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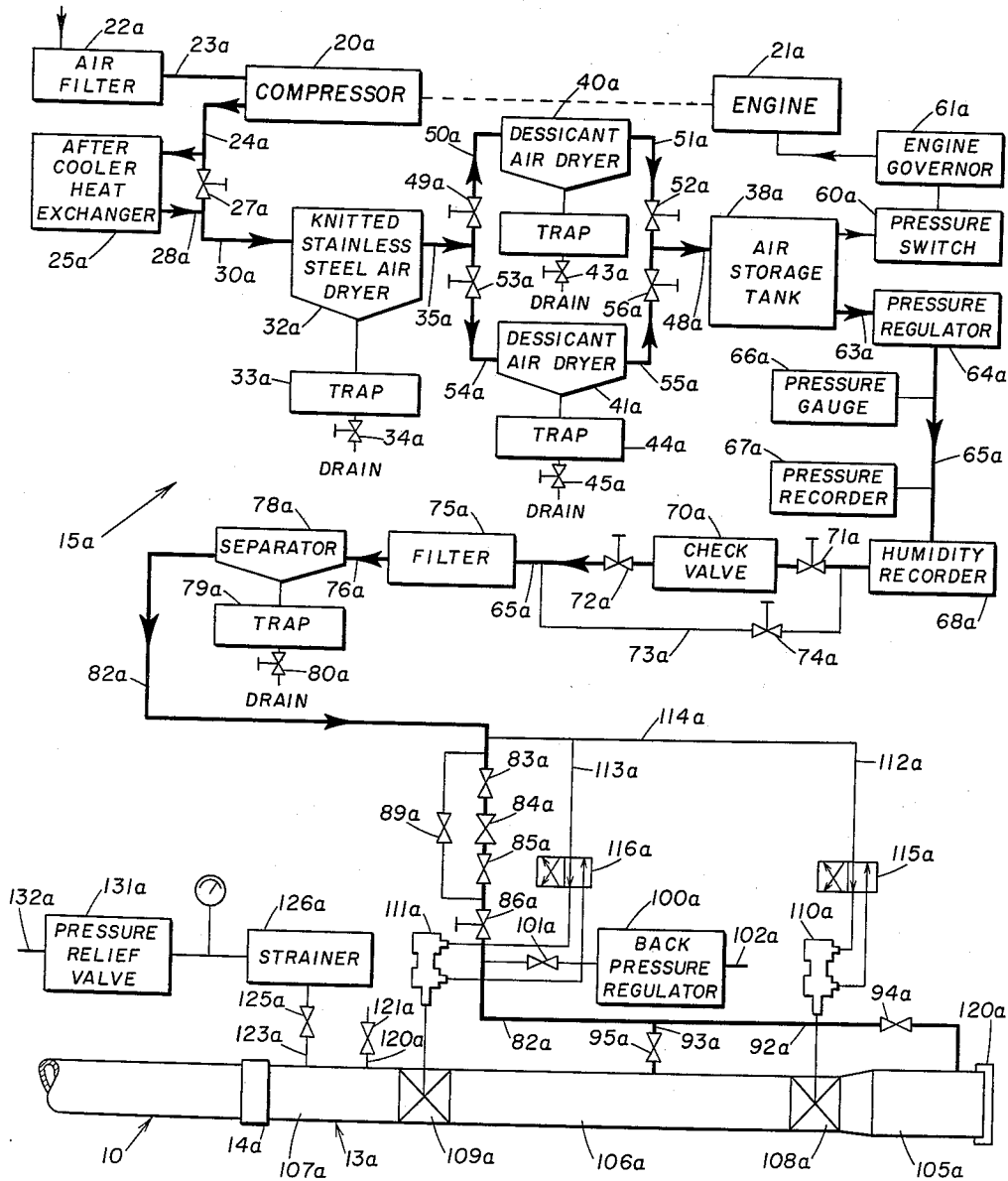


FIG. 3

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3,104,671

APPARATUS FOR PIPELINE TREATMENT WITH CONTAMINANT-FREE FLUID

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This invention relates to a means and a method for treating pipelines.

An object of this invention is to provide a new and improved apparatus for treating pipelines to protect the interior thereof from corrosion.

Another object is to provide an apparatus for treating the internal surfaces of a pipeline to remove all moisture from the internal surfaces of the pipeline.

Still another object is to provide a new and improved apparatus for treating pipelines by propelling a charge of liquid treating substance through a pipeline by means of compressed air.

A further object is to provide an apparatus for treating pipe having a new and improved means for compressing and drying air used to propel a charge of coating substance through a pipeline.

