Sept. 27, 1966 P. HAMMELMANN 3,275,247

CONTROLLABLE JET NOZZLE PIPE CLEANING DEVICE

Filed Jan. 11, 1965 2 Sheets-Sheet 1

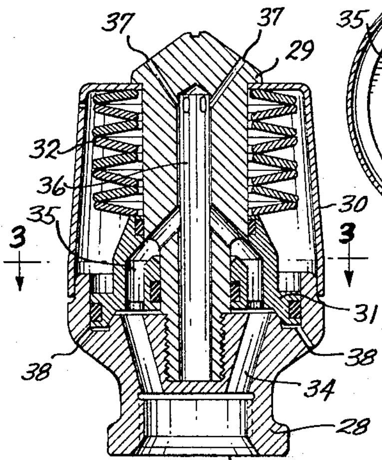

Fig. 1

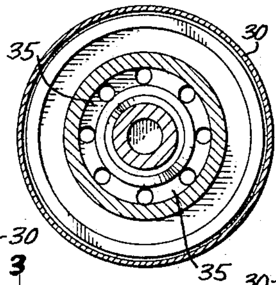

Fig. 3

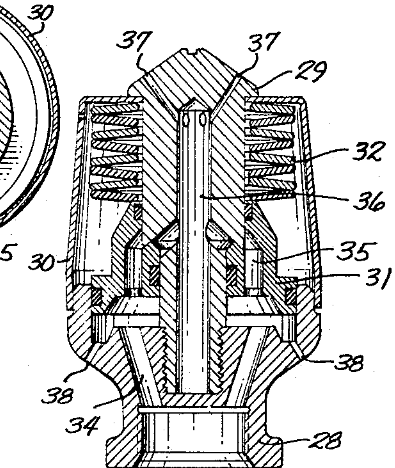

Fig. 2

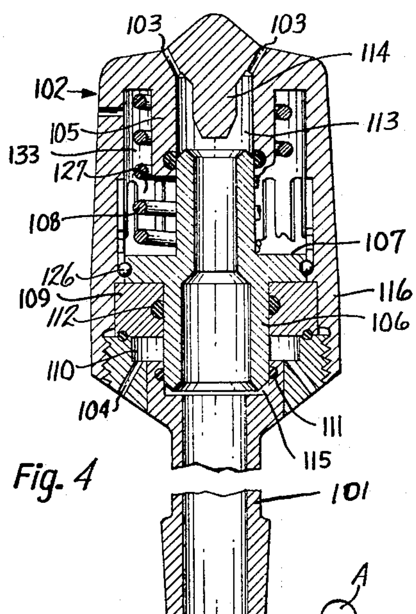

Fig. 4

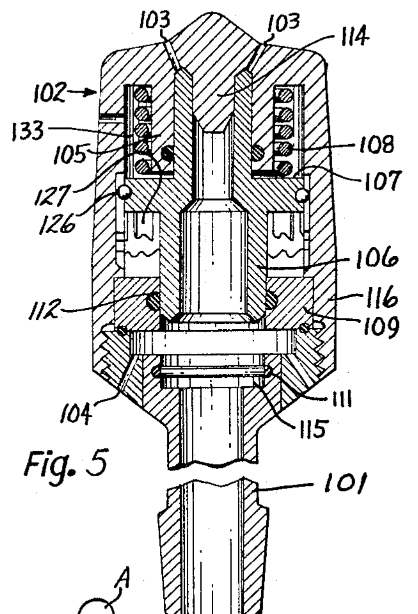

Fig. 5

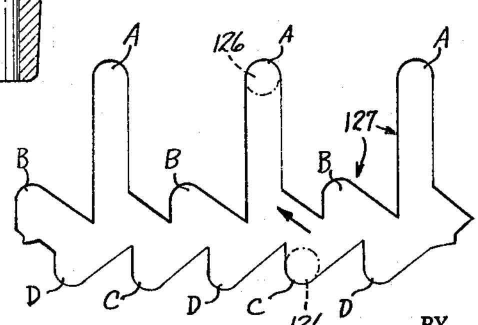

Fig. 6

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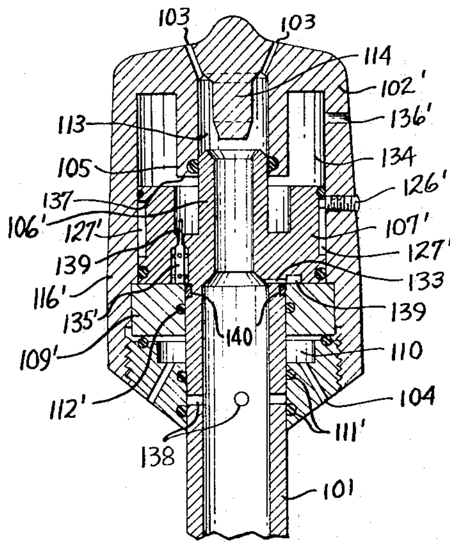

Fig. 9

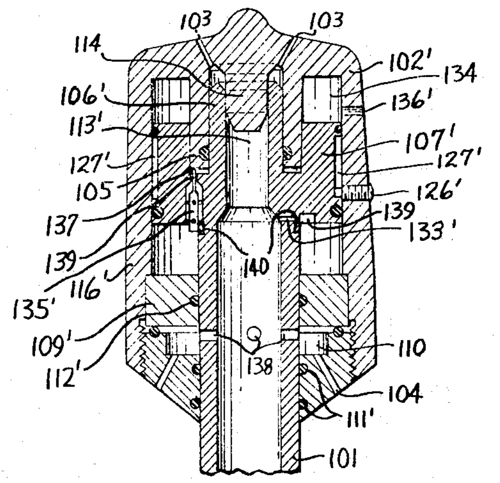

Fig. 10

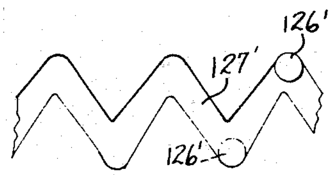

Fig. 11

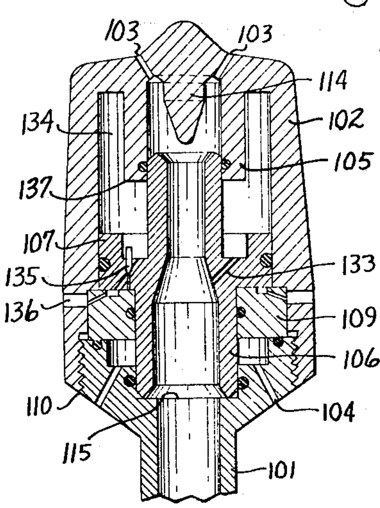

Fig. 7

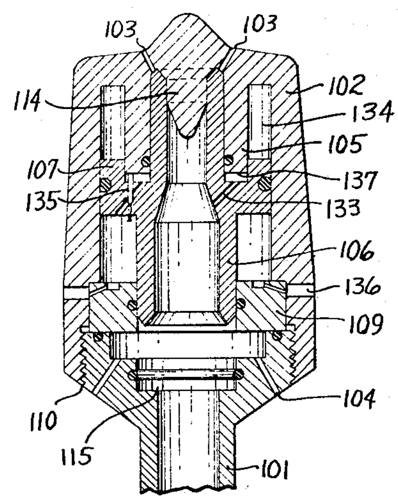

Fig. 8

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3,275,247
CONTROLLABLE JET NOZZLE PIPE CLEANING DEVICE

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Claims priority, application Germany, Feb. 1, 1960, H 38,544, Patent 1,165,945; Mar. 11, 1960, H 38,886; Mar. 16, 1960, H 38,925
11 Claims. (Cl. 239—447)

This application is a continuation-in-part of my co-pending applications Serial No. 86,061 filed January 31, 1961, now abandoned, for Devices for Cleaning Pipes, Conduits, Storage Tanks and the Like and Serial No. 202,526 filed June 14, 1962, for Apparatus for the Cleaning of Sewer Systems now Patent No. 3,165,109 issued January 12, 1965. This invention relates to cleansing devices which are intended for cleansing pipes and ducts, as well as storage and transport containers which are used for the transport and storage of oils and oil products and acids, as well as of milk, beer, fruit juices, and the like.

