Oct. 16, 1962 E. N. DOYLE ET AL 3,058,137

PIPE LINE TREATING APPARATUS

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FIG. 1A

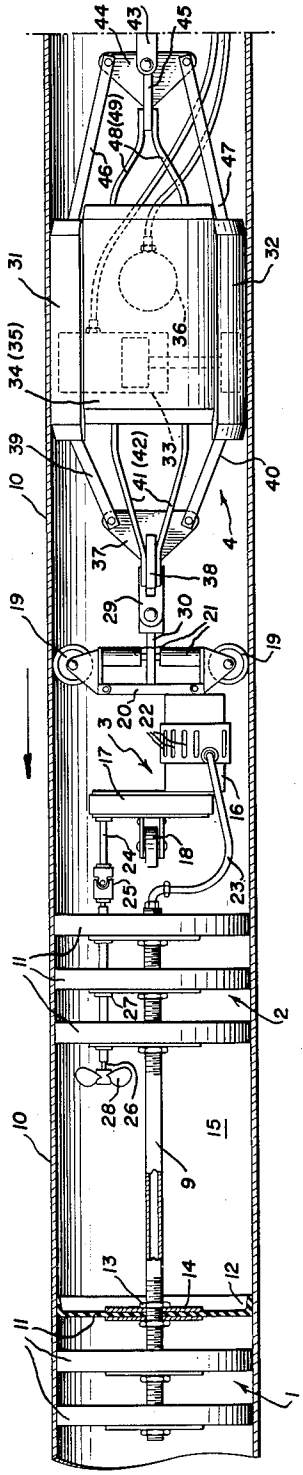
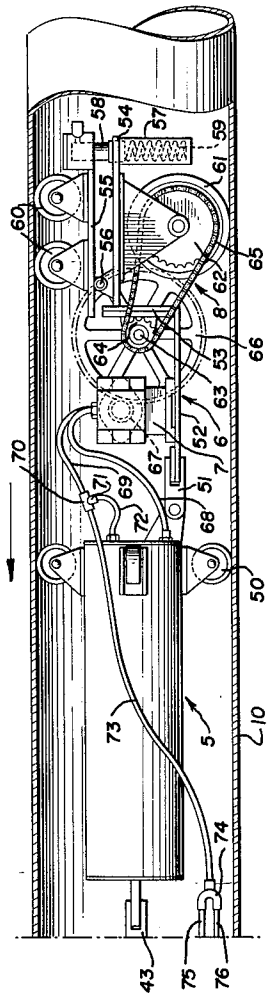


FIG. 1B



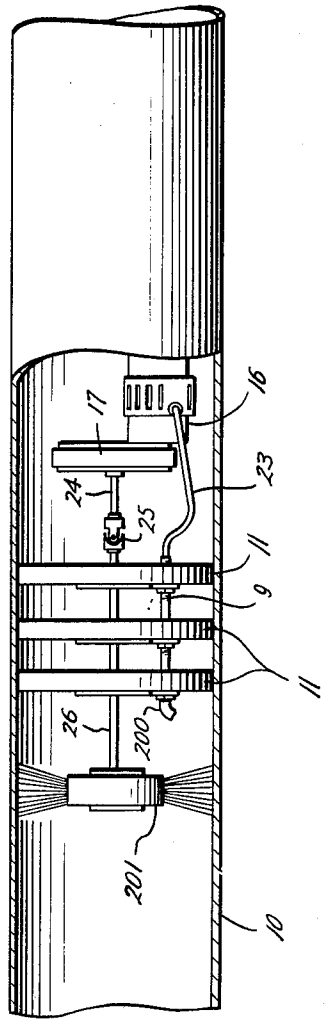
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FIG. 2



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PIPE LINE TREATING APPARATUS

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11 Claims. (Cl. 15—104.06)

This invention relates to pipe line treating apparatus and more particularly to apparatus for accomplishing cleaning, coating and the like of the inner wall of a pipe line.