A still further object is to provide an apparatus for treating the interior of pipelines wherein the compressed air is successively passed through a moisture condensing means or mechanical air dryer and chemical desiccant or moisture absorbing means for removing moisture from the compressed air prior to its passage to a storage tank.

Another object is to provide an apparatus for treating internal surfaces of pipelines having moisture condensing means and chemical desiccant means interposed between the compressor and a storage tank and having another desiccant or moisture removing means interposed between the storage tank and the pipeline whereby the air introduced into the pipeline to propel the charge of coating compound through the pipeline is free of moisture and will not introduce moisture which might prevent proper adhesion of the coating compound to the pipe and which may contaminate the coating compound.

Still another object is to provide an apparatus for propelling a charge of compound through a pipeline to coat the interior thereof, which includes a source of dried air at each end of the pipeline for maintaining predetermined pressure conditions upstream and downstream of the charge of coating substance being moved or propelled through the pipe by the compressed air.

A further object is to provide a new and improved method for treating pipelines to remove moisture from the pipeline and then to coat the interior of the pipeline with a protective substance without introducing moisture into the pipeline during the coating process.

A still further object is to provide a new and improved method of drying air to be utilized in treating pipelines which includes compressing the air, passing it successively through a mechanical moisture removing device and a chemical removing device to a storage tank and then through a filter and another moisture removing means to the pipeline.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a schematic illustration showing the apparatus of the invention for performing the method of the invention for treating the internal surfaces of a pipeline;

FIGURE 2 is a diagrammatic view of the air supply

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and regulating system connected to one end of the pipeline for treating the pipeline in accordance with the method of the invention; and,

FIGURE 3 is a diagrammatic illustration of the air supply and regulating system connected to the other end of the pipeline and used in the treating of the pipeline in accordance with the method of the invention.

Referring now to the drawings, the pipeline 10, which is to be treated to protect it from corrosion, may be formed of many sections and be of considerable length. Identical tubular access joints 13 and 13a are secured to the opposite ends of the pipeline by means of couplings 14 and 14a to permit the introduction or removal of a treating substance, such as a cleaning substance or a coating substance, and of the plugs between which the substance is disposed during its movement through the pipeline. Identical air supply and regulating systems 15 and 15a are connected to the access joints 13 and 13a, respectively. Prior to the introduction of the coating substance into the pipeline, the pipeline may be cleaned by any suitable means, such as the apparatus disclosed by Curtis, et al. in Patent No. 2,480,358, which may include a pair of longitudinally spaced plugs between which is contained a cleaning fluid as well as brushes for engaging the internal surfaces of the pipe. The cleaning apparatus is introduced into the pipeline either through the access joint 13 or the access joint 13a, as desired. In the event that it is desired to move the cleaning apparatus from the access joint 13 to the access joint 13a, the cleaning apparatus and liquid are introduced to the pipeline through the access joint 13. During such movement of the cleaning apparatus from the access joint 13 to the access joint 13a, the system 15a is employed to maintain a proper downstream or back pressure to prevent leaking of the cleaning fluid past the forward or downstream plug. When the cleaning apparatus reaches the access joint 13a, the apparatus and excess cleaning fluid are removed. Dried air is then circulated through the pipe 10 through the access joints 13 and 13a by means of either the air supply and regulating system 15 or air supply and regulating system 15a to completely remove all excess cleaning fluid and any moisture from the pipeline.

A charge 18 of coating substance disposed between a pair of plugs 19, such as the plugs illustrated in the patent to Curtis, 2,707,934, may then be introduced into one end of the pipe through an access joint, e.g., the access joint 13, and is then propelled by the air supply and regulating system 15 through the pipeline to the access joint 13a for removal from the pipe through the access joint 13a. During such movement of the plug and the charge of coating substance through the pipe 10, the air supply and regulating system 15a is employed to maintain a predetermined back pressure downstream of the charge 18 of coating substance so that no coating substance will leak forwardly of the forward or downstream plug 19. If desired, dried air may then again be circulated through the now coated pipe to insure thorough drying or curing of the coating thus deposited on the internal surfaces of the pipe. The access joints can then be removed and the pipeline placed back in operation.

It is essential to the proper cleaning and coating of the pipeline that the air introduced to the pipeline to move the charge of cleaning fluid or coating substance through the pipe be free of moisture since any moisture collecting or condensing on the internal surfaces of the pipe or contaminating or mingling with the coating compound will result in improper coating of the pipe thereby rendering the protection of the pipe ineffective to some degree.