For this cleansing process, devices are known in which the cleansing fluid is sprayed systematically by cleansing heads with controlled nozzles, under high pressure, over the inner wall or interior of the pipe or container to be cleaned. The motion of the spraying head with nozzles is frequently controlled by a preceding high-speed turbine, which, whether it is operated with or without waste water, requires a bulky, costly transmission gear for reducing its speed. The nozzles then point backwards to the direction of the principal axis of the cleanser. Through the reaction or shock of the cleansing medium, in the form of liquid, steam or compressed gas jets, ejected at high pressure from the nozzles of the cleanser head carrying them, a backwardly directed jet reactive force is produced and transmitted to the cleanser head and the supply hose connected to the cleanser head. If it is desired to impart a reverse thrust to the filling hose, the cleanser heads must be changed.

A disadvantage of sprinkler cleansers of the aforesaid type is that in pipelines with bends, welded places or sluice valves, they do not always reach as far as the inspection point or point of access, which may be removable, or accessible ports or joints in the pipe system. If the hose becomes jammed in the pipe, it is not easily withdrawn. This disadvantage is particularly great because the pulling effect of the reaction cleansing jets can inherently be exerted over very long stretches, for instance, up to 100 meters. If excessive frictional forces are encountered in the line to be cleansed, the line must be broken at some not easily accessible place in order to change the nozzles. In this connection also, it is an essential prerequisite that the pipeline should be accessible externally at the point where the trouble occurs. Sometimes the pipeline has to be cut in order to remove the obstruction or change the cleansing head.

An object of the invention is to provide a device for cleansing pipes and ducts, storage containers and the like, with a flexible hose connection for the controllable supply of a high-pressure liquid (30 to 80 atm.) into a head with nozzles arranged obliquely to the wall of the pipe to be cleansed. The reaction of jets of cleansing medium from the nozzles draws the hose by reactive force farther into the pipe to be cleansed, the pressure of the liquid in the nozzle head operating a remotely controlled piston which, according to its position, controls the supply of cleansing liquid to nozzles directed obliquely backwards.

The invention is further based on the knowledge that as far as possible all rapidly rotating components should be eliminated within the drive and gear since, in addition to the difficulties in regard to sealing or packing, the constantly fluctuating temperatures require a simple and rugged construction.

The invention includes the provision of recoil or reaction nozzles, arranged preferably circumferentially symmetrical to the pressure line in the nozzle head, which are closed, with increasing liquid pressure, by means of an auxiliary valve formed by parts of the piston and the nozzle head, deactivating the reaction or recoil nozzles which draw the head farther into the pipe or duct.

The invention can advantageously be embodied in a compact form by using a cylindrical nozzle casing with an internal valve piston formed by a hollow body, spring loaded against the liquid pressure which, with fluctuating pressure, slides back and forth to activate forward-discharging and rearward discharging nozzles alternately. Additionally the head or valve may be rotated progressively on a sliding surface in the nozzle casing under the action of a control cam.

A further feature of the cleansing head is that, in each case according to the adjustment of the pressure, the hose travels forwards or backwards in the pipe or duct to be cleaned. A special control is provided for the feedback water admixed with the fresh water. With automatic feedback control of the pressure, the control valve further moves to and fro so that the cleanser head exerts a selectively controllable scrubbing action on the inside of the pipe or duct.

The deposits in the pipe are attacked from all sides, always at an oblique angle. The cleansing power of the head is increased compared with devices of known type with the same expenditure of cleansing agent. Cleansing is completed in a shorter time. Control means for the cleanser head can be constructed in different ways although, basically, in all cases what is required is a longitudinally movable, pressure-controlled, i.e. spring-loaded valve piston, or fluid-pressure piston.