While the inner wall of a relatively short pipe or tube can be treated successfully with relative ease by means of several types of devices now available to the trade, more severe problems arise when the work to be treated is, as in the case of a pipe line, thousands of feet, or even several miles, in length. In treating the interior of relatively short tubular work, it is readily possible to maintain a direct connection to the treating device from an open end of the work so that direct control of the treating device can be had at all times during the operation. In the case of a pipe line, however, it is obviously impractical to maintain direct control over the treating apparatus. Once within the pipe line, the treating apparatus must function automatically to travel the entire length of the pipe line to be treated and must also carry out its treating operation or operations uniformly and continuously throughout such travel. Further, for greatest economy and simplicity of operation, it is desirable that the apparatus be capable of treating a relatively great length of work in a single pass therethrough, without requiring adjustment, replenishment of materials, or the like.

Accordingly, it is an object of the invention to devise a simple, more dependable and effective apparatus for treating the inner wall of a pipe line.

Another object is to provide an apparatus of the type referred to which is propelled through the pipe line by fluid pressure and which, in a particularly advantageous embodiment, incorporates means actuated by such fluid pressure for operating at least one working part of the treating apparatus.

A further object is to provide, in such an apparatus, novel and effective means for automatically regulating the speed with which the apparatus travels through the pipe line.

A still further object is to devise means, in such an apparatus, for controlling the operation of at least one component thereof automatically in response to the speed with which the apparatus travels through the pipe line.

Yet another object is to provide an especially effective and dependable device for cleaning the inner wall of a pipe line.

In order that the manner in which these and other objects are attained, in accordance with the invention, can be understood in detail, reference is had to the accompanying drawings, which form a part of this specification, and wherein:

FIGS. 1A and 1B are side elevational views illustrating a pipe line cleaning apparatus constructed in accordance with one embodiment of the invention, some parts being shown in vertical section, and

FIG. 2 is a somewhat simplified illustration of certain features which may be used in the alternative of FIG. 1 details.

Referring now to FIGS. 1A and 1B, the embodiment of the invention there illustrated comprises a mobile train constructed to negotiate the pipe line to be cleaned, the train comprising a pair of spaced plug means **1**, **2** employed in propelling the train as later described, an air

motor unit **3**, automatic brake means **4**, a fluid reservoir **5**, and a carriage, indicated generally at **6**, supporting a pump **7** and pump drive means **8**.

Plug means **1**, **2** are identical in construction and are mounted on opposite end portions of a common tubular, somewhat flexible shaft **9** which extends along the axis of the pipe line, a section of the latter being shown at **10**. The plug means each comprise a plurality of axially spaced scraper cups or discs **11** each having an outer diameter substantially equal to the inner diameter of the pipe line to be cleaned, so that the rearwardly extending peripheral lips **12** of the cups **11** not only scrape and wipe the inner wall of the pipe line but also form a substantially fluid-tight seal therewith. Each cup **11** is secured to shaft **9**, as by nuts **13** and clamping plates **14**, so that the cups lie in planes at right angles to the axis of shaft **9**. While the cups **11** have been illustrated as each having a rearwardly extending peripheral lip, with all of the cups **11** being identical, it will be understood that the cups or discs can be of any suitable design and that each plug means **1**, **2** can employ cups or discs of different design, some being provided mainly to seal with the wall of the pipe line and others mainly to scrape the wall.

The axial space between adjacent cups **11** is relatively small. However, plug means **1** and **2** are spaced from each other by a substantial axial distance and so coact with the wall of the pipe line to define a relatively large chamber **15** in which a suitable cleaning mixture is provided. Such mixture may comprise any suitable cleaning liquid and a particulate abrasive material, such as crushed quartz, corundum, or the like.