The air supply and regulating system 15 includes an air compressor 20 which is driven by an engine 21. The air is supplied to the compressor through an air filter 22 and the conduit 23. The compressed air from the com-

pressor is conducted through the outlet conduit 24 to a heat exchanger 25 where the compressed air is cooled. The heat exchanger 25 may be of any suitable type and be cooled by the passage of air over cooling fins, by refrigeration, by the use of Dry Ice, or the like. A bypass valve 27 is connected across the conduit 24 and the outlet conduit 28 of the heat exchanger so that, if desired, the compressed air may bypass the heat exchanger and flow directly through the conduit 30 to a mechanical air dryer 32 where moisture is removed from the compressed and cooled air by condensation. The mechanical dryer may be of any suitable type, such as the type which has a multiplicity of screens of a fine mesh, constructed of a stainless steel wire, placed perpendicularly to the direction of the flow of air for the purpose of collecting moisture from the air flowing through the screen. The moisture condensed on the screens collects in a trap 33 which is provided with a drain valve 34a whereby the moisture collected in the trap may be discharged from the trap.

The air flowing from the mechanical dryer 32 to the air storage tank 38 may be conducted through either the chemical air dryer 40 or through an identical chemical air dryer 41 which employ any suitable desiccant agent to absorb any remaining moisture from the air prior to its storage in the tank. The chemical air dryers 40 and 41 may employ any suitable chemical desiccant agent having hygroscopic characteristics, such as silica gel, calcium hypochlorate, or the like. Each chemical air dryer is provided with a trap 42 in which moisture may be entrapped and drained off through the drain valve 43 in the event the chemical agent becomes saturated and drips moisture. The chemical air dryer 41 similarly may be provided with a trap 44 for collecting moisture which may be drained therefrom.

The outlet conduit 35a is connectable to the inlet conduit 48 of the air storage tank through the valve 49, the inlet conduit 50 of the air dryer 40, the outlet conduit 51 of the chemical air dryer 40 and the valve 52. The outlet conduit 35 of the mechanical air dryer is also connectable to the inlet conduit 48 of the air storage tank through the inlet conduit 54 of the chemical air dryer 41, the chemical air dryer 41, its outlet conduit 55 and the valve 56.

It will be apparent that if the valves 49 and 52 are closed and the valves 53 and 56 are open, the air from the mechanical dryer or condenser 32 flows to the air storage tank through the chemical air dryer 41. Since the valves 52 and 49 are now closed, the chemical air dryer 40 may be opened for repair, or the recharging or regeneration of the chemical desiccant. Similarly, if the valves 52 and 49 are open and the valves 53 and 56 are closed, the air from the mechanical air dryer flows to the air storage tank 38 through the chemical air dryer 40. The chemical air dryer 41 may then be opened for repair or the recharging or regeneration of the chemical contained therein.

Operation of the engine 21 and therefore of the compressor 20 is controlled by a pressure switch 60 which is actuated whenever the pressure of the air in the air storage tank drops below a predetermined value to cause the engine governor 61 to start the engine 21 to place the compressor into operation. Since the automatic control of the engine 21 in response to the pressure conditions within the storage tank 38 by means of a pressure switch is old and well known, it will not be described further.

The provision of a mechanical air dryer for removing moisture from the compressed and cooled air by condensation of the moisture prior to passage of the air to the chemical air dryer prolongs the useful life of the chemical air dryers so that the period of time between recharging or regeneration of the hygroscopic chemical agents of the chemical air dryers are lengthened.

The provision of the after cooler increases the efficiency of the mechanical air dryer since hot air may carry a greater amount of moisture in the form of water vapor

than cold air. Thus the cooling of the air, which is heated during its compression by the compressor 28, by means of the heat exchanger increases the efficiency of the mechanical air dryer and thus further prolongs the life and the efficiency of the chemical air dryer since only relatively small amounts of moisture need be absorbed by the chemical agents in the air dryers 40 and 41. The outlet conduit 63 of the air storage tank is provided with a pressure regulator 64 which controls the pressure in the conduit 65 to maintain it at a lower value than the pressure of the air in the air storage tank.

A pressure gauge 66, a pressure recorder 67 and a humidity recorder 68 may be connected to the conduit 65 to enable the operator to be fully aware of the pressure and humidity conditions of the air being delivered to the access joint 13.

A check valve 70 is connected in the line 65 in series with the manual valves 71 and 72 disposed on opposite sides thereof to enable the check valve to be isolated from the line. A bypass conduit 73 is connected across the valves 70 and 71 and 72 and is provided with an emergency bypass valve 74 which is ordinarily closed but may be opened to permit continued operation of the air supply and regulating system in the event of the malfunction of the check valve 70, the check valve then being disconnected from the system by the closure of the manually operable valves 71 and 72. The check valve of course is provided to prevent reverse flow of air towards the air storage tank.