The nozzles of the cleanser head may be tilted in different directions, can be placed in a series of rows or in a cross-shaped arrangement.

Notwithstanding the incorporation of an automatic pressure control, the dimensions of the nozzle head in length and diameter are not greater than those of the simple nozzle head of known type for reactive motion in one direction only. Accordingly, the advantage is gained that pipes and ducts with sharp bends can be serviced and the nozzle head can travel through them in each case as desired either forwards or backwards.

Exemplary embodiments of the invention are shown in the accompanying drawings.

In order to be able easily to compare the different forms of embodiment, the nozzle heads are shown in longitudinal section through the middle and on approximately the same scale.

Referring to the drawings:

FIGURE 1 is a longitudinal central section through one form of the cleansing device showing parts in one position, and FIGURE 2 is a similar view showing parts in a different position. FIGURE 3 is a transverse section through the device taken on line 3—3 of FIGURE 1.

FIGURE 4 is a central longitudinal section through a modified type of nozzle device showing parts in one relationship, and FIGURE 5 is a similar view through the same device showing parts in a different relationship. FIGURE 6 is a diagrammatic representation of structure of the nozzle mechanism in developed representation.

FIGURE 7 is a central longitudinal section through another modification of the nozzle construction showing parts in one relationship, and FIGURE 8 is a similar view showing parts in a different relationship.

FIGURE 9 is a central longitudinal section through still another form of nozzle construction with parts in one relationship, FIGURE 10 is a similar view of the device with parts in a different relationship, and FIGURE

11 is a diagrammatic representation of nozzle head rotating structure in developed form.

The nozzle cleaning head can, for example, consist of a mouthpiece **28**, a head piece **29** and a casing **30**, as well as a longitudinally reciprocable hollow piston **31** and a Belleville spring **32**.

The mouthpiece **28** is provided with a hose-connecting opening **33** and several ducts **34** branching off from such opening. Passages **35** are arranged in the piston **31** corresponding, respectively, to the ducts **34**. The head piece **29** is also provided at its center with a central bore **36**, one end of which is in fluid connection with the passages **35** of the piston **31** and the other end of which is in communication with nozzle openings **37** in the end of the head piece **29** opposite the hose-connecting supply opening **33**.

Upon admission of the cleaning liquid under pressure, the cleaning head piston **31** is either in a position as shown in FIGURE 1, in which position the water jet can be ejected from the frontal nozzle openings **37**, or the piston is pressed by greater water pressure against the action of the spring **32** in upward direction to the position of FIGURE 2, so that the fluid connection with the passage **36** is interrupted and the connection with the rearward nozzle openings **38** is opened. In this case the water jet is ejected through these nozzle openings **38** in the rearward direction.

The aggregate cross section of the frontal nozzle openings **37** is so limited that a drop in pressure cannot occur at the pump, since at a certain preset operational pressure the amount of water which can be supplied by the pump is greater than the amount of water ejected from the nozzle openings **37**. Accordingly the pressure is increased in the accumulators to such a degree that the spring **32** is contracted by the piston **31** being moved toward the nozzle tip by such increased water pressure. Thus the liquid supply to the nozzle openings **37** is interrupted by movement of the piston, which simultaneously uncovers a connection to the rearward nozzle openings **38**. The cross sections of these nozzle openings **38** are selected so that more liquid can be ejected than can be supplied from the pump. Consequently a maximum pulling and cleaning action is achieved by the ejection of large jets from the rear nozzle openings **38**, as well as the pressure in the ducts **34** being relieved so that the pressure in the accumulator system connected to supply opening **33** and on the piston **31** drops to a value less than the force exerted on it by spring **32**. Such spring therefore returns the piston **31** toward the supply opening **33** into its original position of FIGURE 1 in which it closes the annular passage leading to the rear nozzle openings **38** and opens the passages **35** and central bore **36** leading to the forward nozzle openings **37**. The throttling effect on the nozzle head discharge resulting from the constriction again produced by such forward openings results in a renewed pressure increase in the accumulators causing piston **31** again to be forced forward to the position of FIGURE 2, despite the opposition of the force of spring **32**, to shut off the flow through forward openings **37** and open the rear openings **38**. The above-described operation whereby water is ejected alternately through the forward openings **37** and rearward openings **38** is repeated automatically until the liquid supply is shut off.