Located immediately behind plug means **2**, and thus adjacent the trailing end of shaft **9**, the air motor unit **3** includes an air motor **16**, of any suitable conventional construction, output gearing **17**, forwardly disposed stabilizing wheels **18** mounted on the housing of gearing **17** for rolling engagement with the wall of the pipe line, and rearwardly disposed stabilizing wheels **19** pivotally carried by a frame **20** fixed to the trailing end of motor **16**. Disposed for rolling contact with the pipe line wall, wheels **19** can be urged outwardly by rectilinear motor means **21** which can be, for example, a simple hydraulic jack, a coil spring device or a piston-and-cylinder arrangement actuated both by fluid pressure and spring pressure. Advantageously, forwardly disposed wheels **18** can also be equipped with means for urging the same outwardly against the pipe line wall, in the manner just described.

The inlet of air motor **16** communicates with the interior of the pipe line behind plug means **2**, as via louvers **22** in the motor casing. The outlet of motor **16** is connected by hose or conduit **23**, to the trailing end of shaft **9**, so that the air discharges from the motor into the interior of the pipe line ahead of plug means. If the apparatus is disposed in a pipe line in the manner shown, and a positive air (or other fluid) pressure is maintained behind plug means **2** while the interior of the pipe line ahead of plug means **1** is allowed to remain at a lower pressure, such as atmospheric pressure, there results a pressure differential across the combination of plug means **1** and **2** which is effective both to drive the apparatus continuously through the pipe line and to drive air motor **16**.

The output shaft **24** of gearing **17** is connected via universal joint **25** to a shaft **26** which extends parallel to shaft **9** and is journalled in suitable fluid-tight bearing means **27** in clamping plates **14** of plug means **2**, the leading end of shaft **26** being disposed in the space between plug means **1** and **2**. Fixed to the leading end of shaft **26** is a rotary agitator **28** of any suitable type, here illustrated as of conventional propeller form. Gearing **17** is suitably

designed to convert the rotary motion of the output shaft of motor 16 to rotary motion of member 28 at a speed suitable to effect the most advantageous agitation of the cleaning mixture in the space between plug means 1 and 2. With air motor 16 of the more conventional high-speed type, device 17 will ordinarily be a speed reduction gearing.

Brake means 4 trails air motor unit and is connected thereto via a universal joint 29, the forward member 30 of the universal joint being fixed to frame 20. The brake means comprises a first pair of opposed brake shoes 31, 32 urged outwardly against the wall of the pipe line by a fluid pressure-actuated motor indicated at 33, shoe 31 being attached to the cylinder of motor 33 and shoe 32 to the piston thereof. Brake means 4 also includes a second pair of opposed brake shoes 34, 35 spaced apart on an axis at right angles to the axis of the movement imparted to brake shoes 31, 32 by motor 33. Brake shoes 34, 35 are actuated by fluid pressure motor 36, spaced rearwardly from motor 33, one shoe being attached to the cylinder of the motor and the other to the piston thereof. Universal joint 29 includes plates 37 and 38 disposed at right angles to each other and rigidly secured together, plate 37 lying in a plane extending between shoes 31, 33 and plate 38 lying in a plane extending between shoes 34, 35. The forward ends of shoes 31, 32 are connected to plate 37 by links 39 and 40, respectively, each link being pivoted at one end to plate 37 and at the other end to the corresponding brake shoe, the nature of such pivoted connections being such that the brake shoes are constrained to move only in the direction of movement provided by motor 33. Brake shoes 34, 35 are similarly connected to plate 38 by pivoted links 41 and 42.

Another universal joint 43, similar to joint 29, is spaced rearwardly from the brake shoes and includes a pair of plates 44, 45 disposed at right angles to each other and secured rigidly together, plates 44 and 37 lying in a common plane and plates 45 and 38 lying in a common plane. The trailing ends of brake shoes 31, 32 are connected to plate 44 by pivoted links 46 and 47, respectively. The trailing ends of shoes 34, 35 are connected to plate 45 by pivoted links 48 and 49, respectively. It is thus obvious that the motors 33 and 36 are operative to force the brake shoes radially outwardly into engagement with the pipe line wall, the frictional braking effect obtained depending upon the pressure applied to the motors.