The line 65 is connected to the input of a filter 75 provided to remove solid particles, oil or the like, from the air which is being conducted from the air storage tank to the access joint 13. The outlet 76 of the filter 75 is connected to the input of another chemical air dryer 78 wherein any remaining moisture which may still be present in the air is absorbed by a hygroscopic agent. The air dryer 78 is provided with a trap or sump 79 to collect the moisture which may drip from the chemical agent in the event it becomes saturated. The trap may be drained by means of the manually operable drain valve 80.

The supply conduit 82 connects the output of the air dryer 78 to the access joint 13 through a valve 83, a check valve 84 and a valve 85 and a control valve 86 which are connected in series in the supply conduit 82. The valves 83 and 85, of course, may be closed in the event of the malfunction of the check valve 84 to isolate it from the supply conduit. A bypass line 88 is connected across the valves 83, 84 and 85 and is provided with a bypass valve 89 which may be opened to permit continued emergency flow of the compressed air towards the control valve 86 in the event the check valve 84 must be disconnected or isolated from the line. The supply conduit 82 is provided with a pair of branch conduits 92 and 93 provided with control valves 94 and 95, respectively.

It will not be apparent that the air delivered to the access joint through the control valves 94 and 95 has been sequentially treated to insure that it contains or carries a minimum of moisture and that the treatment includes the steps of compressing the air, cooling the air to decrease its moisture carrying capacity, passing it through a mechanical air dryer to separate from the air any droplets of moisture which may be present in the air to cause condensation of the moisture from the air on the stainless steel screens, passing the partially dried air through a chemical air dryer provided with hygroscopic chemicals which absorb water vapor from the air, storing the air under a relatively high pressure in a storage reservoir or tank, permitting flow of the gas by means of the pressure regulator 64 to a line of lower pressure 65 thereby permitting its partial expansion, passing the air through a filter to remove extraneous material, such as dust or oil particles therefrom and finally passing the filtered air through a final chemical air dryer.

It will thus be seen that a new and improved method for treating air has been described which includes com-

pressing the air, cooling the air, removing all droplets of moisture from the air, condensing at least a portion of the water vapor from the compressed and cooled air and passing the partly dried air through chemical agents which remove additional moisture from the air by absorption.

A back pressure regulator 100 is connected through a valve 101 to the supply line 82 immediately downstream of the control valve 86 and functions, when the valve 101 is opened, to release air from the supply line 86 through the vent pipe 102 in the event that the pressure therein exceeds a predetermined value.

The access joint 13 may comprise a tubular member divided into an outer chamber 105 and an intermediate chamber 106 and an inner chamber 107 by a pair of gate valves 108 and 109 which may be of any suitable type, spherical or ball type valves having passages sufficiently large to permit the plugs 19 to pass therethrough. The provision of the three chambers separated by gate valves permits the introduction of plugs and treating substances into the pipeline without causing loss of pressure therein. The valves are operated by pneumatic drive motors 110 and 111, respectively, which are supplied with compressed air through the conduits 112 and 113 connected to the conduit 114 which is connected to supply conduit 82. Control valves 115 and 116 are provided in the lines 112 and 113, respectively, to control the flow of air to the reversible pneumatic drive motors. If desired, of course, the valves 107 and 108 may be of the manually operable type. The pneumatic drive motors and the control valves 115 and 116 may be of any suitable type.

The outer chamber 105 of the access joint 13 is enlarged outwardly of the gate valve 107 and is provided at its open end with a closure 120, which may be of any suitable type, such as that shown in the patent to Curtis, 2,663,326, which is movable to open the outer end of the closure access joints to permit insertion of the plugs 19 therethrough.

The branch conduit 92 opens into the outer chamber 105 of the access joint adjacent the closure 120 whereby dry air under pressure may be admitted to the access joint to force a plug to be moved downstream through the access joint and thence through the pipe 10. The branch conduit 93 opens to the intermediate chamber 106 adjacent the gate valve 108. By appropriate opening or closing of the valves 94 and 95, air under pressure may be selectively admitted to the outer and intermediate chambers of the access joint.

The inner chamber 107 of the access joint is provided with an inlet conduit 120 controlled by a valve 121, connectable through any suitable conduit means, such as a hose, to a reservoir or source of fluid treating substance. The access joint is also provided with an outlet conduit 123, open to the inner chamber 107 and having a valve 125, which is connected to a strainer 126. The strainer is provided with an outlet 130 in which is connected a pressure relief valve 131 which controls the flow of gas through the vent pipe 132. A pressure gauge 135 may be connected to the strainer outlet conduit 130 to indicate the pressure of the gas therein. The strainer is provided to remove solids or liquids from the gas flowing out of the access joint through the outlet or bleeder conduit 123.

The air supply and regulating system 15a and the access joints 13a are identical in all respects to the air supply and regulating system 15 and the access joint 13 and each element thereof is provided with the reference numeral, to which the letter "a" has been added, of the corresponding element of the system 15 or the access joint 13.

