backs of a group of replaceable brushes 11 having stiff bristles such as thin metal wires. Merely by way of illustration, and for clarity, Fig. 8 shows three sets of brush holders each representing a group of brushes in arcuate array, but a greater or lesser number may be employed, and they may be of various transverse widths according to pressure area selected. For most installations, a complete circle of brushes is to be preferred. The clevice spring compression adjustment enables the brushes to be radially expanded or contracted to fit a range of pipe diameters and affords a yieldable outward pressure of the scraping or scouring ends of the bristles against the pipe surface during brush travel rotatably and longitudinally inside the pipe. To limit the extent of outward pressure and undue stress on the scraping bristles a pipe engaging shoe or roller 51 is rotatably mounted on a forwardly projected stud on the brush holder 50. Fig. 7 shows this roller 51 as having a cylindrical pipe engaging tread outwardly positioned slightly below the bristle tips and with a forwardly projecting conical nose for camming engagement with the pipe end upon entry into the same. Provision for radial adjustment of the roller axis will enable its position to be changed in compensation for different bristle length and wear.

Prior to operation on the pipe, the sections may be placed side by side as seen in Fig. 3, on inclined rails 52 to roll downwardly toward the pipe clamping jaws 2 and 3. The lowermost of the group of pipe joints is retained by an abutment stop or ratchet 53 whose lower end is secured to one end of a rock lever 54. The opposite end of the rock lever is connected to a similar abutment pawl 55 to provide an escapement mechanism whereby upon clockwise motion of the rock lever 54 the pawl 55 is projected into the downward path of the next succeeding pipe while the companion pawl 53 moves out of the way below the top of the rail 52 to allow the previously held joint to roll off of the feed rails and into the open jaws. Thereafter a counter-clockwise rotation of the lever 54 restores the escapement assembly and allows the pipe group to move down for a distance of one pipe diameter. For receiving the joint or length of pipe, the pivoted jaws 2 are dropped to an open position as indicated by broken lines in Fig. 3, and are later returned for pipe clamping relation with the jaws 3 during the pipe working operation. Following the coating operation the pivoted jaws 3 are swung open to dotted line position so that the painted pipe is free to roll laterally on to spaced rails 56 from which it is picked up by one set of conveyor cradles 57 projecting outwardly from an endless chain or chains 58 which travel between vertically spaced sprockets on a suitable support frame. The base of the frame is connected to a piston rod 59 which is slidable in a hydraulical or pneumatic cylinder 60 positioned in a well 61, whereby the assembly can be raised or lowered in accordance with the height of superposed storage rackes at the discharge side of the conveyor chain. Thus when pipe sections are being racked on the storage rails 62 at first level the elevator will be at its lowest position, and as the stack rises the elevator will be raised. On the loading rack the temporary extension 63 is secured in longitudinally spaced relationship with the cradles 57 and in position suitable to receive the painted pipe as it is carried around the uppermost sprockets and discharged by gravity from the conveyor cradle. Motive power for actuating these pipe handling movable parts may be under control of the operator, as for example by providing a control panel within easy reach at the operator station when the carriage is fully retracted.

The swing clamp jaws 2 and 3 and the escapement rock lever 54 may be keyed to rock shafts for their respective swinging operations. A suitable operating mechanism for each rock shaft will be a fluid pressure responsive piston and cylinder motor as seen in Fig. 9, wherein a piston rod 70 projects from the cylinder 71 and is linked to a crank arm 72 fixed to a rock shaft for its actuation upon in-

troduction of fluid under pressure on one side or the other of the piston in the cylinder.

In the use of the apparatus, a pipe section to be painted is clamped in position and the operator will manipulate the controls to rotate the power shaft and the brush **11** at a relatively high speed. Upon engagement of the traction drive the carriage moves forward with the rotating brush entering the inside of the tube for thoroughly scraping and loosening dirt accumulation and rust. On the forward stroke the control valves **40** and **41** for spray gun operation will be in closed position but the valve **42** for delivering cleaning air will be open and the swirling pressure air will blow out the dirt loosened by the brushes. When the projection of the brushes to the far end of the pipe has been completed, the pipe will be cleaned unless it happens to be in badly corroded condition. In the latter event, the carriage may be retracted and then again projected to the forward limit with the brush and air blast continuing to scrape off the accumulations. The cleaning operation may be repeated as often as necessary. Upon final retraction of the carriage the paint supply valve and the atomizing air valve are both opened, whereby the rotating guns lay down a protective coating on the clean surface. The blast of air being delivered through the nozzle **38** ahead of the gun on the back stroke will insure the blowing out of all loosened dirt immediately in advance of the paint being sprayed.

While the foregoing specification has been limited to a preferred embodiment of the invention, it is to be understood that various modifications may be made such as come within the scope of the appended claims.

I claim:

1. In a machine for applying a protective coating on the interior of pipe, a series of three concentrically nested and spaced apart rotary tubes of greater length than the pipe to be coated, a traveling carriage rotatably supporting said tube series and having track engaging supporting wheels, a trackway to be engaged by said wheels upon longitudinal travel of said carriage into and out of the pipe, means to locate a pipe to be coated in end to end alignment with said trackway for the tracking on the pipe interior of said wheels beyond said trackway, power drive mechanism connected with the carriage at its end remote from the pipe locating means operable to impart travel to the carriage, a power take off drive from said mechanism to rotate said tube series, coupling connections at the tube ends remote from the pipe locating means to supply coating liquid to one tube and pressure air, at different pressures respectively, to the other tubes, a pipe interior rotary cleaning brush and an outwardly directed spray gun carried in axially spaced relation on and for rotation with said rotary tubes at the forward end of the carriage, an air jet nozzle fixed on the tubes for rotation therewith, with the nozzle discharge located between the gun and the cleaning brush and directed away from the gun to swirl out loosened dirt from the pipe, a valved connection between the nozzle and the interior of the tube carrying the higher pressure air and valved connections between the gun and the tubes carrying the coating liquid and the lower pressure air.

2. In a machine for protectively coating the inside surface of a pipe, a holding fixture for a pipe to be coated, means for feeding and discharging pipe into and out of coating poistion in said fixture, a trackway fixed in relation to said fixture for longitudinal alignment with a pipe located by said fixture as a continuation of the trackway, a traveling carriage mounted for reciprocation on said trackway and the fixture held pipe into and out of the pipe, a pipe interior surface engageable cleaning scraper rotatably mounted on the carriage, a coating liquid applier carried by said carriage ahead of said scraper and an air blower discharge nozzle located between the scraper and said coating applier and directed to blast cleanings in the direction away from said coating applier.

3. A machine for working the inside of pipe including a track, a traveling carriage tracking on said track and carrying a work performing device for projection and retraction into and out of a pipe, a pair of clamping jaws to hold a pipe in alignment with the path of said carriage, means mounting the clamping jaws for their opening and closing, a conveyor to discharge worked pipe from the opened clamp jaws and means to feed an unworked pipe into the opened jaws to be clamped thereby for a working operation during projection and retraction of said work performing device.

4. A machine for applying protective coating to the inside of pipe, including a pipe locating support, a traveling carriage reciprocally arranged for travel through the pipe, a liquid coating applicator and a rotary brush supported in axially spaced relation to one another by said carriage for travel therewith, a brush driving and locating hub, a collapsible linkage connecting the brush to the hub, adjustable means for setting the radial position of the brush through said linkage to fit internal pipe diameter and having an elastic element yieldably resisting linkage collapse, a pipe engaging guide shoe fixedly located relative to the brush for cooperation with said elastic element in controlling pipe brushing contact, and a pressure air delivery nozzle between the applicator and the brush with its outlet directed away from the applicator for blowing loosened dirt out of the pipe in the direction opposite to the applicator.

5. In a machine for working the interior surface of pipe, a pipe support, a rotary pipe scraper to traverse the pipe interior from end to end, a support for said rotary scraper, means to move the supports relative to one another longitudinally of the pipe for the traverse of the pipe by said rotary scraper, elastic means yieldably urging the scraper outwardly and means to relieve scraper contact on the pipe of the full force of said elastic means comprising a pipe engaging bearing cooperating with the elastic means to limit the outward movement of the scraper.

6. In a machine of the character described, a support for a pipe to be cleaned, a reciprocatory carriage mounted in end to end relation with a supported pipe for projection into said pipe, a rotary brush on the carriage to traverse the pipe interior and scrape dirt therefrom and a carriage mounted pressure air delivery nozzle spaced axially of the brush and directed toward the surface being cleaned at an angle to blow the cleanings through the pipe.

7. In a machine of the character described, a support for a pipe to be cleaned, a reciprocatory carriage mounted in end to end relation with a supported pipe for projection into said pipe, a rotary brush on the carriage to traverse the pipe interior and scrape dirt therefrom and a carriage mounted pressure air delivery nozzle spaced axially of the brush and directed toward the surface being cleaned at an angle to blow the cleanings through the pipe, said nozzle being rotatably mounted and having its angle of discharge arranged to produce helical swirling air currents which carry the cleanings out the end of the pipe.

8. A machine for working pipe interiors, including a traveling carriage, a longitudinally extending track therefor, means to locate a pipe in end to end alignment with the track as a continuation thereof for reception of one end of the carriage, power drive mechanism connected to the opposite end of the carriage to propel the carriage, spaced apart internested tubes rotatably mounted in the carriage and rotatably drive connected with said power drive mechanism, a tube interior cleaning brush mounted on one of the tubes for rotation at the forward end of the carriage, a pressure air nozzle to blow cleanings from the pipe and connected with an air supply within one of the tubes, a paint applicator adjacent the nozzle and connected to receive paint supply within an-

other tube, and couplings joined to the tubes for the delivery thereinto of pressure air and paint respectively.

9. A machine for protectively coating the interior of pipes, including a pipe support, means active on the internal wall surface of a supported pipe to clean the same, means to apply a protective coating on the cleaned surface, a support rotatably mounting both means in axial succession to one another for projection and retraction within the supported pipe and of a length at least as great as the length of the pipe, means to impart relative longitudinal movement to the supports for the projection and retraction of the cleaning means and the coating means, a coating supply conduit leading to said coating means and extending along the length of its support, and control mechanism operable for the selective co-operative working of the cleaning means and the coating means.

10. A pipe interior surface protective coating machine, including a pipe support, a cleaning head for operation on the interior surface of a supported pipe to condition the same for a subsequent coating operation, a support for said cleaning head, power drive mechanism operative with one of the supports to impart relative travel to the head and the pipe in a direction axially of the pipe for the reciprocatory traverse of the pipe surface by said cleaning head, a pipe coating applicator carried by said support for and in axially spaced relation with said cleaning head, a pressure air delivery nozzle positioned axially between the cleaning head and the coating applicator and directed to deliver an air stream toward the cleaning head and away from the coating applicator, and means to impart relative rotation between the pipe and the cleaning head, the nozzle, and the applicator.

11. Pipe interior coating apparatus, including a stationary track, a support to locate a pipe in end to end

succession with the track as an extension thereof, a reciprocatory carriage on the track for projection and retraction of its forward end within the pipe and to track thereon and of a length to extend when projected with its forward end at the far end of the pipe, a cleaning brush carried at the forward end of the carriage, a coating applier also carried by the carriage and positioned ahead of the brush to trail the same during a coating operation upon carriage retraction and an air blast nozzle positioned between the brush and the applier and directed away from the applier to blow cleanings in the direction of carriage retraction and away from the applier.

12. A pipe interior surface protective coating machine, including a pipe support, a cleaning head for operation on the interior surface of a supported pipe to condition the same for a subsequent coating operation, a support for said cleaning head, power drive mechanism operative with one of the supports to impart relative travel to the head and the pipe in a direction axially of the pipe for the reciprocatory traverse of the pipe surface by said cleaning head, an applicator mounted in tandem relation with and axially ahead of said cleaning head on its support to apply a protective coating on said surface after a cleaning operation and on a return stroke imparted by the power drive mechanism and a pressure air delivery nozzle mounted at the cleaning head and directed to blow cleanings out of the pipe and away from the coating applicator.

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