Brake shoes 31, 32 and 34, 35 are rectangular in plan, and present a frictional braking surface having the form of part of a cylinder. In transverse cross-section, the braking surface of each shoe extends circularly for substantially 90°. Thus, in combination, the four brake shoes provide a substantially complete cylindrical braking surface. A particular advantage of the brake means is its highly simplified construction in which all supports, other than motors 33, 36 and the pivoted links connecting the shoes to the universal joints, are eliminated.

Brake means 4 is so constructed and operated that brake shoes 31, 32 and 34, 35 are in constant contact with the pipe line wall, and any increase in fluid pressure supplied to the motors 33, 36 results in a corresponding positive increase in the braking effect of the brake means. Though each element of the train develops frictional forces tending to slow the train, brake means 4 provides the principal frictional force for regulating the speed with which the train negotiates the pipe line.

Located immediately behind brake means 4, the pressure fluid reservoir 5 is an axially elongated cylindrical tank, the front end of the tank being connected to universal joint 43. At its rear end, the tank is provided with a plurality of stabilizing wheels 50 mounted for rolling engagement with the pipe line wall.

The trailing end of reservoir 5 is coupled to carriage 6 by a universal joint 51. At its forward end, carriage 6 comprises a flat, longitudinally extending frame member 52, the trailing end of which is fixed to a transversely disposed plate 53. A flat frame member 54 is rigidly secured to plate 53 and extends rearwardly therefrom, members 52 and 54 being parallel but disposed on opposite sides of the longitudinal axis of the carriage, member 54 being disposed relatively close to said axis. Located outwardly from member 54 is a longitudinally extending plate 55. At their leading ends, members 54 and 55 are pivotally interconnected for movement about an axis, at 56, extending transversely of the carriage. At its trailing end, member 54 carries a cylinder 57 extending transversely of the carriage, away from member 55. Member 55 carries a piston 58 extending into cylinder 57 and a coil spring 59 is disposed within the cylinder, being maintained in compression between the end wall of the cylinder and the piston to urge members 54 and 55 apart.

Mounted on plate 55, on the side thereof opposite member 54, are stabilizing wheels 60 disposed in line for rolling engagement with the wall of the pipe line. Mounted on member 54, on the side thereof opposite plate 55, is a friction wheel 61 disposed for rolling engagement with the pipe line wall. A sprocket wheel 62, forming part of drive means 8, is connected to friction wheel 61 for rotation therewith. A bracket fixed to the forward face of plate 53 rotatably supports a transversely extending shaft 63. Secured to one end of shaft 63 and disposed in alignment with sprocket wheel 62 is a second, smaller sprocket wheel 64, and the usual drive chain 65 extends about sprocket wheels 62 and 64. To the opposite end of shaft 63 there is secured a relatively large gear 66 meshing with a small gear 67 fixed to the drive shaft of pump 7.

As the train travels through the pipe line, the resulting rotary motion of friction wheel 61, dependent upon the speed of the train, is multiplied first by the sprocket drive and then through gears 66 and 67, and applied to drive pump 7. The pump is of the semi-positive displacement type, so that the fluid pressure developed thereby is a function of the speed of rotation of the pump drive shaft and, therefore, of the speed of the train along the pipe line.

The inlet of pump 7 is connected to reservoir 5 via flexible hose or conduit 68. The outlet of pump 7 is connected via flexible hose or conduit 69 to a T-fitting 70. One branch 71 of fitting 70 includes a restricted orifice and is connected via flexible hose or conduit 72 to reservoir 5. The other outlet of fitting 70 is connected via hose or conduit 73 to the inlet of dual outlet fitting 74. One outlet of fitting 74 is connected via a length of a flexible hose or conduit 75 to the pressure input fitting of motor 33 of brake means 4. The remaining outlet of fitting 74 is similarly connected by a length of hose or conduit 76 to the pressure input fitting of motor 36 of the brake means. Thus, the output of pump 7 is connected in parallel to the two brake actuating motors 33, 36 and also, via the restricted orifice and hose or conduit 72 to the fluid reservoir 5. It is apparent that the force developed by motors 33, 36 to urge the brake shoes outwardly is proportional to the output of pump 7, the effective areas of the pistons of motors 33 and 36 and the area of the restricted orifice in fitting 70. Since all of these factors are relatively constant save for the output pressure of the pump, the frictional forces developed by brake means 4 is substantially proportional to the output pressure of the pump and thus to the speed of the train as it travels through the pipe line.

When the train begins to move through the pipe line, the frictional effect of brake means 4 is relatively small because of the low speed of the train. As the speed of the train increases, the braking effect supplied by brake means 4 increases until a balance of forces is obtained which limits the speed of the train to a desired value.

Should the cups or discs 11 encounter a major obstruction on the wall of the pipe line being cleaned, the speed of the train decreases, there is accordingly a decrease in the friction braking effect of brake means 4 and therefore an increase in the effective propelling force, tending to overcome the obstruction and maintain the desired velocity.

In operation, the apparatus is introduced through an open end of the pipe line to be cleaned and the space between plug means 1 and 2 is substantially completely filled with the abrasive fluid cleaning mixture. With the apparatus disposed in the pipe line, fluid pressure is applied behind plug means 2 and the resulting pressure differential across the combination of the two plug means drives the train along the pipe line. Such pressure differential also causes air motor 16 to be operated, rotating agitator 28 to agitate the cleaning composition and assure that the same is uniformly and intimately brought into contact with the inner wall of the pipe line.

The effectiveness of the cleaning operation depends upon the residence time of chamber 15 with respect to the pipe line wall area in question, the type of cleaning mixture employed and the effectiveness of agitator 28. An advantageous way to control the effectiveness of the cleaning operation is by changing the speed of the train along the pipe line, so changing the residence time of chamber 15 with respect to any given portion of the pipe line wall. The speed of the apparatus along the pipe line can be varied by changing the size of the restricted orifice in branch 71 of T-fitting 70, so varying the relative quantity of fluid bled from the output side of the pump back into reservoir 5.

Tubular shaft 9, and thus chamber 15, can be of substantial length and shaft 9 is accordingly made sufficiently flexible to allow the combination of shaft 9 and plug means 1 and 2 to negotiate bends in the pipe line being cleaned. Motor unit 3, brake means 4, reservoir 5 and carriage 6 all being relatively short, the universal joints or couplings 25, 29, 43 and 51 adequately provide the train with the flexibility necessary for negotiation of a pipe line having turns and bends.

The portion of shaft 9 disposed between plug means 1 and 2 is of course exposed directly to the abrasive cleaning mixture. Accordingly, it is advantageous to have shaft 9 extend along the axis of the pipe line, as shown, so as to be in a zone of lower agitation. While agitator 28 has been shown located above shaft 9, this location can be changed as desired. When the fluid cleaning mixture contains relatively heavy abrasive particles, the agitator can advantageously be disposed below shaft 9, so that the abrasive particles are not allowed to collect by gravity in the space adjacent the lower portion of chamber 15.

Air motor unit 3 is particularly advantageous because of its simplicity, no special power source being necessary. It is also to be noted that, throughout the train, the use of framing elements solely to carry longitudinal forces is avoided. Thus, brake means 4 is connected to the plug means via the air motor casing directly, reservoir 5 is connected to the air motor unit via the brake shoes of brake means 4, and carriage 6 is connected to brake means 4 directly via reservoir 5.

It is to be understood that various features of the apparatus described with reference to FIGS. 1A and 1B can be employed advantageously in other pipe line apparatus than a cleaning device.

It will be apparent that the embodiments shown and described illustrate but do not limit the invention and that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

For example, in some portions of some pipe lines, T joints are encountered, which cause the loss of cleaning abrasives and fluids whether air or gas, which may be in the chamber 15. In such circumstances a modification of the invention such as that illustrated in FIGURE 2 is of particular value.

Instead of having two sets of cups 11, only one set is used, and the air motor discharge shaft 9 is arranged to jet air upon the pipe 10 ahead of the cups 11, as by a nozzle 200. The nozzle 200 preferably jets air toward the pipe around the full 360° and various forms of 360° nozzles and "blow rings" may be used. The shaft 26 is located in the center of the cups 11, and has mounted thereon wire brush or other scraper means 201, adapted upon rotation of the shaft 26 to brush or scrape the internal diameter of the pipe. Scrapings are moved along the pipe line in front of the unit by the air jetting from the air motor discharge via shaft 9.

In further alternative embodiments, additional air motors each driving its own brush or scraper are used and in still others the FIG. 3 brush unit is used in the same "train" as the FIG. 1A liquid abrasive equipment, in combination therewith, as is apparent from the foregoing to those skilled in the art.

We claim:

1. In a pipe line treating apparatus, the combination of means for moving the apparatus through the pipe line to be treated, fluid pressure actuated means forming an operative component of the apparatus, a pump having its output connected to said fluid pressure actuated means, and means operative to drive said pump at a rate proportional to the speed of movement of the apparatus through the pipe line, whereby said pump is caused to supply fluid to said fluid pressure actuated means at a pressure proportional to said speed, and wherein said fluid pressure actuated means is a frictional braking device operative to control the movement of the apparatus through the pipe line.

2. Apparatus in accordance with claim 1 in further combination with

plug means capable of slidingly and sealingly engaging the wall of the pipe line;

a rotary device forming an operative part of the apparatus;

an air motor connected to said plug means to trail the same as said plug means moves through the pipe line;

said air motor having its inlet in communication with the space behind said plug means and its exhaust in communication with the space ahead of said plug means;

and drive means connecting said air motor to drive said rotary device;

introduction of air under pressure behind said plug means when the apparatus is disposed in the pipe line and the pipe line communicates with the atmosphere ahead of said plug means, being effective both to drive the apparatus through the pipe line and to operate said air motor.

3. In a pipe line treating apparatus, the combination of plug means engageable with the inner wall of the pipe line, a train of components connected to said plug means and including a fluid reservoir, a pump and means supporting said pump, said pump having its inlet connected to said reservoir, fluid pressure actuated means forming an operative part of said train, the output of said pump being connected to said fluid pressure actuated means, and means carried by said train and operative to drive said pump at a rate proportional to the speed of movement of the apparatus through the pipe line, whereby said pump is caused to supply fluid from said reservoir to said fluid pressure actuated means at a pressure proportional to said speed, establishment of a fluid pressure differential across said plug means being effective to move the apparatus through the pipe line.

4. In a pipe line treating apparatus of the type including a train of components arranged for movement through the pipe line to be treated, the combination of a frictional braking member mounted on said train for move-

ment in a direction transverse with respect to the direction of travel of said train; fluid pressure actuated means connected to said braking member and operative to urge the same outwardly into braking contact with the wall of the pipe line during travel of the apparatus therethrough, a fluid reservoir carried by said train, a pump carried by said train, said pump having its input connected to said reservoir and its output connected to said fluid pressure actuated means, and drive means connected to drive said pump and including a drive member disposed for rolling engagement with the wall of the pipe line, said pump when actuated by said drive means being operative to supply fluid to said fluid pressure actuated means at a rate proportional to the rate of movement of the apparatus through the pipe line.

5. In a pipe line treating apparatus of the type including a train of components arranged for movement through the pipe line to be treated, the combination of a pair of frictional braking members mounted on said train for opposed movement outwardly into braking contact with the wall of the pipe line; a fluid pressure actuated device comprising a piston and a cylinder, one of said braking members being connected to said piston and the other to said cylinder, whereby fluid pressure in said cylinder tends to move said braking members outwardly; a fluid reservoir and a pump both carried by said train, the input of said pump being connected to said reservoir and the output of said pump being connected to said cylinder, and drive means carried by said train and operatively connected to said pump to drive the same at a rate proportional to the rate of movement of the apparatus through the pipe line, said pump when so driven being operative to establish in said cylinder a fluid pressure proportional to said rate of movement.

6. In a pipe line treating apparatus, the combination of a train of component units arranged for movement through the pipe line to be treated, and automatic braking means disposed between and connecting two of said component units, said braking means comprising a pair of longitudinally extending frictional brake shoes arranged with their frictional faces directed away from the line of movement of said train, actuating means disposed between said brake shoes and operatively connected thereto to urge the same outwardly into braking contact with the wall of the pipe line being treated, a pair of connecting links pivoted at one end to a first of said two component units and at the other end to the leading ends of said brake shoes, and a second pair of connecting links pivoted at one end to the trailing ends of said brake shoes and at the other end to the second of said two component units.

7. In a pipe line treating apparatus, the combination of means for moving the apparatus through the pipe line to be treated, fluid pressure actuated means forming an operative component of the apparatus, a carriage, a pump mounted on said carriage and having its output connected to said fluid pressure actuated means to supply fluid under pressure thereto, a friction wheel mounted on said carriage for rotation and for bodily shifting movement transverse to the axis of its rotation, means mounted on said carriage and operatively connected to said wheel to urge the same into rolling engagement with the wall of the pipe line, and to drive means connected between said friction wheel and said pump to drive said pump at a rate proportional to the rate of travel of the apparatus through the pipe line; and wherein said carriage comprises two longitudinally extending frame members overlying each other and pivotally connected together at one end for movement toward and away from each other, the pivotal axis for each of said frame members extending transversely of the line of movement of said carriage, said friction wheel being mounted on one of said frame members and the other of said members being provided with means for engagement with the wall of the pipe line being treated, said apparatus further comprising means connected between said frame members and spaced from said adjacent ends, said last-mentioned means being operative to bias said frame members away from each other to maintain said friction wheel in contact with the wall of the pipe line.

8. In a pipe line cleaning apparatus, of the type adapted to travel through the pipe line to be cleaned, the combination of a pair of plug means spaced apart in the direction of movement of the apparatus, said plug means co-acting with the wall of the pipe line, when the apparatus is disposed therein, to define a chamber for containing a fluid cleaning composition; an agitator operatively disposed between said plug means; an air motor arranged to trail said plug means as the apparatus moves through the pipe line; drive means connected between said motor and said agitator; means connecting the exhaust of said air motor to the space ahead of said plug means, and means communicating between the intake of said air motor and the space behind said plug means, introduction of air under pressure to the pipe line behind said plug means, when the apparatus is disposed in the pipe line and the pipe line communicates with the atmosphere ahead of the apparatus, being effective both to drive the apparatus through the pipe line and to operate said air motor.

9. Apparatus in accordance with claim 8 and wherein at least one of said plug means includes a member having a peripheral portion effective to scrape the wall of the pipe line being cleaned.

10. Apparatus in accordance with claim 8 and further comprising frictional braking means arranged to trail said air motor, and means for actuating said braking means to provide a braking force proportional to the speed of travel of the apparatus through the pipe line.

11. In a pipe line cleaning apparatus, the combination of a hollow shaft; a pair of plug means mounted on said shaft and spaced axially from each other, said plug means co-acting with the wall of the pipe line, when the apparatus is disposed therein, to define a chamber for containing a fluid cleaning composition; an air motor arranged to trail said shaft and plug means, said air motor having an inlet, an exhaust and output drive means, said inlet communicating with the space behind said plug means; conduit means connecting the exhaust of said motor to said hollow shaft and thus to the space ahead of said plug means; an agitator operatively disposed in the space between said plug means, and means connecting said output drive means to said agitator to drive the same, introduction of air under pressure behind said plug means, when the apparatus is disposed in the pipe line and the pipe line communicates with the atmosphere ahead of the apparatus, being effective both to drive the apparatus through the pipe line and to operate said air motor.

References Cited in the file of this patent

UNITED STATES PATENTS

2,865,321	Von Arx	Dec. 23, 1958
2,887,118	Loeffler et al.	May 19, 1959
2,897,779	Perkins	Aug. 4, 1959

FOREIGN PATENTS

567,658	Great Britain	Feb. 26, 1945