It will be seen that, if desired, the mechanical dryer 32 or 32a may be provided with an suitable cooling means for cooling the air passing therethrough and thus increasing the removal of the moisture therefrom by condensation.

In use, when it is desired to treat a pipeline 10 in any manner requiring the use of compressed dried air, such

as cleaning the pipe, drying the pipe after the cleaning operation, coating the pipe with a suitable protective substance, and drying or curing the coating substance deposited on the internal surface of the pipe, the opposite ends of the pipe, which may be underground throughout most of its length, are exposed and the access joints 13 and 13a are connected thereto by means of any suitable quick disconnect couplings 14, such as the well known "Dresser" couplings.

The pressure regulator 64 of the air supply and regulating system 15 is set to cause the air in the supply conduit 82 to be maintained at a relatively high pressure, e.g., fifty pounds per square inch, while the pressure regulator 64a of the air supply and regulating system 15a is set to maintain a relatively lower pressure in the supply line 82a, e.g., ten pounds per square inch. The valve 101a controlling flow to the back pressure regulator 100a is opened and the back pressure regulator 100a is set to maintain the pressure within the supply line 82a at not more than ten pounds per square inch, whereby the back pressure regulator permits flow of air through the vent 102a from the pipeline whenever the pressure exceeds ten pounds per square inch. The valve 101 of the back pressure regulator 100 of the air supply and regulating system 15, however, is closed so that the back pressure regulator 100 is now ineffective.

The air supply and regulating system 15 is then placed in operation to supply dry air to the supply line 82 by closing the heat exchanger bypass valve 27 so that all air compressed by the compressor 20 is caused to flow through the heat exchanger 25. One set of valves 52 and 49 or 56 and 53 is opened and the other side is closed to cause either the air dryer 40 or the air dryer 41 to be placed in series with the mechanical air dryer 32 between the heat exchanger and the air storage tank so that all air flowing through the air storage tank passes through a mechanical air dryer and a chemical air dryer. The bypass valve 74 is closed so that the air flowing to the supply line 82 can flow only forwardly and cannot flow backwardly. The bypass valve 89 is closed and the main control valve 86 is opened. The branch conduit valves 94 and 95 are now closed as is the valve 121 of the supply line 120. The valve 125 of the outlet or bleed line 123 is also closed. The air supply and regulating system 15 will then cause dried air to flow either into the outer chamber 105 or the intermediate chamber 106 whenever the valves 94 or 95, respectively, are opened.

The air regulating and supply system 15a is similarly placed into operation by closing the heat exchanger bypass valve 27, opening one pair of the valves 49a and 52a or 53a and 56a and closing the other pair of such valves. The bypass valve 74a is closed and the main control valve 86a is opened. The valves 125a of the outlet conduit 123a and the valve 120 of the inlet conduit valve 121 of the inlet conduit 120 are closed. The valve 94a of the branch conduit 92a is closed as is the gate valve 108a. The gate valve 109a is open so that the air supply and regulating system 15a will cause air to flow into the intermediate chamber 106a and through the inner chamber 107a into the downstream end of the pipe 10 whenever the valve 95a is open and the pressure within the pipeline drops below a predetermined value.

Since the air supply and regulating system 15 is delivering air to the access joint 13 at a higher pressure than the air being delivered to the access joint, when valve 95 is open and the gate valve 109 is open, to flow from the access joint 13 to the access joint 13a and thence outwardly through valve 95a, the branch conduit 93a and the valve 101a and the back pressure regulator 100a to the vent 102a and thence to the atmosphere. If for some reason, such as leaks in the pipeline, the pressure within the intermediate chamber 106a drops below the value at which the pressure regulator 64a has been set, e.g., ten pounds per square inch, the pressure regulator will open to permit air to flow from the air supply sys-

tem 15a into the intermediate chamber 106a and thence through the open gate valve 109a to the downstream end of the pipeline 10.

