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FOREIGN PATENTS

678,206 1/1964 Canada 134/167

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[54] **SPRAY NOZZLE FOR CLEANING THE INTERIOR OF TUBING HAVING INTERIOR DEPOSITS**
8 Claims, 3 Drawing Figs.

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239/601, 134/167

[51] Int. Cl. **B08b 9/02**

[50] Field of Search. 239/452,
 556, 589, 601; 134/166(c), 167(c), 168(c)

[56] References Cited

UNITED STATES PATENTS

3,165,109 1/1965 Hammelmann 134/167

ABSTRACT: A spray nozzle which is intended for cleaning the interior of tubing is mounted on a line adapted to supply pressured cleaning fluid and is advanced through a tubing length to be cleaned. The nozzle includes an axially extending body adapted for connection to the supply line. The nozzle further includes a spray opening in the body extending about a peripheral surface of the body. The annular opening is forwardly and radially outwardly inclined. At least one jet port is provided in an axial extremity of the body, with the port being inclined forwardly and radially outwardly thereof. Passage means are provided in the body for conducting fluid under pressure to the jet port to issue therefrom as an obliquely inclined jet which impinges upon the interior of the tubing in advance of the nozzle to loosen and detach deposited material therefrom. The passage means also conducts the fluid to the spray opening to issue therefrom as a cone-shaped, fan spray which washes the deposited material loosened and detached by the jet from the tubing and carries it away.

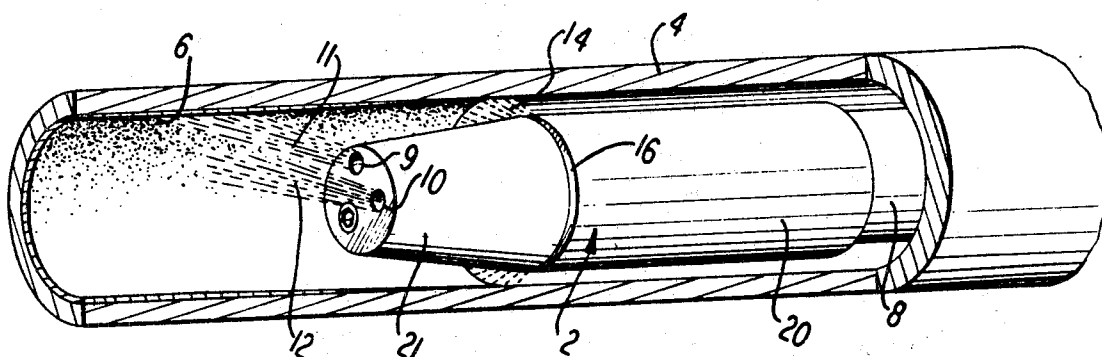


FIG. 1

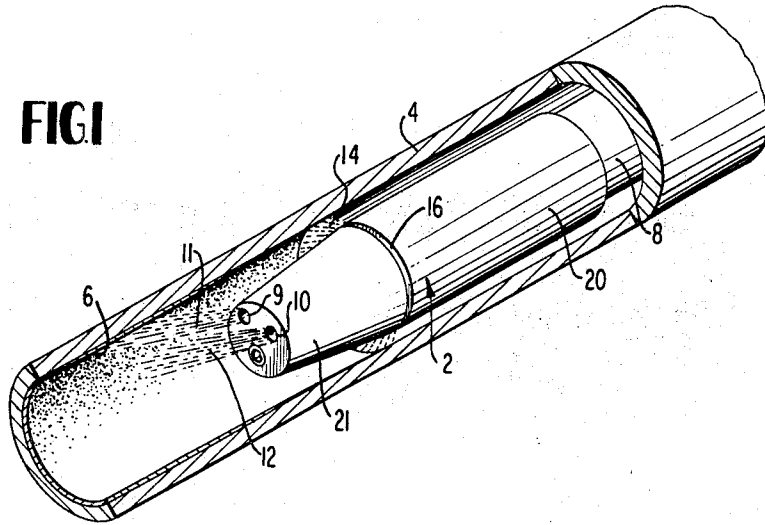


FIG. 2

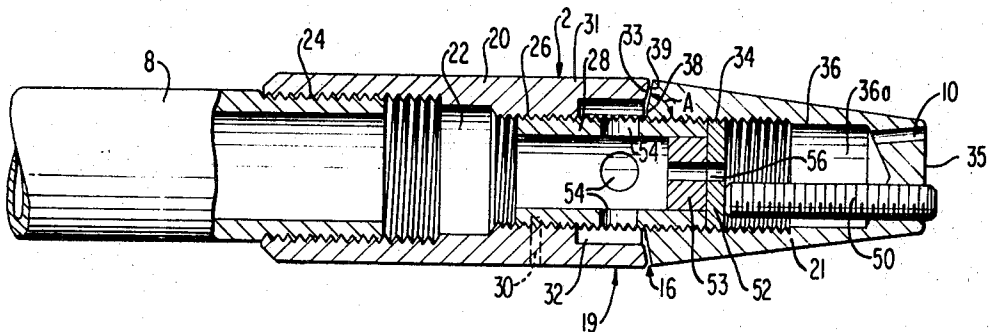
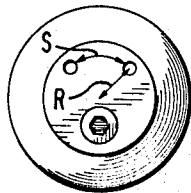


FIG. 3



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SPRAY NOZZLE FOR CLEANING THE INTERIOR OF TUBING HAVING INTERIOR DEPOSITS

BACKGROUND OF INVENTION

This invention relates to a spray nozzle for cleaning the interior of a tubing subjected to internal deposits on the tubing such as scale, biological slime and the like.

In cleaning the interior of tubing subject to internal deposits (such as scale, fungal growths, slimes and the like) it is a frequent practice to utilize spray nozzles which are passed through the tubing. One common type of spray nozzle for this purpose is mounted at the end of a high pressure, liquid supply line with the nozzle being configured to direct fluid in a 360° fan against the interior of the tubing (see for example, Kane U.S. Pat. No. 2,901,184).

Although nozzles of this type may be satisfactory for clearing loosely adhered internal deposits from pipes to be cleaned, problems may be encountered in removing deposits which are adhered relatively more tenaciously to the pipe interior. This is because the energy in the spray of water issuing in a full 360° fan of water is inherently dissipated to a greater extent that it would be if the water were concentrated in a narrow jet to impinge upon a narrow area of the deposit. Thus, the use of a fan-type spray alone may sometimes result in inadequate cleaning of material from the interior of the pipe.

Although it has previously been proposed to provide a spray nozzle for cleaning tubing employing both a 360° fan spray of the type described and a centrally directed jet (see for example, Wheeler U.S. Pat. No. 72,348), the jet in this prior device was not provided for the purpose of detaching portions in advance of the fan jet. Indeed, it could not do this as a centrally directed jet would not impinge upon the walls of the tubing.

Another problem arising with spray nozzles of the fan spray type utilized for cleaning inside tubing may arise if it is necessary to change the fan spray characteristics. Such change in characteristics is frequently necessary in order to compensate for the different characteristics of different materials to be removed. For this purpose, it is desirable that the spray nozzle can be readily adjusted as to thickness of the fan spray. However, adequate provision must be made to ensure that fan spray characteristics cannot be changed accidentally while the spray nozzle is in use in the tubing.

OBJECTS AND SUMMARY OF INVENTION

It is therefore a general object of the invention to provide a spray nozzle for cleaning the interior of tubing, which obviates or minimizes problems of the type previously noted above.

It is a particular object of the invention to provide a spray nozzle for cleaning tubing internally which utilizes the pressure energy of the liquid supplied to the nozzle to the best advantage by utilizing a portion of the liquid as a high energy jet to loosen and detach the deposit and the remainder of the jet as a relatively lower energy 360° fan spray to wash away the loosened and detached deposit.

It is a further object of the invention to provide a spray nozzle including a conical fan spray wherein the nozzle may be adjusted and set to maintain predetermined desired characteristics of the fan spray.

A spray nozzle constructed in accordance with a preferred embodiment of the invention is intended for clearing interior deposits from tubing utilizing a supply line for fluid under pressure moved internally through the tubing in a forward direction. The nozzle includes an axially extending body adapted for connection to a forward end of the fluid supply line. The body has an axially extending peripheral surface adapted to be spaced from adjacent interior surfaces of the tubing and extends generally parallel thereto and a radially extending, forward end, i.e., axial surface extremity. The body also includes axially extending first and second members connected together in axially spaced and opposed relation by connecting means. The connecting means selectively varies the axial spacing of the members to define an annular spray opening extending about a peripheral surface of the body and

spaced rearwardly of the forward end thereof. The spray opening is inclined radially outwardly and forwardly of the body. The body also includes at least one longitudinally extending jet port intersecting the forward end surface. The jet port is inclined forwardly and radially outwardly of the body. Passage means are provided within the body adapted to conduct fluid from the supply line to the port to issue therefrom as a relatively high energy jet to impinge obliquely upon the interior wall of the tubing to detach and loosen the deposit thereon. The remainder of the liquid is conducted by the passage means to the annular opening and issues therefrom as a forwardly inclined, cone-shaped, fan spray having sufficient energy to wash away from the walls of the tube the deposit already loosened and detached by the high energy jet.

In another important aspect of the invention, the width of the annular spray opening may be selectively adjusted and set to maintain a fan spray of predetermined angular and thickness characteristics. This is achieved by mounting the first and second members on an externally threaded connecting tube engaging corresponding internally threaded portions of the members. By relative rotation of the members they may be threaded axially toward and apart from each other to control the width of the fan spray. To enable the spacing to be set to not less than a predetermined value, an axially extending, limiting screw is connected with one of the members. The limiting screw at its rear end impinges upon an abutment member connected with the connecting tube once the approaching members have reached the predetermined spacing. Thereafter, the limiting screw prevents further closing motion of the members to maintain the predetermined characteristics of the fan spray.

THE DRAWINGS

A spray nozzle for clearing interior deposits from tubing constructed in accordance with a preferred embodiment of the invention is illustrated in the accompanying drawings in which:

FIG. 1 is a perspective view, partially broken away, of a length of tubing having an interior deposit, with a spray nozzle constructed in accordance with the preferred embodiment of the invention shown positioned in working relation within the tubing;

FIG. 2 is a cross-sectional side view of the spray nozzle shown in FIG. 1; and

FIG. 3 is a forward end view of the spray nozzle shown in FIG. 2.

DETAILED DESCRIPTION

Referring to FIG. 1 of the drawings, a spray nozzle 2 constructed in accordance to a preferred embodiment of the invention is shown being utilized to clean a length of tubing 4 having a layer 6 of interior deposits which it is desired to remove. For example, the tube 4 may form part of a system for conveying cooling water through a steam condenser at an electrical generating plant. In this instance, the layer of deposit 6 may comprise a scale composed of calcium phosphate, iron, copper and manganese. The exposed surface of the scale is fairly soft. However, the scale next to the interior tubing wall, or "skin" may be considerably harder. It will be appreciated, however, that the invention may be utilized for cleaning other forms of tubing subjected to different types of internal deposit such as, for example, chemical deposits, biological slimes, fungal growths and the like.

In performing the cleaning operation the nozzle 2 is mounted on the forward end of a supply line 8 connected to a remote supply of liquid under pressure (not shown). The liquid may comprise water or other suitable cleaning agents. The supply line 8 is advanced internally through the tubing 4 in a forward direction.

In operation, the spray nozzle 2 directs a portion of the water supplied to it through the conduit 8 forwardly and obliquely out of the spray nozzle through two jet ports 9 and

10 in the form of two high energy jets 11 and 12 which impinge upon the layer 6 of deposit in advance of the spray nozzle. The high energy jets 11 and 12 impact upon the deposit with sufficient energy to penetrate through the deposit to the tubing skin and cause local breaking up of the deposit. These jets also produce considerable cracking and loosening of the deposit for a considerable area on either side of the actual points of impact with the deposit layer 6.

The loosened up deposit is thereafter completely removed from the tubing and washed away by a "following", cone-shaped, fan spray 14. This spray is inclined forwardly and generally radially outwardly from the spray nozzle 2 through an annular spray opening 16 extending entirely about the nozzle 2 intermediate its axial ends.

The structure of the spray nozzle 2 may be seen with more particularity from FIG. 2. The nozzle 2 includes a body 19 composed of a tubular rear body 20 and a generally frustoconical front body 21.

The rear body 20 has an axially extending outer peripheral surface spaced from and parallel to the interior walls of the tubing 4. Body 20 also includes an internal central passage 22 extending axially of the rear body from one end to the other. At the rear open end of the central passage 22 the rear body includes internally threading 24 for threaded connection with an externally threaded coupling portion located at the forward end of the previously mentioned liquid supply conduit 8.

Adjacent and spaced from the forward end of the rear body 20 is an internal, annular constricted portion 26 projecting radially into the passage 22. The constricted portion 26 is internally threaded to receive the externally threaded rear end of a tubular connecting body 28. Body 28 is concentric with the rear body 20 and extends forwardly and outwardly thereof. Once the connecting body 28 has been threadedly engaged with the constricted portion 26 of the rear body 20, a suitable locking pin 30 may be fixed between the rear body 20 and connecting body 28 to prevent any further threading or unthreading relative motion between them. A portion of the rear body 20 extending forwardly from the constricted part 26 constitutes an annular lip 31 spaced internally from the connecting tube 28 to define an annular chamber 32 between the lip and the tube. The forward radial end of the lip 31 is dished inwardly to provide a peripherally extending, radially inwardly inclined rear shoulder 33.

The function of the connecting member 28 is to support the previously mentioned front body 21 which is of generally frustoconical shape, in concentric relation with the rear body 20 and extending forwardly therefrom. The connecting member 28 adjacent its forward end enters and threadedly engages a corresponding, internally threaded bore 34 in the front body 21. The internally threaded bore 34 terminates at its forward end axially adjacent an unthreaded, internal bore portion 36. Bore portion 34 and 36 are of the same diameter. Bore portion 36 has a closed, radially extending forward end or axial extremity 35.

The previously mentioned jet ports 9 and 10 extend forwardly and radially outwardly from the bore 36 through the front end wall 35. The ports 9 and 10, at their open forward ends, are positioned at the same radial distance R from the R from the central axis of the nozzle, and are angularly spaced by an arc S of less than 180°.

In addition, the front body 21 includes a rearmost, radially extending, end face 38 of generally the same peripheral diameter as the outside diameter of the adjacent rear body 20. The end face 38 is dished rearwardly outwardly and includes a radially and peripherally extending front shoulder 39 generally parallel to and coextensive with the previously mentioned rear shoulder 33 on the rear body 20.

It will be appreciated that the front and rear shoulders 39 and 33 define the previously mentioned annular opening 16 for the fan spray. In the preferred embodiment an inclination of the shoulders 39 and 33 to the radial plane of about 10° was found to provide optimum results in the removal of scale.

Another factor controlling the characteristics of the fan spray is the axial spacing or gap between the shoulders 39 and 33. The front and rear portions of the front and rear bodies 21 and 20 on which the front and rear shoulders 39 and 33 are formed, constitute front and rear members whose relative axial spacing may be changed by relative threading motion along the common connecting tube 28. Specifically, by threading or unthreading the front body 32 from the connecting member 28 the gap may be reduced or increased until an optimum value revealed by experiment is obtained for the particular type of tubing and deposit involve. It would, of course, be possible to utilize separate front and rear members not integral with the adjacent front and rear bodies, to provide the shoulders defining the spray opening 16.

Thereafter, it is important to lock the front body 21 in position relative to the rear body 20 so that the thickness of the opening 16 does not become accidentally altered in use, such as by impacts or rubbing of the nozzle portions along the interior of the tubing 4. For this purpose a limiting member 50 is provided. The limiting member 50 in the preferred embodiment comprises an elongate screw passing in threaded engagement through the forward radial end 42 of the front body into the bores 36 and 34 parallel to and radially offset from the axis thereof. When the opening 16 has been set to a desired predetermined axial thickness, the limiting member 50 is threaded inwardly of the front member 21 until the free rearward end of the limiting member 50 abuts against an abutment plate 52. The abutment plate 52 extends transversely of the bore portion 34 in threaded engagement therewith. A rearward side of the abutment plate 52 abuttingly contacts the forward end of the previously mentioned connecting member 28. A backup member 53 positioned snugly within the forward end of the connecting tube abuts a rear face of the abutment plate 34.

It will be appreciated that, once the limiting screw 50 has contacted the abutment plate 52, further threading motion of the front member 21 towards the back member 20 is prevented by the abutting contact between the member 50 and the plate 52. Thus, once the gap 16 is set for the predetermined value, it cannot become accidentally reduced by inadvertent further threading motion of the front member 21 along the connecting tube 28. Such threading motion might tend to occur during manipulation of the tool between different pipes to be cleaned, or because of rubbing of the component 21 on the tubing interior.

To direct liquid to the annular opening 16 four symmetrically and equally spaced openings 54 extend radially through the wall of the connecting member 28. The openings 54 place the interior of the connecting member 28, which communicates through the passage 22 with the liquid supply line 8, in fluid communication with the annular chamber 32. This interior portion of member 28 in turn communicates with the annular opening 16 by way of openings 54, so that water may be directed outwardly therefrom from opening 16 in the forwardly directed, cone-shaped, fan spray 14, in the manner previously described.

To provide a path for liquid to the jet ports 9 and 10 for directing the relatively higher energy jet streams 11 and 12 outwardly of the nozzle, a central axial passage 56 is provided in the abutment plate 52 and backup member 53 for conducting liquid from the interior of the connecting tube 28 to the bores 34 and 36. The bores 34 and 36 are of relatively much greater cross-sectional area than either the ports 9 and 10 or the passage 56 and constitute a settling chamber 36a downstream of the spray opening in which the turbulence of the preparation of the liquid proceeding to the jet ports 9 and 10 is reduced. This reduction of turbulence enables the jets 11 and 12 to operate at a maximized velocity, thereby enhancing the energy dissipated by the jet streams upon impact with the deposit to increase the loosening and detaching action of the jets.

It should also be noted that ports 54 serve to radially deflect the cleaning fluid to at least partially align the cleaning fluid

flow with the spray-defining gap 16. This deflection, in being spaced from slot 16, but nearly radially aligned with the slot, may tend to reduce wear on slot 16 and reduce turbulence in slot 16 which would impair the formation of conical spray 14.

The confinement of the jets 11 and 12 to a narrow quadrant yields an intensified and highly localized "trenching" action. This action tends to expose the base of the deposit 6 so that the flushing action of spray 14 is of maximum effect. With sprays 11 and 12 being essentially parallel, they yield a "chisel like", noninterfering, spray pattern of maximum effectiveness.

It has been found that particularly effective results have been achieved where the angle of inclination A of jet 14 is on the order of 10°, where the width of gap 16 is on the order of .012 inch, with cleaning fluid being supplied to the nozzle at a pressure of about 3000 p.s.i. In this embodiment, the orifices 9 and 10 extend generally parallel to each other and longitudinally of the central axis of the nozzle. These orifices 9 and 10 are circumferentially displaced by an arc S of about 90°.

SUMMARY OF ADVANTAGES

In constructing a spray nozzle for cleaning interior deposits from tubing in accordance with the present invention, certain significant advantages are provided.

In particular, the division of a portion of the liquid into at least one high energy jet stream directed obliquely ahead of the tool to loosen the deposit, together with the use of the remainder of the liquid flow in a relatively lower energy fan spray to remove the loosened deposit, provides for most effective utilization of the total energy in the water flow.

Also significant is the construction of the annular opening for the fan spray involving the provision of concentric, axially spaced front and rear members whose relatively axial spacing may be limited to a predetermined value by the limiting screw to maintain the characteristics of the fan spray in operation.

The settling chamber provided downstream of the fan spray for the portion of liquid proceeding to the jet ports is also important for the contribution it makes in reducing the turbulence of the liquid jets, thus increasing their energy dissipation on impact of the jets and their cleaning effect.

The "chisel like" operation of the aligned, and closely spaced, noninterfering jets 9 and 10 yields particularly effective trenching action.

The flow deflecting influence of orifice 54, prior to the forming of spray 14, is believed to tend to reduce wear and turbulence in the immediate area of outlet 16.

The passage of set screw 50 symmetrically through chamber 36a, in relation to orifices 9 and 10, provides a uniquely simple adjustment which does not interfere with or unbalance, these jet-forming orifices.

Although the invention has been described with reference to a preferred embodiment, it will be apparent to those skilled in the art that additions, deletions, modifications, substitutions and other changes may be made within the spirit of the invention as embraced in the following claims.

I claim:

1. A spray nozzle for cleaning the interior of tubing utilizing a supply line for fluid under pressure moved internally through the tubing in a forward direction, said spray nozzle comprising:

an axially extending body adapted for connection to a forward end of the fluid supply line for concurrent movement therewith internally through the tubing, said body including:

an axially extending, peripheral surface adapted to be spaced from and extend longitudinally of, an interior surface of said tubing;

a generally transversely extending, forward end surface; axially extending first and second members;

connecting means connecting said first and second members in axially spaced, opposed relation, said connecting means causing selective variation in the axial spacing of said members to define

an annular spray opening in said body spaced rearwardly of said forward end surface and extending peripherally about said peripheral surface, said spray opening being inclined radially outwardly and forwardly of said body;

at least one longitudinally extending, jet port in said body intersecting said forward end surface, said jet port being inclined forwardly and radially outwardly of said body;

passage means within said body and said members adapted to conduct fluid under pressure from the supply line to said spray opening to issue therefrom as a generally cone-shaped, fan spray inclined forwardly of said body, said passage means further conducting fluid to said jet port to issue therefrom as a jet inclined forwardly and radially outwardly of said body;

said at least one jet port and said annular spray opening respectively defining means for causing said jet to issue at a first energy level and means for causing said fan spray to issue at a second energy level, with said first energy level being greater than said second energy level; and

releasable limiting means connected with said members to maintain said members at not less than a predetermined axial spacing, said limiting means upon release permitting selective axial increase and decrease of the axial spacing between said members.

2. A spray nozzle as defined in claim 1 wherein said first member includes:

an annular, radially extending rear shoulder inclined forwardly and radially outwardly of said body;

wherein said second member includes:

an annular, radially extending forward shoulder spaced forwardly from said rear shoulder in opposed, generally parallel, coextensive, relation thereto; and

wherein said connecting means includes:

an externally threaded connecting tube extending between corresponding internally threaded portions of said members, relative rotation between said members thereby causing relative axial motion between said shoulders to vary the axial extent of said spray opening.

3. A spray cleaning nozzle as defined in claim 2 further including first and second limiting means connected with said first and second members, respectively, said first and second limiting means moving into mutual abutting contact upon relative approaching motion of said members to said predetermined axial spacing to prevent further relative approaching motion thereafter, said limiting means thereby limiting said spacing to said predetermined amount.

4. A spray nozzle as defined in claim 2, wherein said body includes:

a generally tubular rear body, said rear body including:

a rear end portion adapted for connection with the forward end of the fluid line; and

a forward end portion;

a generally tubular front body including:

a rear end portion; and

a closed forward end portion integral with said forward end surface; and wherein

said first member defines said rear body, with said rear shoulder facing in a forward direction; and wherein

said second member defines said front body, with said forward shoulder disposed in closely spaced, forwardly adjacent relation to said rear shoulder.

5. A spray nozzle as defined in claim 3 wherein said first limiting means includes:

an axially extending, limiting screw threadedly engaged with said second member extending rearwardly therefrom towards said first member;

said second limiting means includes:

an abutment member fixedly connected with a forward end of said connecting tube, said abutment member being abuttingly impinged upon by a free rear extremity of said limiting screw when said shoulders are at said

predetermined axial spacing to prevent further relative closing motion of said shoulder.

6. A spray nozzle for cleaning the interior of tubing utilizing a supply line for fluid under pressure moved in a forward direction through the tubing, said spray nozzle comprising:
- an axially extending body adapted for connection to a forward end of the fluid supply line for concurrent movement therewith through the tubing, said body including:
 - a longitudinally extending peripheral surface adapted to be spaced from an interior surface of a tubing; and
 - a transversely extending forward end surface;
 - an annular, spray opening in said body spaced rearwardly of said forward end surface and extending peripherally about said peripheral surface, said spray opening being inclined radially outwardly and forwardly of said body;
 - at least one longitudinally extending, jet port in said body intersecting said forward end surface, said jet port being inclined forwardly and radially outwardly of said body;
 - central passage means within said body adapted to conduct fluid under pressure from a supply line to said spray opening to issue therefrom as a generally cone-shaped, fan spray inclined forwardly of said body;
 - an enclosed settling chamber within said body communicating with said jet port; and
 - constricted passage means of relatively smaller cross-sectional area than said settling chamber placing said settling chamber in fluid communication with said central passage means.
7. A spray nozzle for cleaning the interior of tubing utilizing a supply line for fluid under pressure of about 3000 p.s.i., with said line being moveable in a forward direction through the tubing, said spray nozzle comprising:
- an axially extending body adapted for connection to a forward end of the fluid supply line for concurrent movement therewith through the tubing, said body including:
 - a peripheral surface extending longitudinally of a central axis of said body and adapted to be spaced from an interior surface of a tubing;
 - a transversely extending forward end surface;
 - axially extending first and second members;
 - connecting means connecting said first and second members in axially spaced opposed relation said connecting means causing selective variations in the axial spacing of said members to define
 - an annular, spray opening in said body spaced rearwardly of said forward end surface and extending peripherally about said peripheral surface, said spray

opening at one predetermined setting having a width of about .012 inch and being inclined radially outwardly and forwardly of said body at an angle of about 10° in relation to a plane extending perpendicular to said axis;

- a plurality of longitudinally extending, generally parallel jet ports in said body intersecting said forward end surface, said jet ports being inclined forwardly and radially outwardly of said body and circumferentially displaced by an angle not exceeding about 90°;
 - central passage means within said body adapted to conduct fluid under pressure from a supply line to said spray opening to issue therefrom as a generally cone-shaped, fan spray inclined forwardly of said body;
 - an enclosed settling chamber within said body communicating with said jet port;
 - constricted passage means of relatively smaller cross-sectional area than said settling chamber placing said settling chamber in fluid communication with said central passage means; and
 - first and second limiting means connected with said first and second members, respectively, said first and second limiting means moving into mutual abutting contact upon relative approaching motion of said members to a predetermined axial spacing defining said predetermined setting of said spray opening to prevent further relative approaching motion thereafter, said limiting means thereby limiting said spacing to said predetermined amount.
8. A spray nozzle as defined in claim 7 wherein said first limiting means includes:
- an axially extending, limiting screw threadedly engaged with said second member extending rearwardly therefrom through said settling chamber and towards said first member, in symmetrical relationship with said jet ports; and wherein
- said second limiting means includes:
- an abutment member fixedly connected with a forward end of said connecting means, said abutment member being abuttingly impinged upon by a free rear extremity of said limiting screw when said members are at said predetermined axial spacing to prevent further relative closing motion of said members; and
 - deflecting means spaced from said spray opening and operable to deflect fluid from said central passage means generally radially outwardly and toward said spray opening.