By the arrangement of several accumulators, which can be operatively connected and disconnected individually, the frequency of the reversing process can be controlled depending on whether a longer forward or rearward movement of the nozzle, corresponding to the degree of fouling of the sewer system to be cleaned, is desired. Alternatively the supply capacity of the pump can be adjusted so that such supply and the ejected liquid are in equilibrium. In this arrangement the water is ejected continuously only from the nozzle openings **38**.

FIGURES 4, 5 and 6 show an exemplary alternative embodiment of the invention in which means for rotating the piston in the nozzle head are arranged in such head in rotational symmetry. In FIGURE 4 the mouth piece or spigot **101** for the attachment of the pressure hose is widened at the top to receive a cap sleeve forming the principal part of the cleanser head **102**. This contains the forwardly-directed oblique nozzles **103** while the rearwardly-directed oblique nozzles **104** are arranged in the mouthpiece **101**.

The upper part of the cleanser head **102** has an associated valve sleeve **105** extending downwards from the inner crown of the cleanser head to receive the hollow piston **106**, the shoulder **107** of which is loaded by a coil spring **108** to bear on the sealing ring **109**, on which the valve piston **106** seats in its resting position. In this position, as shown in FIGURE 4, the piston closes the antechamber **110** against the cleansing fluid, which is fed to the bore of the mouthpiece **101** at a high pressure of between 30 and 80 atmospheres.

Sealing against the pressure fluid is effected by the circular gaskets **111** and **112**. When the cleansing head is set in operation and the valve piston **106** is in the resting position of FIGURE 4, the pressure fluid is first discharged through the piston's central bore into the antechamber **113** and thence is discharged through the nozzles **103**.

When the pressure of the cleansing fluid builds up until the loading of the valve piston **106** by the spring **108** is overcome, the piston **106** lifts until on reaching the crown of the cleansing head it practically fills the space of the antechamber **113** and its own cavity is closed by the valve plug **114** as shown in FIGURE 5. The nozzles **103** are now also closed so that the jets directed obliquely forward stop. The bottom control end **115** of the piston **106** has meanwhile risen sufficiently to open the antechamber **110** for communication between mouthpiece **101** and the ring of rear nozzles **104**. The cleansing fluid is sprayed under high pressure out of the nozzles **104** which now begin to act as reaction jets.

Being directed obliquely, jets **104** exert a particularly good cleansing and specifically a good scouring effect on the dirt lodged on the pipe or container wall, and the force of these reactive jets issuing from the nozzles pull the connecting hose forward. If the forward motion of the cleansing head is impeded, this will become apparent at the supply end of the hose by its failure to advance. It is then only necessary to reduce the fluid pressure until it acts on the valve piston **106** with less than the force of spring **108**. The spring then presses the piston **106** back on its seating from the position of FIGURE 5 to the position of FIGURE 4. The forward nozzles **103** then again discharge reactive jets of the cleansing fluid which push the cleansing head and the connecting hose backwards.

By repeatedly raising and lowering the pressure, the hose can be moved to and fro until the obstruction is removed and the cleansing of the pipe under high pressure is continued, while the hose is simultaneously drawn forward.

The periphery of the shoulder **107** of the hollow piston **106** contains a semicircular recess receiving a control ball **126** simultaneously rolling on a control cam track **127** in the inner wall of the barrel **116** in the cleanser head **102**, as shown in developed form in FIGURE 6. The latter figure shows the central, rising parts of the cam track **127**, indicated at AA and, to right and left thereof, two reversing profiles, indicated by BB. This control cam track effects rotation of the piston **106** as a result of its axial movement influenced by the pressure variations or pressure pulses in the pipe, because of the action of the cam track on the control ball **126** in the sequence shown by the broken-line ball-representing circles **126** on the control cam curve of FIGURE 6, indicating the path taken by the control ball.

At low pressure, as assumed for the control cam track curve shown in FIGURE 6, the ball **126** rests in an initial position indicated in that figure by CC. When the fluid pressure rises, the piston **106**, shoulder **107** and the control ball **126** are pressed upwards until the ball **126** comes into the end position shown in FIGURE 6 at AA. Thereby, the piston **106** is also rotated, as clearly shown by the obliquely-ascending arrow between CC and AA in FIGURE 6.

The embodiment according to FIGURES 7 and 8 is an example of the possibility, according to the invention, of constructing a reciprocable cleansing head controlled exclusively by hydraulic means influenced by pressure variations to operate different groups of jet nozzles. The essential components are the same as in the other embodiments, except that no spring is required. The general construction of the nozzle body **102** with the water supply mouthpiece or spigot **101**, the reciprocable piston **106** with its hollow end sliding in valve sleeve **105** and adapted to receive the valve plug **114** are all similar to the construction described in connection with FIGURES 4 and 5. In this instance, however, there is no bleed opening provided in the chamber of the nozzle body above the piston shoulder **107**, as shown in the previously described types of cleansing head.

The particular feature of the construction shown in FIGURES 7 and 8 which differs from the cleansing heads described above is the provision of a small bleed passage **133** in the body of the piston **106** by which the central bore of such piston is placed in restricted communication with the nozzle body cavity **134** of the cleansing head **102**. When the cleansing fluid is fed through the mouthpiece **101** into the central bore of the piston **106** for discharge through the forwardly-directed nozzles **103**, as shown in FIGURE 7, a small amount of such liquid is bypassed through the passage **133** into the annular spray head chamber **134**.

The piston shoulder **107** has a passage extending through it which is controlled by a valve **135** that is in open position when the piston is at rest in the position shown in FIGURE 7. The liquid which seeps into the body chamber **134** through the piston passage **133** is allowed, by suitable proportioning of the cross-sectional areas of the piston passage **133** and the passage controlled by valve **135** so that the valve-controlled passage is larger than the piston passage, to drain past valve **135** out through the discharge port **136** into the pipe or container to be cleansed.

When the pressure of the cleansing fluid is sufficiently high to reciprocate piston **106** upward so that the valve plug **114** fits in the piston's central bore, the forward nozzles **103** are closed in the manner previously explained and cleansing liquid is discharged through the rearwardly-directed nozzles **104** from the antechamber **110**, as shown in FIGURE 8. When the pressure of liquid supplied to the mouthpiece **101** is still further increased somewhat, the end of auxiliary valve **135** is pressed against the lower edge **137** of the guiding sleeve **105**. By such contact the valve is moved to closed position sealing the chamber **134** so that, as liquid under pressure is supplied gradually to this chamber through the bleed passage **133**, the piston **106** is forced from the position of FIGURE 8 to that of FIGURE 7. When the piston has been returned to the position of FIGURE 7, the lower end of the control valve **135** will engage the sealing ring **109** so that such valve will be moved again into open position to enable liquid to be drained from chamber **134** faster than it is supplied to such chamber through piston passage **133**. The piston will then begin to be moved from the position of FIGURE 7 toward the position of FIGURE 8 again by fluid pressure on piston **106** in accordance with the operation explained above.

The type of nozzle construction shown in FIGURES 9, 10 and 11 has features similar to the type of nozzle shown in FIGURES 4, 5 and 6 and to the type of nozzle

shown in FIGURES 7 and 8 and has additional capabilities. In this type of construction means are provided for rotating the spray or nozzle head relative to the mouthpiece or spigot **101** to which the pressure hose can be attached. As in the two types of nozzle head shown in FIGURES 4 and 5 and in FIGURES 7 and 8, a cap sleeve forming the principal part of the cleanser head **102'** contains the forwardly-directed oblique nozzles **103** while the rearwardly-directed nozzles **104** are arranged in the opposite end of the casing **116'**.

In this instance the valve piston **106'** is integral with the mouthpiece **101** and the shoulder **107'** is integral with and projects outward from the hollow valve piston **106'**. The upper end of the piston's hollow stem is engaged in the valve sleeve **105** projecting downwards from the inner crown of the cleanser head. The lower portion of the cleanser head casing **116'** is sealed around the mouthpiece **101** by the seals **111'** and **112'**, which can slide relative to the mouthpiece so as to enable the nozzle casing to move both axially and rotationally relative to such mouthpiece.

When the cleansing head is set in operation, the nozzle casing **116'** may be in the relation to the mouthpiece **101** shown in FIGURE 9 in which the sealing ring **109'** of the nozzle head abuts the lower side of the shoulder **107'**. In this relationship fluid under high pressure, which may be between 30 and 80 atmospheres, is supplied to the antechamber **113** and thence is discharged through the forward nozzles **103**. With the nozzle casing **116'** in this forward position, the apertures **138** in the mouthpiece **101** are sealed between the gasket **111'** so that the mouthpiece body wall serves as a control member blocking flow of water to the antechamber **110**. During this operation liquid under pressure passes through the small bleed opening **133'** in the side of the valve piston **106'** into an annular groove in the base of the shoulder **107'** which communicates with one end of a passage through the piston shoulder **107'** which, under the conditions illustrated in FIGURE 9, is closed by a reciprocable valve **135'**.

Fluid under pressure passing through the bleed opening **133'** builds up pressure between the bottom of the valve piston shoulder **107'** and the sealing ring **109'** carried by the nozzle head which causes these components to separate, sliding the sealing ring down the mouthpiece **101** toward the position shown in FIGURE 10. The fluid pressure in the space between the shoulder **107'** and the sealing ring **109'** tends to hold the valve **135'** in closed position. In addition buttons on the valve stem frictionally engage the wall of the piston passage, tending to hold the valve in any position in which it is adjusted without interfering with flow around the valve and through the piston passage when the valve is in open position.

When the nozzle head casing **116'** has been slid down around the mouthpiece **101** to the position of FIGURE 10, the end **139** of the valve projecting above the piston shoulder **107'** is engaged by the end **137** of the valve sleeve **105** and further movement of the casing causes the valve to be moved to the open position shown in FIGURE 10. The valve cannot fall out of the piston passage because a button projecting from the side of the valve will engage the valve-retaining ring **140** encircling the mouthpiece. The fluid under pressure in the chamber between the sealing ring **109'** and the piston shoulder **107'** will be released to flow through the piston passage into the valve casing chamber **134** from which it can escape from the nozzle body through the aperture **136'** in its wall.

With the parts in the relationship shown in FIGURE 10 the mouthpiece body wall serves as control means by fitting tightly around the valve plug **114** to interrupt the flow from the interior of the mouthpiece **101** to the forward nozzles **103**, but cleansing fluid will flow through the ports **138** in the wall of the mouthpiece into the antechamber **110** for discharge through the rearward nozzles **104**. Even though the end of the mouthpiece passage is plugged by the valve plug **114**, pressure will be exerted on it tending to slide the nozzle casing **116'** toward the position shown in FIGURE 9. In addition pressure fluid passing through the piston shoulder port past the valve **135'** will tend to build up pressure between such piston shoulder and the end surface **137** of the valve sleeve **105**, which pressure also will tend to move the nozzle casing **116'** from the position of FIGURE 10 toward that of FIGURE 9. When the nozzle head casing has reached approximately the midposition of its travel, the ports **138** supplying liquid through antechamber **110** to the rear jets **104** will be closed by the lower end of the nozzle casing and the valve plug **114** will have been withdrawn from the end portion **113'** of the mouthpiece bore so that cleansing fluid again will be discharged from the forward jets **103**.

During the reciprocation of the nozzle casing **116'** back and forth along the mouthpiece **101** as described, such casing is also rotated relative to the mouthpiece. Such rotation is accomplished by the inner end of pin **126'** projecting into the interior of the casing being engaged in a cam groove **127'** provided in the periphery of the shoulder **107'**. Such cam groove is of undulating contour circumferentially of the piston shoulder, as shown in the developed form of such cam groove in FIGURE 11. Each time that the casing **116'** moves in one direction or the other along the mouthpiece **101**, the end of pin **126'** engaged in the cam groove will traverse an inclined section of such groove to effect an incremental rotation of the casing **116'** about its axis relative to the piston shoulder **107'** and the mouthpiece **101** with which such shoulder is integral. The rotative driving action effected by interengagement of the pin **126'** and the cam groove **127'** is similar to the rotation effected by engagement of the ball **126** in the cam groove **127**, as discussed in connection with FIGURES 4, 5 and 6.

I claim as my invention:

1. Cleaning nozzle mechanism comprising a conduit for supplying fluid under pressure, a nozzle head mounted on said conduit and having first jet means and second jet means at spaced locations in said nozzle head and directed in generally opposite directions, respectively, and further having first and second valve elements spaced apart, and control means having first and second valve elements spaced apart and cooperable with said first and second nozzle head valve elements, respectively, by reciprocation of said control means with respect to said nozzle head between a first position in which engagement of said two first valve elements blocks communication between said conduit and said first jet means while said second jet means are in communication with said conduit and a second position in which engagement of said second two valve elements blocks communication between said conduit and said second jet means while said first jet means are in communication with said conduit, and said control means further including pressure-receiving surface means upon which pressure is exerted by fluid under pressure from said conduit for creating a force effecting relative reciprocation of said control means and said nozzle head.

2. The cleaning nozzle mechanism defined in claim **1**, including means engaged between the control means and the nozzle head for effecting relative rotation of the control means and the nozzle head in addition to relative reciprocation thereof.

3. The cleaning nozzle mechanism defined in claim **2**, in which the means for effecting relative rotation of the control means and the nozzle head is operable to effect such rotation simultaneously with and coordinated with relative reciprocation of the control means and the nozzle head.

4. The cleaning nozzle mechanism defined in claim **2**, in which means for effecting relative rotation of the control means and the nozzle head is operatively connected to the control means to effect intermittent rotation thereof relative to the nozzle head in response to reciprocation of the control means relative to the nozzle head.

5. The cleaning nozzle mechanism defined in claim **2**, in which the means for effecting relative rotation of the control means and the nozzle head is operatively connected to the nozzle head to effect intermittent rotation thereof relative to the control means in response to relative reciprocation of the control means and the nozzle head.

6. The cleaning nozzle mechanism defined in claim **1**, and spring means engaged between the nozzle head and the control means and acting on the control means in opposition to the action of fluid under pressure on the control means.

7. The cleaning nozzle mechanism defined in claim **1**, in which the control means is a hollow pistion subjected to pressure fluid, spring means engaged with said piston and urging it in a direction opposite that in which the pressure of the pressure fluid tends to move it, and rotary drive means connected to said piston and operable to effect rotation thereof in response to reciprocation of said piston.

8. The cleaning nozzle mechanism defined in claim **7**, in which the pressure-receiving surface means includes a step in the bore of the hollow piston against which pressure of the fluid is exerted.

9. The cleaning nozzle mechanism defined in claim **7**, in which the rotary drive means includes cam means operatively connected to the hollow piston for effecting rotation thereof.

10. The cleaning nozzle mechanism defined in claim **1**, in which the jet means include two rings of orifices, the orifices in each ring being spaced apart circumferentially and diverging in the direction away from the other ring of orifices.

11. The cleaning nozzle mechanism defined in claim **1**, and a longitudinally shiftable conduit for supplying the fluid under pressure, the nozzle head being mounted on and movable with said conduit, and one jet means includes a ring of orifices adjacent to and directed alongside said conduit for propelling the nozzle head and conduit in one direction and the other jet means includes a second ring of orifices in a portion of the nozzle head remote from the first ring of orifices for discharge of fluid therefrom to propel the nozzle head in the opposite direction.

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