If it is now desired to move a charge of cleaning fluid from the access joint 13 through the pipeline 10 to the access joint 13a, the valves 94 and 95 of the air supply and regulating system 15 are closed. The gate valves 108 and 109 are closed by the pneumatic drive motors 110 and 111, respectively. The closure 120 is then opened to permit the insertion of a forward or downstream plug 19, such as the plug described in the patent to Curtis, 2,480,358, into the outer chamber 105 of the access joint 13. The closure is then again secured in place and the gate valve 108 and the branch conduit valve 94 opened. The increased pressure behind the plug thus introduced into the access joint causes to move through the open valve 108 into the intermediate chamber. Gate valve 109 may then be opened to permit the plug 19 to move through the gate valve 109 and the inner chamber 107 into the pipeline 10 due to the pressure of the air flowing through valve 94. When the downstream or forward plug 19 moves into the intermediate inner access chamber 107 and past the inlet conduit 120, the valve 94 and the gate valve 109 are closed. The inlet conduit 120 is then connected to the supply of cleaning fluid and the valve 121 is opened. As the cleaning liquid or substance is forced into the pipe from any suitable source, it moves the forward plug 19 out of the inner chamber 107 and through the coupling 14 into the pipe 10. The amount of the charge of cleaning substance introduced into the inner chamber 107 and the pipe 10 is varied in accordance with the condition of the internal surfaces of the pipe and the length of the pipeline to be cleaned thereby. When the proper amount of cleaning substance has been introduced into the pipeline, the valve 121 is closed. The gate valves 108 and 109 are of course now in closed position. The closure is again opened and the upstream or rear cleaning plug 19 is introduced into the access joint and the closure 120 is again secured to the access joint. The valve 94 is then opened to permit flow of compressed air into the outer compartment 105 of the access joint rearwardly of the plug 19 to cause it to move forwardly towards the gate valve 108 which is now opened. The rear plug moves into the intermediate chamber. The gate valve 108 is then closed as is the valve 94. The valve 95 of the branch conduit 93 is then opened to cause the rear plug to move through the intermediate chamber toward the gate valve 109 which is then opened to permit movement of the rear plug into the inner compartment 107. When the gate valve 109 is opened, the valve 125 is also opened to permit the escape of air trapped between the two plugs. The valve 125 is kept open until all the air has escaped from between the two plugs so that the space between the two plugs is completely filled with the cleaning fluid or substance.

When the valve 125 is closed, the pressure differential across the plugs and the charge of air cleaning substance increases and causes the plugs and the charge of cleaning fluid to move through the pipeline toward the access joint 13a. The rate of travel of the charge of cleaning fluid is dependent upon the pressure differential which is maintained constant by the pressure regulator 64 of the system 15 and the pressure regulators 64a and 109a of the system 15a. As the plugs move toward the access joint 13a, a pressure of ten pounds per square inch is maintained in the pipe forwardly or downstream of the forward plug, the back pressure regulator opening to permit escape of air whenever the pressure downstream of the forward plug increases above ten pounds and the air supply and regulating system 15a delivering air to the pipeline forwardly or downstream of the forward plug 19 whenever the pressure forwardly or downstream of the forward plug decreases below ten pounds. This decrease in pressure sometimes occurs due to leaks in the pipeline.

When the forward plug traverses the pipeline 10 and enters into the forward inner compartment 107a of the access joint 13a and approaches the valve gate 109a, the valve 109a is closed by means of the pneumatic drive motor 111a. The valve 125a of the outlet conduit 123a is opened so that the rear or upstream plug continues to move forwardly forcing the cleaning fluid upwardly through the outlet conduit into the strainer 126a where the cleaning fluid is retained and any air trapped therein escapes through the pressure relief valve 131a and the vent 132a. When the rearmost plug 19 moves into the inner compartment 107 and contacts the forward plug 19, the valve gate 109a is again opened to permit the plugs to move into the intermediate chamber 106a and thence to the valve gate 108a. The gate valve 109a is then closed to retain the pressure within the pipeline 10 and the closure 120a is opened. The valve 108a is then opened whereupon the air under pressure in the intermediate chamber 106a moves the plugs through the gate valve 108a to the outer chamber 105a of the access joint 13a for removal therefrom. If necessary, the valve 94a may be opened to permit air to flow into the intermediate chamber behind the plugs to cause the plugs to move through the gate valve 108a into the outer chamber 105a. The closure 120a is then opened and the plugs are removed from the access joint 13a.

If desired, of course, a new charge of cleaning fluid may be caused to travel from the access joint 13a to the access joint 13 in the same manner, the pressure regulator 64a of the air supply system 15a then being set at a higher value, say fifty pounds, and the valve 101a of the back pressure regulator is closed. The pressure regulator 64 is set at a lower value, e.g., ten pounds, and the valve 101 of the back pressure regulator 100 is opened.

After the pipe has been cleaned by the movement of the charge of cleaning fluid therethrough one or more times, it may be desired to blow dry air from one end of the pipe to the other to evaporate and remove any cleaning fluid remaining in the pipe. If it is then desired to blow dry air from one end of the pipe to the other to evaporate and remove any cleaning fluid remaining in the pipe to dry the pipe of any moisture by air introduced through the access joint 13 and discharged from the other end of the pipe through the access joint 13a, the main control valve 86a of the air supply and regulating system 15a is closed, the bleeder valve 12a, the gate valve 109a is closed and the bleeder valve 125 is opened. The pressure relief valve 131a is set to open at any desired value or at a relatively low pressure so that the air may flow at a controlled rate from the access joint 13 through the pipe 10 to the access joint 13a and then escape to the atmosphere through the strainer 126a and the vent 132a.

