May 19, 1959 J. E. LOEFFLER ET AL 2,887,118

PIPE CLEANING DEVICES

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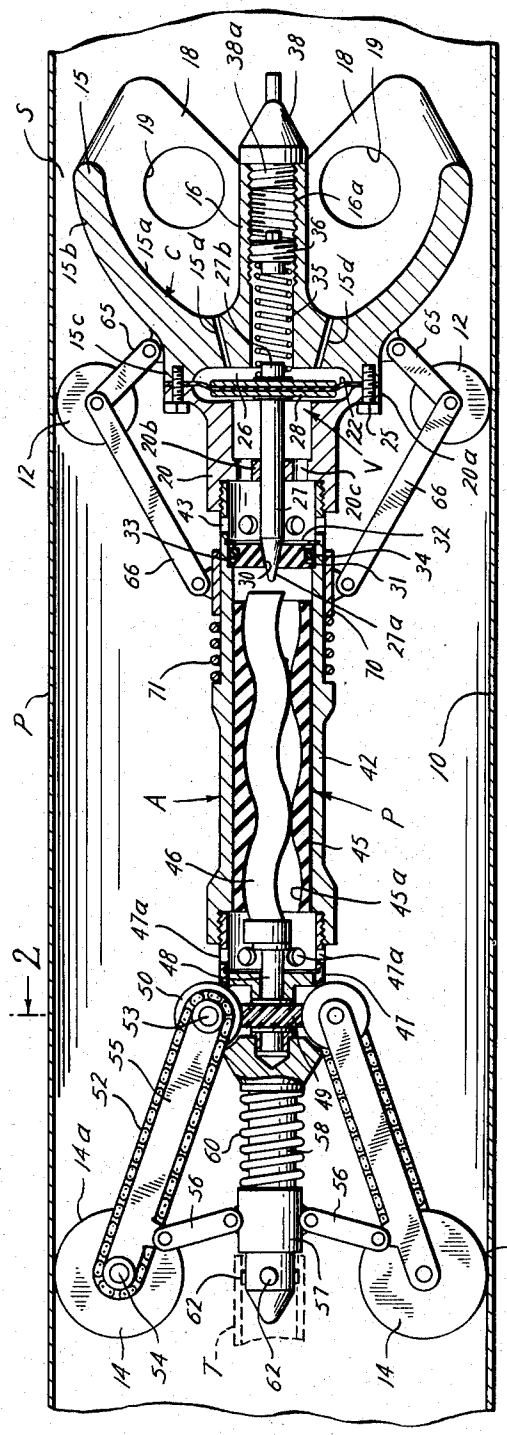


Fig. 1

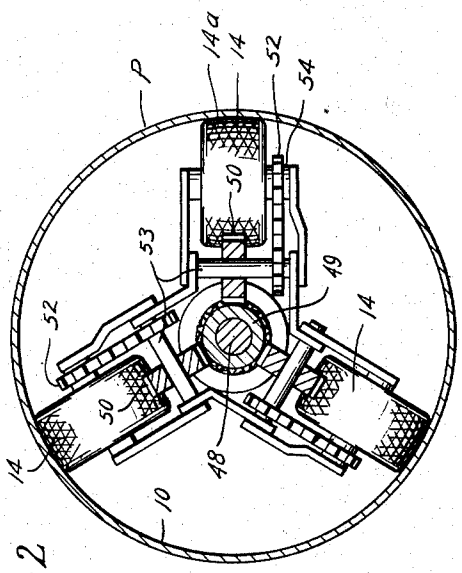


Fig. 2

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Fig. 3

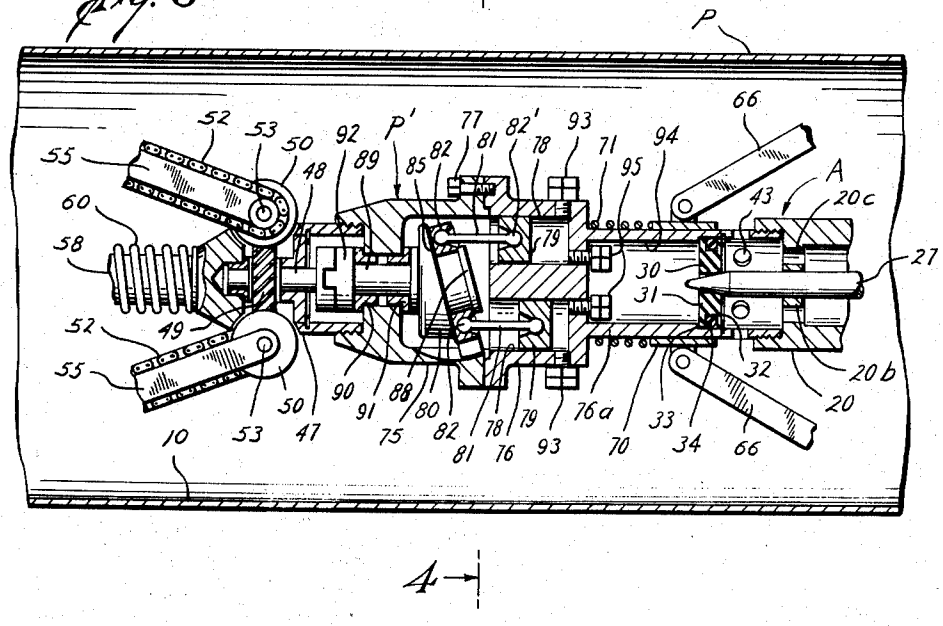
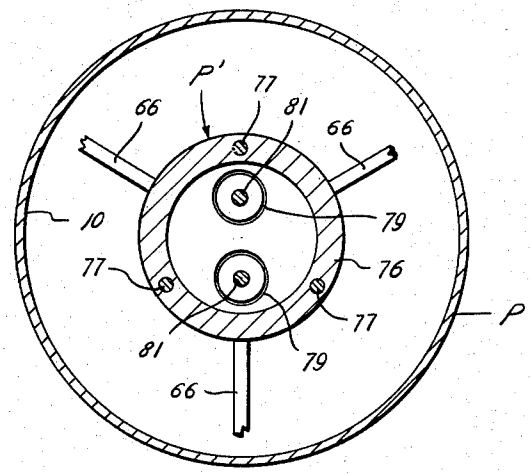


Fig. 4



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PIPE CLEANING DEVICES

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14 Claims. (Cl. 134—112)

This invention relates to new and useful improvements in pipe cleaning devices.

An object of this invention is to provide a new and improved cleaning device which is adapted to clean the interior of a length of pipe by directing fluid against the inner wall of the pipe.

An important object of this invention is to provide a pipe cleaning device for cleaning pipe lines and the like, wherein the device is urged through the pipeline by a fluid pressure differential, and wherein the fluid creating such fluid pressure differential is directed against the inner surface of the pipe to remove corrosion products and other undesirable material therefrom.

Another object of this invention is to provide a new and improved cleaning device for a pipeline, wherein the device has a cleaning head for directing fluid into engagement with the inner surface of the pipeline to clean the corrosion products and other undesirable matter therefrom, and wherein means are provided for automatically maintaining a constant predetermined fluid velocity around the cleaning head regardless of the variation in the flow rate of the fluid in the pipeline.

A further object of this invention is to provide a cleaning device for pipelines and the like in which the device is so constructed that it keeps all the material which has been removed from the inside of the pipeline in a position ahead of the device as the device is moved through the pipeline, whereby the removed material is thereafter easily removed from the system by strainers; the device being operable by fluid pressure and having no scrapers, wire brushes or the like, in contact with the inside surface of the pipe, whereby the fluid alone is utilized for effecting the cleaning of the pipe.

A still further object of this invention is to provide a new and improved cleaning device which is adapted to be propelled through a pipeline or the like for cleaning the interior of same by a fluid acting on the rear of the device, such device having therewith a means for retarding or preventing the forward movement of the cleaning device by the fluid acting thereon until the pressure of the fluid acting on the rear of the device reaches a predetermined amount as compared to the fluid pressure forward of the cleaning device, whereby a predetermined pressure differential around the cleaning device is maintained for the purpose of effecting an efficient cleaning of the interior surface of the pipeline.

The construction designed to carry out the invention will be hereinafter described together with other features thereof.

The invention will be readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is a sectional view illustrating one form of the cleaning device of this invention.

Figure 2 is a sectional view taken on line 2—2 of Figure 1.

Figure 3 is a sectional view illustrating the modified portion of the cleaning device of Figure 1.

Figure 4 is a sectional view taken on line 4—4 of Figure 3.

In the drawings, the latter A designates the longitudinal body of the cleaning device of this invention, which body A has a cleaning head C at its forward end for directing fluid in the pipe or pipeline P against the inner surface **10** thereof to remove corrosion products and other undesirable materials therefrom, as will be explained in detail hereinafter. The body A has mounted therein a pressure differential valve V which is adapted to be operated to open and close same in accordance with a predetermined pressure differential across the cleaning head C. A pump P, which is preferably of the positive displacement type, is also located in the body A, and it is so constructed that it cannot operate unless the valve V is open. The cleaning device of this invention is centered within the pipe P by a plurality of forward wheels **12** and a plurality of rear wheels **14**. The rear wheels are so connected with the pump P that they transmit their rotational movement to the pump to operate same. However, the pump P cannot be operated until the valve V is opened and, therefore, the entire cleaning device is held against movement until the valve V opens. The opening of the valve V occurs when a predetermined fluid pressure is present across the cleaning head C. Thus, as will be explained more in detail hereinafter, the cleaning device of this invention is adapted to direct fluid against the inner surface **10** of the pipe P through which it is moved by the fluid and is further adapted to automatically maintain constant predetermined velocities around the cleaning head C regardless of the variation in the flow rate of the fluid in the pipeline.

Referring now to Figures 1 and 2, wherein the details of the first form of the invention are illustrated, therein it can be seen that the cleaning head C is substantially bowl-shaped, with the bowl portion **15** having an internal centrally located tube **16** formed therewith. Radially extending ribs **18** with openings **19** therein are provided at spaced intervals between the central tube and the bowl **15** so as to strengthen or rigidify the bowl **15**. The holes **19** provide for circulation uniformly to all portions of the interior or forward side **15***a* of the bowl **15**. The outside or rear side **15***b* of the bowl **15** is spaced from the inner surface or wall **10** of the pipe P so as to provide an annular area or space S through which fluid can flow around the cleaning head C.

Connected to the rear of the bowl **15** of the cleaning head C is an annular valve sleeve or housing **20** which forms part of the body A. The valve housing **20** has an annular flange **20***a* which is bolted to an annular flange **15***c* of the bowl **15**. Actually, a flexible circular diaphragm or actuattor **22**, which if formed of rubber or similar material, extends between the flanges **20***a* and **15***c* and is held in position by a plurality of screws **25** which extend through both of the flanges. The valve chamber **26** is formed by a pair of opposed circular recesses formed in the valve housing **20** and the bowl **15**, adjacent their respective flanges **20***a* and **15***c*. The flexible diaphragm **22** is connected to a slidable valve rod **27** which has its rearward end **27***a* shaped like a cone. Metal discs **28** are disposed on each side of the diaphragm **22** to stiffen the central portion of the diaphragm to improve its fluid response.

The valve V is closed when the pointed end **27***a* of the valve element **27** extends into the conical or tapered opening **30** of the valve seat **31**. The valve seat **31** may be formed of numerous materials, but preferably it is formed of rubber or a similar resilient elastic material. A snap ring **32** is utilized for holding the valve seat **31** in position against the shoulder **33**. A resilient O-ring

34 may also be included to improve the seal of the seat 31 with the valve body A. A coil spring 35 is positioned within the tube 16 and is confined between a threaded retaining plug 36 and the forward end 27*b* of the valve element 27, whereby the spring 35 normally urges the valve element 27 to a closed position. The threaded plug 36 is movable longitudinally by rotating same to a different position with respect to the threads 16*a* inside of the tube 16. The internal threads 16*a* are protected and a nose is provided by the nosepiece 38 which has its threaded portion 38*a* also in engagement with the thread 16*a*. It will be noted that the valve element 27 is guided in its sliding movement by the annular bushing 20*b* of the valve housing 20.

Fluid is admitted to the opposite sides of the flexible diaphragm to control the movement of the valve element 27 through the plurality of spaced inclined openings 15*d* in the bowl 15 of the cleaning head and by openings 20*c* which are circumferentially spaced around the annular bushing 20*b* and the valve element 27.

The valve housing 20 has connection with a special sleeve 42 which also forms a part of the valve body A and which has a plurality of ports 43 so that fluid can flow from the rear of the cleaning head C through such openings and through the openings 20*c* to the rear side of the diaphragm 22 of the valve V. It will thus be evident that the fluid pressure differential acting on the valve V will determine when such valve V is opened or closed. It will also be evident that the fluid pressure on the rearward side of the flexible diaphragm 22 must be sufficiently great to overcome the urging of the coil spring 35. The extent of such urging of the spring 35 can, of course, be adjusted by increasing the compression of the spring 35 by a movement of the adjusting plug 36. Thus, the valve V can be set to open and close at a predetermined fluid pressure differential across the valve diaphragm 22, which pressure differential corresponds to the fluid pressure differential between the rear side and the forward side of the cleaning head C.

The pump P is of a known construction and is of the positive displacement type, with a stator 45 being mounted in the pump sleeve 42 so as to be held against movement with respect to the sleeve 42. The stator 45 is preferably formed of hard rubber or a similar material and the bore is specially constructed in the well-known manner to form a double internal helical opening 45*a*. The rotor 46 is formed of metal or a similar material and is in the shape of a helix. The rear portion of the rotor 46 extends into a tubular member 47 which is threaded to the rear portion of the pump sleeve 42. A shaft 48 on said rotor 46 extends rearwardly and is connected to a helical gear 49 which is driven by gears 50 in engagement therewith. The gears 50 are interconnected with their respective wheels 14 and each is driven by a chain 52 so that rotation of each wheel 14 transmits rotation through the chain 52 to the gear 50 with which it is associated. Actually, each gear 50 is mounted on a shaft 53 which has a suitable sprocket engaging with the chain 52. The other end of the chain 52 engages with a similar sprocket (not shown) on the shaft 54 for each of the reels 14. A longitudinal plate 55 extends from the shafts 53 and 54 and provides for pivotal movement of the wheels 14 inwardly with respect to each other by a movement of the arm 55 about the shaft 53. The wheels 14 are maintained in their outwardly extended position by links 56 which are joined to a slidable sleeve 57 which is mounted on a rear tubular extension 58 connected to the sleeve 47, so that all three of the wheels 14 are in constant engagement with the inner wall or surface 10 of the pipe P. The sleeve 57 is normally urged rearwardly by a coil spring 60 so as to transmit an outward force to the wheels 14 through the connecting links 56. Stop lugs 62 are provided at the outer end of the tubular extension 58 to limit the extent of outward movement of the wheels 14. In some cases it may be desirable to manually retract the wheels 14 by forcing a tubular member T (shown in dotted lines in Figure 1) over the stop lugs 62 so as to engage the rear end of the sleeve 57 to urge same forwardly against the action of the spring 60. Such tubular member T can be mounted on another cleaning device or any other suitable device which can be forced against the sleeve 57 by fluid pressure or otherwise.

The wheels 14 are basically for the purpose of transmitting movement to the gear 49 for driving the pump rotor 46 which is adapted to be turned with an eccentric movement relative to the stator 45 when the valve V is open. Prior to the time that the valve V opens, the wheels 14 frictionally engage the pipe surface 10 so as to prevent the wheels 14 from sliding in the pipe P when the pump cannot be operated. To increase the frictional contact between the wheels 14 and the inside of the pipe 10, the external circumferential surfaces 14*a* of the wheels 14 are preferably knurled or otherwise roughened. As the pump rotor 46 rotates, fluid is moved into the pump through the ports 47*a* in the sleeve 47. It will also be noted that the wheels 14 serve to center the rear portion of the cleaning device of this invention within the pipe P.

For centering the device at its forward end, the wheels 12, which are preferably three in number, are positioned on links 65 and 66, with the links 66 being connected to a slidable sleeve 70 mounted on the exterior of the pump sleeve 42. Such sleeve 70 is urged forwardly by a coil spring 71 so that the wheels 12 are all urged radially outwardly into constant engagement with the inside surface 10 of the pipe P.

In the operation or use of the cleaning device shown in Figures 1 and 2, the device is placed in a pipe or pipeline P or similar tubular member, and fluid under pressure is forced through the pipe P so as to apply a fluid pressure to the rear surface 15*b* of the cleaning head C (the fluid moves from left to right in Figure 1). Initially, the fluid pressure is not sufficient to create a pressure differential across the cleaning head C which is of sufficient magnitude to overcome the force of the spring 35 on the valve element 27, so therefore the spring 35 maintains the valve element 27 in its closed position. While the valve V is in its closed position, the positive displacement pump P cannot move. Therefore, the wheels 14 are prevented from moving and the entire cleaning unit is prevented from moving forwardly by reason of the frictional engagement of the wheels 14 with the interior wall 10 of the pipe P. In other words, the failure of the pump P to operate because of the valve V being closed, acts as a brake to prevent the movement of the wheels 14. Thus, it is evident that the cleaning device of this invention cannot move forwardly until a predetermined pressure differential is developed across the cleaning head C. As the pressure differential increases across the cleaning head C, the velocity of the fluid moving through the annular space S is, of course, increased so that a cleaning action on the pipe at the annular area around the cleaning head C is obtained, which is particularly effective due to the high velocities created and due to the directing of the fluid force against the pipe. It will be noted that no scraping or rubbing or mechanical agitation of the interior wall or surface 10 is utilized, but only the fluid force is utilized for the cleaning action.

When the fluid pressure has reached a predetermined value so that the pressure on the rear side of the cleaning head C is sufficient to unseat the control element 27 of the valve V from its seat 31, then the pump P can begin to pump and as it is permitted to pump, the wheels 14 are, therefore, permitted to rotate. The rotation of the wheels 14 permits the entire cleaning unit or device to move forwardly with the fluid force acting thereon.

As the cleaning device begins to move forwardly, the pressure differential will, of course, be reduced to some extent and there will be a tendency for the valve diaphragm 22 to move rearwardly to again seat the valve element 27 and close the valve. Such tendency will, of

course, reduce the pumping action of the pump P and will in turn reduce the speed at which the wheels **14** are permitted to turn. It will thus be evident that the rate at which the wheels **14** rotate, and thus the forward movement of the cleaning device through the pipe P, is controlled solely by the differential fluid pressure across the cleaning head C, and therefore a constant predetermined fluid velocity around the cleaning head is obtained by setting the valve V to open at a predetermined pressure differential across the cleaning head C, whereby such constant fluid velocity is automatically maintained regardless of the variation in the flow rate of the fluid in the pipeline. It would also be evident that the material which is removed by this device is constantly maintained ahead of the cleaning device as the device progresses forwardly in the pipe. By keeping all of the removed material ahead of the cleaning device, it assures the discharge of all, or substantially all, of the removed material and it facilitates the straining of same with the strainers used in connection with pipelines.

In the form of the device shown in Figures 3 and 4, the pump P of Figures 1 and 2 has been modified and the modified pump construction is designated by the letter P' in Figures 3 and 4. Except for the different pump constructions of Figures 3 and 4, the remainder of the cleaning device is the same as that shown in Figures 1 and 2 and has the same numerals for the corresponding parts. The pump P' has a rear housing section **75** which is connected to the sleeve **47** at its rear portion and is bolted or otherwise secured to a forward housing section **76** by bolts **77**, or any other suitable securing means. The reduced diameter portion **76***a* at the forward end of the forward housing section **76** is threaded or otherwise connected to the valve housing or body **20**.

The forward housing section **76** is formed with two cylinders **78**, with each having a piston **79** disposed therein for sliding relative movement. The pistons **79** are reciprocated in the cylinders **78** by a wedge-shaped plate or disc **80** which is connected to the pistons **79** through links **81**. At the forward end of each link **81**, a ball **82'** is provided which fits within a socket in its piston **79** so that a ball and socket joint is provided. The rear end of each link **81** also has a ball **82** formed therewith which fits into a socket in bearing ring **85** mounted on the disc **80**. As the disc **80** is rotated, the ring **85** and the links **81** do not rotate but remain in the same position as shown in the drawings so that there is a reciprocating movement imparted to the pistons **79** by reason of the wedge-shape of the disc **80**.

The wedge-shaped disc **80** has an annular flange **88** extending across the upper end of the ring **85** to retain such ring **85** in position on the disc **80**. Such flange **88** may be separately threaded to the disc **80**, but as shown in the drawings, the flange **88** is formed as an integral part of a disc **80**.

A shaft **89** extends through a pair of opposed bushing rings **90** and **91** to a slidable connection coupling **92** which is of known construction and permits misalignment of the shafts **89** and **48** during rotation thereof while at the same time maintaining the driving connection.

The fluid inlet to the cylinders **78** is through check valves **93** which permit the fluid to flow into the cylinder **78** but prevent outward flow therethrough. The outward discharge of fluid from the cylinders **78** into the chamber **94** is through the check valves **95** which permit fluid flow from the cylinders **78**, but do not permit fluid to return through the valves into the chambers **78**.

The operation of the pump P' is similar to the operation of the pump P of Figure 1 in that it is a positive displacement-type pump and cannot operate when the valve element **27** is seated in a closed position. However, when the valve element **27** is moved to open flow through the valve V, then the wheels **14** (Figure 1) can rotate and such rotation imparts a driving of the gears **50** and **49** to rotate the plate **80**. As the plate **80** is rotated, the arms **81** are reciprocated to alternately force fluid through the valves **95** into the fluid chamber **94** and then out through the openings **43**. The fluid intake to the cylinders **78** is through the check valves **93**.

It is believed evident that the pump P' will thus serve to retard the movement of the cleaning device in a forward direction until the valve V is operated in accordance with its predetermined pressure differential setting as in the form of the invention shown in Figures 1 and 2.

It should be pointed out that although the invention is only illustrated with the rotary pump of Figures 1 and 2 and the reciprocating pump of Figures 3 and 4, the particular type of pump can be changed within the scope of this invention so long as it is a pump which will not function until the valve V is open.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed is:

1. A device for cleaning pipe which is adapted to be moved through the pipe by a fluid moving therein, comprising a body, means carried by said body for directing the moving fluid about the periphery of the body and into contact with the inner surface of the pipe to effect the cleaning of the pipe and for restricting the flow of the moving fluid relative to said body whereby a fluid pressure differential across said device is developed to urge said device through the pipe, and means connected with the body and operationally disposed in the pipe for movement with said body for controlling the rate of movement of the device through the pipe in accordance with the fluid pressure differential.

2. A fluid-actuated device for cleaning pipe, comprising a body, means carried by said body for directing a fluid passing through said pipe into contact with the inner surface of the pipe for cleaning same and for restricting the flow of the fluid relative to said body whereby a fluid pressure differential across said device is developed to urge said device through the pipe, and means connected with said body and operationally disposed in the pipe for movement with said body for retarding movement of the device in said pipe until the pressure differential reaches a predetermined amount.

3. In a pipe-cleaning device adapted to be moved through the pipe by a fluid moving therein, a cleaning head having a means for directing fluid flow around the said head and against the inner surface of the pipe to clean corrosion products and the like therefrom by fluid action and for restricting the fluid flow around said head to obtain a fluid pressure differential across said head to urge the device forwardly in the pipe, and brake means connected to said cleaning head and operationally disposed in the pipe for movement with said cleaning head for preventing forward movement of said device until the fluid pressure differential reaches a predetermined amount, whereby the velocity of the fluid directed against the inner surface of the pipe also reaches a predetermined amount so as to assure effective cleaning of the inside of the pipe.

4. The structure set forth in claim 3, wherein the brake means includes control means for controlling the operation of the brake means in response to changes in the fluid pressure differential.

5. A device for cleaning pipe which is adapted to be moved through the pipe by a fluid moving therein, comprising a cleaning head having means to confine fluid flow to the wall portion of the pipe and create a fluid pressure differential across the cleaning head, a valve means, an actuator for actuating said valve means to open and close same by said fluid pressure differential, passage means establishing fluid communication between the forward side of said cleaning head and one side of said actuator

for said valve means, and other passage means establishing fluid communication between the rear side of said cleaning head and the other side of said actuator whereby the fluid pressure differential across the cleaning head controls the actuation of said valve, and a brake means for preventing forward movement of said device, said brake means being released to permit forward movement of said device upon an opening of said valve means at a predetermined fluid pressure differential across said cleaning head.

6. The structure set forth in claim 5, wherein said brake means includes a positive displacement pump which is operable when said valve means is open, but which is inoperable until said valve means is opened, a roller carried by said cleaning head for frictionally engaging the inner surface of the pipe, and means connecting said pump and said roller in positive driving relationship whereby upon an opening of said valve, the roller is permitted to turn to drive said pump.

7. The structure set forth in claim 5, including means for centering the cleaning device within the pipe through which it moves, whereby the cleaning head is maintained in a centered relationship with respect to the pipe.

8. The structure set forth in claim 5, wherein said brake means includes a pipe engaging means engageable with the inside of the pipe, and a positive displacement type pump carried by said cleaning head for controlling the movement of said pipe engaging means in said pipe, said pump being operable only when said valve means is open.

9. The structure set forth in claim 5, wherein said brake means includes a pipe engaging means engageable with the inside of the pipe, and a rotary pump carried by said cleaning head for controlling the movement of said pipe engaging means in said pipe, said pump being operable only when said valve means is open.

10. The structure set forth in claim 5, wherein said brake means includes a pipe engaging means engageable with the inside of the pipe, and a reciprocating pump carried by said cleaning head for controlling the movement of said pipe engaging means in said pipe, said pump being operable only when said valve means is open.

11. A pipe-cleaning device adapted to be moved through the pipe by a fluid moving therein comprising, cleaning head means directing fluid flow around the periphery of the head and against the inner surface of the pipe to effect cleaning of the pipe and restricting fluid flow through the pipe to obtain a pressure differential across the head to urge the device through the pipe, and brake means connected with said head and operationally disposed in the pipe for movement with the head for retarding movement of the device through the pipe to thereby increase the velocity of fluid passing the head.

12. A pipe-cleaning device adapted to be moved through the pipe by a fluid moving therein comprising; cleaning head means directing fluid flow around the periphery of the head and against the inner surface of the pipe to effect cleaning of the pipe and restricting fluid flow through the pipe to obtain a pressure differential

across the head to urge the device through the pipe; and brake means connected with said head and operationally disposed in the pipe for movement with the head for retarding movement of the device through the pipe to thereby increase the velocity of fluid passing the head; said brake means including, a pump means connected to the cleaning head, rollers connected with said cleaning head for frictionally engaging the inner surface of the pipe, and means connecting said rollers to said pump means in driving relationship whereby upon movement of said cleaning device in said pipe the rollers are rotated to operate the pump means.

13. A pipe-cleaning device adapted to be moved through the pipe by a fluid moving therein comprising; cleaning head means directing fluid flow around the periphery of the head and against the inner surface of the pipe to effect cleaning of the pipe and restricting fluid flow through the pipe to obtain a pressure differential across the head to urge the device through the pipe; and brake means connected with said head and operationally disposed in the pipe for movement with the head for retarding movement of the device through the pipe to thereby increase the velocity of fluid passing the head; said brake means including, pump means connected to said cleaning head, rollers connected to said cleaning head for frictionally engaging the inner surface of the pipe, means connecting said rollers to said pump means in driving relationship whereby upon movement of said cleaning device in the pipe the rollers are rotated to operate said pump means, and control valve means for controlling flow of fluid through the pump, said valve means opening when the fluid pressure differential across the cleaning head reaches a predetermined value and thereafter regulating flow through the pump in response to the differential across the cleaning head to maintain a substantially constant fluid velocity about the cleaning head.

14. A pipe-cleaning device adapted to be moved through the pipe by a fluid moving therein comprising, cleaning head means directing fluid flow around the head and against the inner surface of the pipe to effect cleaning of the pipe and restricting fluid flow through the pipe to obtain a pressure differential across the head to urge the device through the pipe, brake means connected with said head and operationally disposed in the pipe for movement with the head for retarding movement of the device through the pipe to thereby increase the velocity of fluid passing the head, and means controlling the brake means in response to changes in pressure differential across the head to maintain a substantially constant fluid velocity about the cleaning head.

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