The air supply and regulating system 15 is then placed in condition to supply dry air through the access joint 13 to the pipe 10. The valve 27 is closed so that all air flowing from the compressor 20 must flow through the after cooler or heat exchanger 25. Either the valves 53 and 56 or the valves 52 and 49 are then closed so that only one of the desiccant air dryers 40 or 41 is placed in operation. The bypass valve 74 of the check valve 70 is closed and the valves 71 and 72 are opened. The bypass valve 89 of the check valve 84 is also closed and the valves 83 and 85 are opened. The valve 101 of the back pressure regulator is closed. The pressure regulator 64 is set so that the air flowing to the access joint through the supply line 82 is at the desired pressure. The gate valve 108 is placed in closed position by appropriate use of the control valve 115 and the gate valve 109 is placed in open position by appropriate manipulation of the control valve 116. The valve 121 of the supply conduit 120 is closed as is the valve 125 of the relief line 123. The control valve 94 of the branch conduit 92 is closed.

With the gate valve 108 closed and the gate valve 109 open, air compressed by the compressor 20 will flow

through the heat exchanger 26 where it is cooled to the mechanical air dryer 32 wherein moisture is condensed from the compressed and cooled air and then flows through one of the mechanical air dryers 40 or 41 wherein a hygroscopic chemical agent absorbs water vapor from the air. The dried air then flows through the air storage tank and is released therefrom under the control of the pressure regulator to the conduit 65 and thence through the check valve 70, the filter 75 where extraneous matter is removed from the air, and a final separator 78 or dryer where any remaining moisture is removed, to the supply line 82 and thence through the check valve 84 and the open main control valve 86 and the open branch conduit valve 95 into the intermediate chamber 106. The dried air flows from the intermediate or lock chamber to the outer chamber 107 of the access joint 13 and thence through the coupling 14 to one end of the pipeline 10, through the pipeline to the other end thereof, and the coupling 14a to the inner chamber 107 of the access joint 13a. The air escapes to the atmosphere from the inner chamber through the conduit 123a and the open valve 125a to the strainer 126a wherein extraneous matter and liquids are removed and thence through the pressure relief valve which is set to open at a relatively low pressure to the vent 132a and thence to the atmosphere. The air is allowed to flow through the pipe 10 for any desired period of time and when the pipe has been dried, the main control valve 86 and the control valve 95 may be closed, thereby stopping further flow of air to the access joint 13 and thus to the pipeline 10.

After the pipe has been dried, a charge of coating substance which is in liquid form, is introduced into the pipeline between a pair of plugs, such as the plugs illustrated in the patent to Curtis, 2,707,934, in the same manner as described above in connection with the introduction and movement of the cleaning fluid through the pipe. The plugs permit a thin coating of the coating substance to be deposited on the internal surfaces of the pipe during the passage of the charge of the coating substance contained between two plugs through the pipeline. After the internal surfaces of the pipeline have been coated, the plugs are removed and dry air may again be circulated through the pipeline from either air supply and regulating system 15 or 15a as desired to help dry or cure the coating of protective substance on the internal surfaces of the pipeline. After the pipeline is thus treated, the access joints may be uncoupled from each end of the line and the pipeline placed back in operation.

While the manner in which the air supply and regulating systems and the access joints are employed to treat the internal surfaces of the pipeline has been described in connection with the movement of a single charge of cleaning or coating substance through the pipe, it will be apparent that a plurality of spaced charges of any desired treating substance or liquid may be caused to be moved simultaneously through the pipeline, with each charge having plugs 19 on each end thereof, since the provision of the three chambers of the access joints separated by the gate valves 108 and 109 permits the loading or introduction of plugs and charges into the pipeline without loss of pressure therein.

It will further be seen that the air introduced into opposite ends of the pipeline through the access joints to provide upstream and downstream pressure has been completely dried and will introduce moisture into the pipeline which might tend to prevent proper treatment of the internal surfaces of the pipeline or permit or cause the coating to be improperly or inadequately applied to the internal wall surfaces of the pipeline.

It will now be seen that a new and improved means and method for treating the internal surfaces of a pipeline has been illustrated and described which includes an apparatus connectible to each end of the pipeline to be treated having an air supply and regulating system providing dry air at any desired pressure introduced

through the apparatus into opposite ends of the pipeline to move treating means, such as cleaning or coating fluid and substance or devices, such as the plugs of the Curtis Patents 2,480,358, and 2,707,934.

It will further be seen that each air supply and regulating system is provided with means for compressing air, means for cooling the compressed air, means for condensing moisture from the cooled and compressed air, means for absorbing water vapor from the air after an initial amount of moisture has been removed therefrom by condensation and means for delivering the dried air at a regulated pressure to the access joints to move the pipeline treating substances and devices through the pipe.

It will further be seen that the provision of an air supply and regulating system at each end of the pipe permits the maintenance of a desired back pressure in the pipeline forward or downstream of the treating substances and devices whereby the rate of movement of the treating devices and substances through the pipeline may be regulated and whereby leakage is prevented of the treating fluid past such treating devices as the forward plugs referred to above.

It will further be seen that the air supply and regulating system permits the introduction of the treating fluids either through the inlet conduit 123 of the access joint 13 or the inlet conduit 123a of the access joint 13a.

It will further be seen that the circulation of dry air through the pipeline to remove excess moisture or the solvents of the cleaning or coating substances from the pipe after it has been treated therewith may be in either direction through the pipeline as desired.

It will further be seen that while the escape of the dried air during the drying process from the pipeline has been described as being through either the pressure relief valve 131 or 131a, it will be apparent that the valve 125 or 125a could be closed and the valve 95a be opened, if the gate valve 109 or 109a were open to permit the escape of the gas through the valve 101a and the back pressure regulator 100a or 100, as desired.

It will now be seen that a new and improved means and method has been illustrated and described which is simple in operation and which permits the introduction of the treating fluids and devices into the pipeline with a minimum of effort and with a minimum loss of pressure in the pipeline.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

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

1. An apparatus for treating the internal surfaces of a pipeline including: access means connectable to opposite ends of the pipeline for introducing pipeline treating means into the pipeline and individually operable means connectable to said access means for introducing dry air into opposite ends of the pipeline through said access means at different pressures, said individually operable means each including a compressor for compressing air; a heat exchanger connected to the compressor for cooling the compressed air, a condensing means connected to the heat exchanger for condensing moisture from the air cooled by the heat exchanger, and means connected to said condensing means having a hygroscopic agent for absorbing water vapor from the air flowing from the condenser means.

2. An apparatus for treating the internal surfaces of a pipeline including: access means connectable to opposite ends of the pipeline for introducing pipeline treating means into the pipeline and individually operable means connectable to said access means for introducing dry air into opposite ends of the pipeline through said access means at different pressures, said individually op-

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erable means each including a compressor for compressing air; a heat exchanger connected to the compressor for cooling the compressed air, a condensing means connected to the heat exchanger for condensing moisture from the air cooled by the heat exchanger, and means connected to said condensing means having a hygroscopic agent for absorbing water vapor from the air flowing from the condensor means; storage means connected to said hygroscopic agent means for storing dried air; and means for conducting air from said storage means to an associated access means.

3. An apparatus for treating the internal surfaces of a pipeline including: access means connectable to opposite ends of the pipeline for introducing pipeline treating means into the pipeline and individually operable means connectable to said access means for introducing dry air into opposite ends of the pipeline through said access means at different pressures, said individually operable means each including a compressor for compressing air; a heat exchanger connected to the compressor for cooling the compressed air, a condensing means connected to the heat exchanger for condensing moisture from the air cooled by the heat exchanger, and means connected to said condensing means having a hygroscopic agent for absorbing water vapor from the air flowing from the condensor means; storage means connected to said hygroscopic agent means for storing dried air; and means for conducting air from said storage means to an associated access means, said conducting means having pressure responsive means for maintaining the pressure of the air flowing through the pipeline at a predetermined value.

4. An apparatus for treating the internal surfaces of

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a pipeline including: access means connectable to opposite ends of the pipeline for introducing pipeline treating means into the pipeline and individually operable means connectable to said access means for introducing dry air into opposite ends of the pipeline through said access means at different pressures, said individually operable means each including a compressor for compressing air; a heat exchanger connected to the compressor for cooling the compressed air, a condensing means connected to the heat exchanger for condensing moisture from the air cooled by the heat exchanger, and means connected to said condensing means having a hygroscopic agent for absorbing water vapor from the air flowing from the condensor means; storage means connected to said hygroscopic agent means for storing dried air; and means for conducting air from said storage means to an associated access means, said conducting means having pressure responsive means for maintaining the pressure of the air flowing through the pipeline at a predetermined value, and means interposed in said conducting means between said pressure responsive means and said pipeline for removing water vapor from the air passing therethrough.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,104,671

September 24, 1963

Douglas K. McLean

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 69, for "like" read -- life --; column 5, line 70, for "an" read -- any --; column 8, line 21, for "94a" read -- 95a --; line 47, for "125" read -- 125a --.

Signed and sealed this 14th day of April 1964.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents