

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 698 423 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
13.01.1999 Bulletin 1999/02

(51) Int. Cl.⁶: **B08B 9/04**

(21) Application number: **95305517.5**

(22) Date of filing: **08.08.1995**

(54) **Tube cleaner for removing hard deposits**

Reinigungsgerät zur Entfernung von harten Ablagerungen in Rohren

Outil de nettoyage pour enlever des dépôts durs dans les tuyaux

(84) Designated Contracting States:
CH DE ES FR GB IT LI PT

(30) Priority: **08.08.1994 US 287135**

(43) Date of publication of application:
28.02.1996 Bulletin 1996/09

(73) Proprietor: **CONCO SYSTEMS INC.**
Verona, Pennsylvania 15147 (US)

(72) Inventors:
• **Saxon, Gregory J.**
Oakmont, PA 15139 (US)
• **Krysicki, Jerzy**
Oakmont, PA 15139 (US)

(74) Representative:
Frankland, Nigel Howard
FORRESTER & BOEHMERT
Franz-Joseph-Strasse 38
80801 München (DE)

(56) References cited:
US-A- 1 835 238 **US-A- 5 305 488**

- **SOVIET PATENT ABSTRACTS Section PQ, Week 9222 22 July 1992 Derwent Publications Ltd., London, GB; Class P, Page 43, AN 92-182236 & SU-A-1 674 992 (KAVITRON AGRIC WATER SUPPLY PIPELINES) , 7 September 1991**
- **SOVIET PATENT ABSTRACTS Section PQ, Week 8920 28 June 1989 Derwent Publications Ltd., London, GB; Class Q, Page 67, AN 86-119098 & SU-A-1 414 482 (YUZH Vodoprovod Trus)**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 698 423 B1

Description

The present invention relates to a tube cleaner or scraper that is fluid driven through a tube to remove deposits, specifically very hard deposits, from the inner surface of the tube wall.

A variety of heat exchangers use a series of tubes through which a cooling medium is passed so as to cool the tubes, while another medium of higher temperature is in contact with the exterior of the tubes, with heat transfer effected through the tube walls. For example, in steam condensers in large power plants, a series of small tubes are provided for heat transfer. After a period of time, impurities or minerals in the water flowing through the tubes tend to deposit on the inner surface of the tube wall and, in addition to narrowing the cross-sectional flow area of the tube passageway, such deposits form an insulating layer and detract from the heat transfer capabilities of the tubes.

In order to remove deposits or encrustations, a scraper element is inserted into one end of a tube, while the condenser is out of service, and the scraper element is driven by fluid pressure, usually by pressurised water, through the tube, the scraper element scraping the deposits from the inner surface of the tube wall and the pressurised fluid flushing the loosened deposits from the tube. Depending upon the physical nature and chemical composition of the deposits, various types of scrapers have been proposed. Examples of earlier tube scrapers are given in US-A-2,170,997, US-A-2,418,509, and US-A-2,734,208 while US-A-4,281,432 shows an improved tube cleaner with a flexible rubber skirt. These types of scrapers are adapted for use to remove general fouling and less tenacious deposits from tubes. In US-A-5,153,963, a tube cleaner is disclosed for use in removing thick hard deposits, or thick scales that chip off in relatively large pieces, such as a scale containing calcium or silicon, the cleaner having freewheeling cutting wheels that cut through the scale and fracture the scale for removal from the tube.

SU1414-482-A discloses a tube cleaning tool. The cleaning tool has a rod supporting groups of cleaning elements. The cleaning elements are provided with sprung leaves. The leaves of adjacent cleaning elements are placed in tight contact following one another so that the leaves of each successive element are displaced with respect to the leaves of the preceding element in the transverse cross section plane. Each successive cleaning element leaf is displaced with respect to the preceding cleaning element leaf along the outer diameter of the tool by not more than one leaf width.

US-5,305,488 discloses a fluid propelled tube cleaning tool for removal of deposits from the interior wall of a tube. The cleaning tool is provided with a plurality of spaced cutters, each cutter having a plurality of cutting blades extending radially from the cutter.

While the aforementioned tube cleaners are suited

to their purpose, there are certain deposits that are not readily removed by such prior tube cleaners. One such difficult removable deposit is a very thin, brittle scale of a crystalline structure that fractures into very small granular pieces. Such scales are tenacious deposits.

This invention provides a tube cleaner for removing thin hard deposits from an inner surface of a tube the tube cleaner comprising a shaft with at least one scraper element disposed on the shaft, the or each scraper element being formed from a single piece of material and comprising a plurality of resilient fingers extending generally axially of the shaft and which are biased radially outwardly when the tube cleaner is in use, each finger terminating as a radially outwardly extending blade portion wherein adjacent fingers on any one scraper element are of different length, and each blade portion has an arcuate blade edge shaped so that there is only minimal contact with the inner surface of the tube.

Preferably two or three spaced apart scraper elements are axially disposed along said shaft.

Conveniently six rearwardly extending outwardly biased fingers are provided on each said scraper element.

Advantageously each said blade portion has an arcuate blade edge and is arranged to contact said inner surface along 0.0762mm - 0.2286mm (0.003 - 0.009 inch) of an arc of said blade edge.

Preferably the or each scraper element comprises an element punched from spring steel.

Conveniently the fingers of the element are bent so that they form a circle with the blade portion extending radially outwardly from the shaft by a distance greater than the inner diameter of the tube to be cleaned.

According to another aspect of this invention there is provided a method of cleaning a tube to remove the deposits from the inner surface of the tube wall, the method comprising the steps of inserting a tube cleaner into the tube with the blade portions of the fingers being outwardly biased into contact with the inner surface of the tube and moving the tube cleaner through the tube,

A tube cleaner for removing hard deposits from the inside of a tube has a shaft with a nose portion, a tail portion having an outwardly and rearwardly extending flexible skirt, and two or three spaced apart scraper elements disposed along the shaft. The scraper elements are each formed from a single piece of spring steel and have a radially outwardly extending base portion and a plurality of rearwardly extending, outwardly biased fingers, with adjacent fingers being of different lengths.

The invention will become more readily apparent from the following description of a preferred embodiment thereof shown, by way of example only, in the accompanying drawings, wherein:

Figure 1 is a side elevational view of an embodiment of the tube cleaner of the present invention;

Figure 2 is a front end or nose view of the tube cleaner illustrated in Figure 1;

Figure 3 is a plan view of a scraper element in flat state prior to bending the fingers and blade portions;

Figure 4 is a view similar to Figure 3 showing the scraper element after bending to arrange the fingers and blade portions into the desired configuration;

Figure 5 is a schematic view showing the contact of a blade portion of a scraper element to remove hard scale from a tube; and

Figure 6 is a cross-sectional view of a tube after passage of a tube cleaner of the present invention through the tube to remove hard scale.

Referring now to Figures 1 and 2, a tube cleaner 1 for removing hard deposits is illustrated having a shaft 2, with one end, or a nose portion 3, and a second end, or tail portion 4, the tail portion 4 having secured thereto an outwardly and rearwardly extending skirt 5. Spaced axially along the shaft 2, between the nose portion 3 and tail portion 4, are two or three scraper elements 6, illustrated as three scraper elements 6, 6' and 6". Each scraper element 6 is formed of a single piece of metal, preferably spring steel, such as SAE 1050 carbon annealed spring steel. Each scraper element 6 has a radially outwardly extending base portion 7 and a plurality, preferably six, rearwardly extending legs or fingers 8, with each finger 8 terminating as an outwardly extending blade portion 9. The scraper elements 6 are constructed such that adjacent fingers 8 of the scraper element 6 are of different lengths, as seen by reference to Figure 2.

The scraper elements are of a size such that the blade portions 9, at rest position, extend radially outwardly from the shaft 2 a distance greater than the inner diameter of a tube to be cleaned. Thus, the outwardly biased scraper elements 6 must be slightly forced to a position closer to the shaft 2 in order to insert the tube cleaner 1 into the tube to be cleaned. The outward biasing of the scraper element fingers then ensures contact of the blade portions 9 with the inner surface of a tube during movement of the tube cleaner through the tube.

Referring now to Figure 3, a scraper element 6 is illustrated in flat form, as punched from spring steel, prior to bending the fingers 8 and blade portions 9 into the desired shape. The scraper element 6 illustrated has six fingers, a, b, c, d, e and f. While the six fingers, as punched from spring steel, are of the same length in flat condition, adjacent legs constituting the fingers 8 are bent at different points so as to provide different length of adjacent legs 8 upon completion of the formation of the scraper element. For example, legs a and d

are bent along line B₁ at a distance L₁ from the base portion 7, to provide long bent legs; legs b and e are bent along line B₂, at a distance L₂ from base portion 7, to provide bent legs that are shorter than bent legs a and d; and legs c and f are bent along line B₃, at a distance L₃ from base portion 7, to provide bent legs that are shorter than bent legs b and e. Such an arrangement will result in a scraper element, after bending to a desired shape (Figure 4) that will have adjacent fingers 8 of the scraper element of different lengths, although a and d may be the same length, b and e may be the same length, and c and f may be the same length. Although the bent legs 8 have different lengths, the blade portions 9 are arranged such that they form a circle having a diameter $\underline{D}$ which is slightly larger than the inner diameter of the tube that is to be cleaned with the scraper element 6. Thus, the distance from the shaft 2 to the outer arcuate edge 10 of the blade portion 9 is the same for all of the legs 8, although the distance from adjacent blade portions 9 to the outwardly extending base portion 7 will vary. The staggered lengths of the fingers 8 of the scraper element 6 is an important factor. If the finger 8 were all of the same length, the total force of insertion into a tube would be too great to overcome by hand. With staggered finger lengths, however, the force for entry is reduced by providing three stages of actual insertion rather than a single stage for each scraper element 6. As an example the force required to insert conventional scrapers, such as those described in US-A-2,170,997, US-A-2,418,509 and US-A-2,734,208 is about 48.93N (eleven (11) pounds) of pushing force, while with the scraper of the present invention, about 200.17N (forty-five (45) pounds) of force are required to insert the tube scraper into an open end of a tube, with scraper size and tube size being comparable. Thus, the scraper of the present invention requires about 4 to 5 times as much force to insert it into a tube as would a comparable sized conventional scraper if the lengths are equal. The staggered length enables the tube cleaner to be sized so as to thus have more force perpendicular to the tube wall and still be loaded into the tube by hand. As an example, a tube cleaner 1 may have scraper elements 6 as described above where the lengths of the fingers, as measured from the base 7 of the scraper elements 6 to the blade portions 9 of the scraper elements were as follows: Fingers a and d = 17.018mm (0.670 inch), fingers b and e = 16.129mm (0.635 inch) and fingers c and f = 15.24mm (0.600 inch) with the scraper elements 6 formed from SAE 1050 carbon annealed spring steel, No. 2 finish, of a thickness of 0.762mm (0.030 inch). The ability to form a scraper element from a single piece of metal, rather than forming prior scraper blades from separate pieces that had to be assembled, provides lower labour costs associated with their formation and can also provide greater spring force than was generated before.

The contact of a blade portion 9 of a scraper ele-

ment 6 with the inner surface of a tube is shown in Figure 5. As illustrated, a tube 11 has a wall 12 with thin, hard scale 13 on the inner surface 14 of the wall 12. The blade portion 9 is of an arcuate shape such that there is only minimal contact, by section 15 of the blade portion 9 contacting the inner surface 14 of the wall 12, with almost a point-to-point contact achieved, as the blade portion scrapes through the thin hard scale 13, forming grooves 16. Conventional scrapers generally are designed to maximise the contact between a scraper blade edge and the inner surface of the tube wall. To remove a thin, hard scale, however, such a design is unusable. If the force required to fracture the scale were generated at the same time as surface contact were maximised, the friction between the blade of the scraper and the tube wall would be so great as to preclude fluidized pressure movement of a tube cleaner through the tube. By minimising the contact in the present invention, a virtual point-to-point contact is provided, and a significantly higher pressure can be applied by the scraper blade 9 to the tube wall 12 and the tube cleaner 1 can still be propelled through the tube 11 by reasonable fluid pressure. It has been found that the contact of a scraper blade with the inner tube wall should be effected with a contact surface of between 0.0762mm - 0.2286mm (0.003 - 0.009 inch) of the arc of the blade surface with the tube inner wall surface 13 so as to provide scraped grooves 16 in the thin, hard deposits. The blade portion should also have a sharp edge such that a cutting force is applied through the deposits.

The present tube cleaner, with the use of six fingers on each scraper element will provide six spaced contact points on an inner surface of a tube wall by each scraper element to remove hard, thin scale and clean the tube wall to bare metal. With the use of two or three, six-fingers scraper elements, that are axially offset from each other, there will be twelve or eighteen scraper grooves which, with removal of the hard, thin scale, will greatly enhance the heat transfer of the tube. A tube 11 is shown in Figure 6, after passage of a three scraper element tube cleaner as described above with grooves 16 formed in the hard, thin scale 13. By forming the grooves 16 through the deposits of hard, thin scale 13, the heat transfer capability of the tube wall 12 is significantly increased to an extent such that complete removal of the scale is not required.

As scale grows very quickly, subsequent cleaning result in, over time, tubes that approach "as-new" condition after multiple passes of the cleaner.

Thus a tube cleaner for removing hard deposits has two or three scraper elements spaced along a shaft, which elements have fingers that terminate as blades, the blades making a substantially point contact with the tube wall. The present tube cleaner is specifically adapted for the transfer capability of the tube wall 12 is significantly increased to an extent such that complete removal of the scale is not required.

As scale grows very quickly, subsequent cleaning

result in, over time, tubes that approach "as-new" condition after multiple passes of the cleaner.

Thus a tube cleaner for removing hard deposits has two or three scraper elements spaced along a shaft, which elements have fingers that terminate as blades, the blades making a substantially point contact with the tube wall. The present tube cleaner is specifically adapted for the removal of thin, hard deposits from the tube wall inner surface, such as deposits of between 0.127mm - 0.254mm (0.005 to 0.010 inch) of manganese or iron oxide scales, which, while not substantially restricting flow of a heat transfer fluid through the tube, tend to act as an insulating material and has a deleterious affect on the heat transfer capability of the wall of the tube.

Claims

1. A tube cleaner (1) for removing thin hard deposits (13) from an inner surface (14) of a tube (11) the tube cleaner (1) comprising a shaft (2), at least one scraper element (6) disposed on the shaft (2), the or each scraper element (6) being formed from a single piece of material and comprising a plurality of resilient fingers (8) extending generally axially of the shaft (2) and which are biased radially outwardly when the tube cleaner (1) is in use, each finger (8) terminating as a radially outwardly extending blade portion (9) characterised in that adjacent fingers (8) on any one scraper element (6) are of different length and each blade portion (9) has an arcuate blade edge (10) shaped so that there is only minimal contact with the inner surface (14) of the tube (11).
2. A tube cleaner (1) for removing hard deposits (13) on an inner surface (14) of a tube (11) according to Claim 1 wherein two spaced apart scraper elements (6) are axially disposed along said shaft (2).
3. A tube cleaner (1) for removing hard deposits (13) on an inner surface (14) of a tube (11) according to Claim 1 wherein three spaced apart scraper elements (6) are axially disposed along said shaft (2).
4. A tube cleaner (1) for removing hard deposits (13) on an inner surface (14) of a tube (11) according to any one of the preceding claims wherein six rearwardly extending outwardly biased fingers (8) are provided on each said scraper element (6).
5. A tube cleaner (1) for removing hard deposits (13) on an inner surface (14) of a tube (11) according to any one of the preceding Claims wherein each said blade portion (9) has an arcuate blade edge (10) which is arranged to contact said inner surface (14) along 0.0762mm - 0.2286mm (0.003 - 0.009 inch) of an arc of said blade edge (10).

6. A tube cleaner according to any one of the preceding Claims wherein the or each scraper element (6) comprises an element (6) punched from spring steel.

5

7. A tube cleaner according to Claim 6 wherein the fingers (8) of the scraper element (6) are bent so that they form a circle with the blade portions (9) extending radially outwardly from the shaft by a distance greater than the inner diameter of the tube to be cleaned.

10

8. A method of cleaning a tube to remove deposits from the inner surface of the tube wall, the method comprising the steps of inserting a tube cleaner according to any of Claims 1 to 8 into the tube with the blade portions (9) of the fingers (8) being outwardly biased into contact with the inner surface of the tube and moving the tube cleaner through the tube.

15

20

Patentansprüche

1. Rohrreinigungsgerät (1) zur Entfernung von dünnen harten Ablagerungen (13) von der Innenseite (14) eines Rohres (11), wobei das Rohrreinigungsgerät (1) eine Achse (2) umfaßt, wobei wenigstens ein Schabelement (6) auf der Achse (2) angeordnet ist, ferner das oder jedes Schabelement (6) aus einem einzigen Materialstück ausgebildet ist und mehrere federnde Finger (8) umfaßt, die sich allgemein axial von der Achse (2) erstrecken und im Gebrauch des Rohrreinigungsgerätes (1) radial nach außen vorgespannt sind, wobei jeder Finger (8) als ein sich radial nach außen erstreckender Schaufelabschnitt (9) endet, dadurch gekennzeichnet, daß benachbarte Finger (8) jedes Schabelements (6) unterschiedliche Längen aufweisen und jeder Schaufelabschnitt (9) einen bogenförmigen Schaufelrand (10) aufweist, der derart gestaltet ist, daß nur ein minimaler Kontakt mit der Innenseite (14) des Rohres (11) besteht.

25

30

35

40

2. Rohrreinigungsgerät (1) zur Entfernung von harten Ablagerungen (13) auf der Innenseite (14) eines Rohres (11) gemäß Anspruch 1, dadurch gekennzeichnet, daß zwei im Abstand voneinander angeordnete Schabelemente (6) axial entlang der Achse (2) angeordnet sind.

45

3. Rohrreinigungsgerät (1) zur Entfernung von harten Ablagerungen (13) auf der Innenseite (14) eines Rohres (11) nach Anspruch 1, dadurch gekennzeichnet, daß drei im Abstand voneinander angeordnete Schabelemente (6) axial entlang der Achse (2) angeordnet sind.

50

55

4. Rohrreinigungsgerät (1) zur Entfernung von harten

Ablagerungen (13) auf der Innenseite (14) eines Rohrs (11) gemäß irgendeinem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß an jedem besagten Schabelement (6) sich nach hinten erstreckende nach außen vorgespannte Finger (8) vorgesehen sind.

5. Rohrreinigungsgerät (1) zur Entfernung von harten Ablagerungen (13) auf der Innenseite (14) eines Rohres (11) gemäß irgendeinem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß jeder Schaufelabschnitt (9) einen bogenförmigen Schaufelrand (10) aufweist, der derart angeordnet ist, daß er die Innenseite (14) über 0,0762 mm bis 0,2286 mm (0,003 bis 0,009 Zoll) entlang eines Bogens des Schaufelrandes (10) berührt.

6. Rohrreinigungsgerät nach irgendeinem der vorangehenden Ansprüche, dadurch gekennzeichnet, daß das oder jedes Schabelement (6) ein aus Federstahl gestanztes Element (6) umfaßt.

7. Rohrreinigungsgerät nach Anspruch 6, dadurch gekennzeichnet, daß die Finger (8) des Schabelements (6) derart gebogen sind, daß sie einen Kreis bilden, wobei die Schaufelabschnitte (9) sich um eine Strecke von der Achse radial nach außen erstrecken, die größer als der Innendurchmesser des zu reinigenden Rohres ist.

8. Ein Rohrreinigungsverfahren zur Entfernung von Ablagerungen von der Innenseite der Rohrwand, wobei das Verfahren die Schritte des Einführens eines Rohrreinigungsgerätes gemäß irgendeinem der Ansprüche 1 bis 8 in das Rohr, wobei die Schaufelabschnitte (9) der Finger (8) nach außen in Kontakt mit der Innenseite des Rohres vorgespannt werden, und des Bewegens des Rohrreinigungsgerätes durch das Rohr umfaßt.

Revendications

1. Appareil de nettoyage de tubes (1) pour enlever des dépôts fins et durs (13) de la surface intérieure (14) d'un tube (11), comportant une tige (2) sur laquelle est disposé au moins un élément racleur (6), l'élément racleur ou chaque élément racleur (6) étant formé à partir d'une seule pièce de matériau et comportant plusieurs languettes élastiques (8) qui s'étendent globalement axialement par rapport à la tige (2) et qui sont contraintes radialement vers l'extérieur lors de l'utilisation de l'appareil de nettoyage de tubes (1), chaque languette (8) se terminant par une partie formant lame (9) qui s'étend radialement vers l'extérieur, caractérisé en ce que des languettes (8) voisines prévues sur un élément racleur (6) ont des longueurs différentes, et chaque partie formant lame (9) a une arête de lame arquée

(10) dont la forme est telle qu'il n'y a qu'un contact minimal avec la surface intérieure (14) du tube (11).

2. Appareil de nettoyage de tubes (1) pour enlever des dépôts durs (13) de la surface intérieure (14) d'un tube (11) selon la revendication 1, dans lequel deux éléments racleurs espacés (6) sont disposés axialement le long de la tige (2). 5

3. Appareil de nettoyage de tubes (1) pour enlever des dépôts durs (13) de la surface intérieure (14) d'un tube (11) selon la revendication 1, dans lequel trois éléments racleurs espacés (6) sont disposés axialement le long de la tige (2). 10

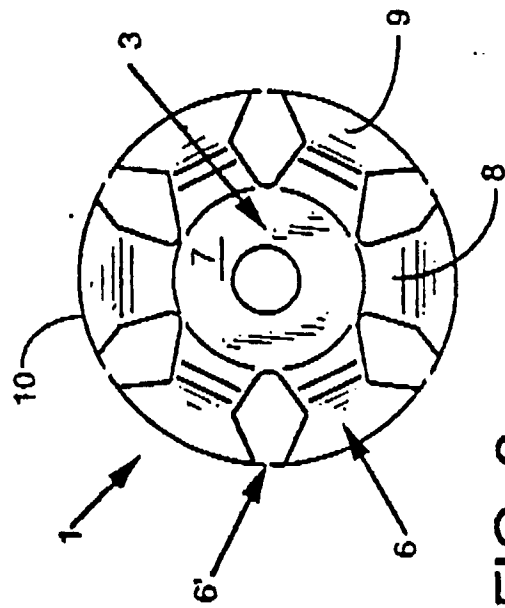
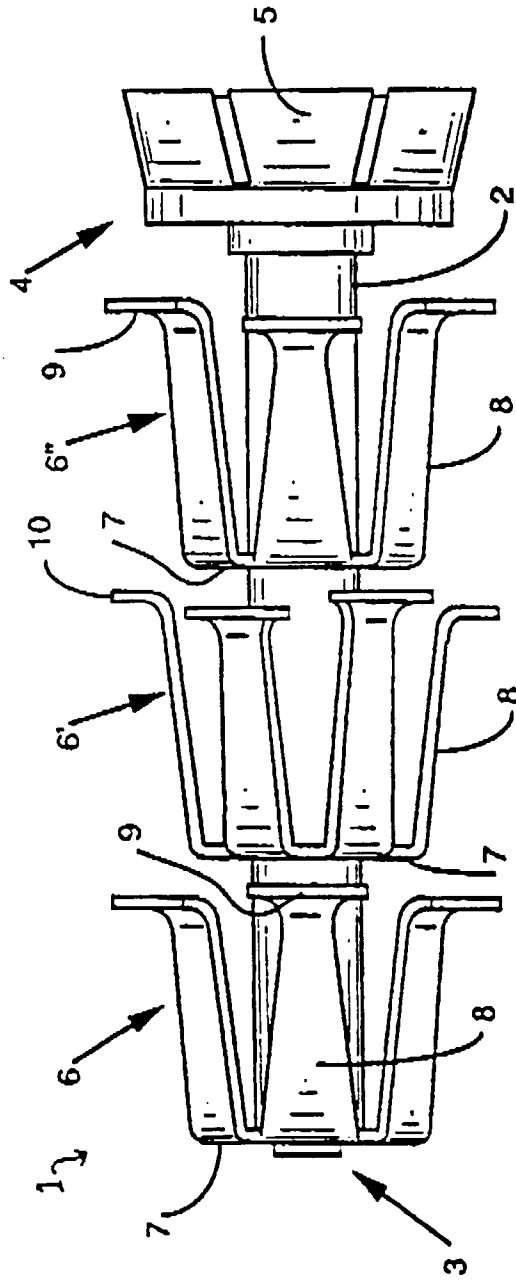
4. Appareil de nettoyage de tubes (1) pour enlever des dépôts durs (13) de la surface intérieure (14) d'un tube (11) selon l'une quelconque des revendications précédentes, dans lequel six languettes (8) s'étendant vers l'arrière et contraintes vers l'extérieur sont prévues sur chaque élément racleur (6). 15 20

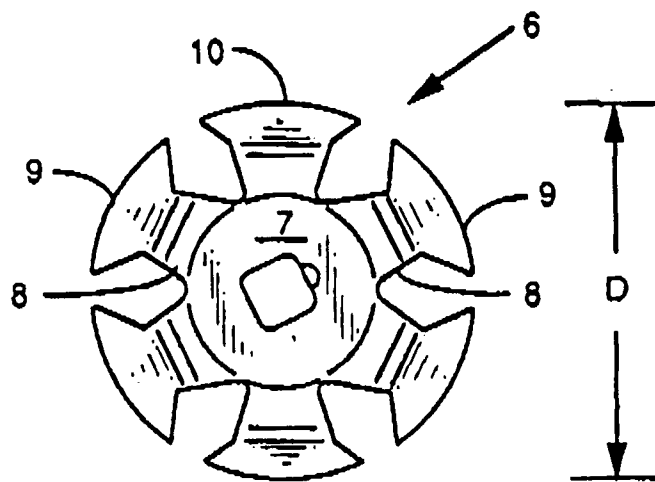
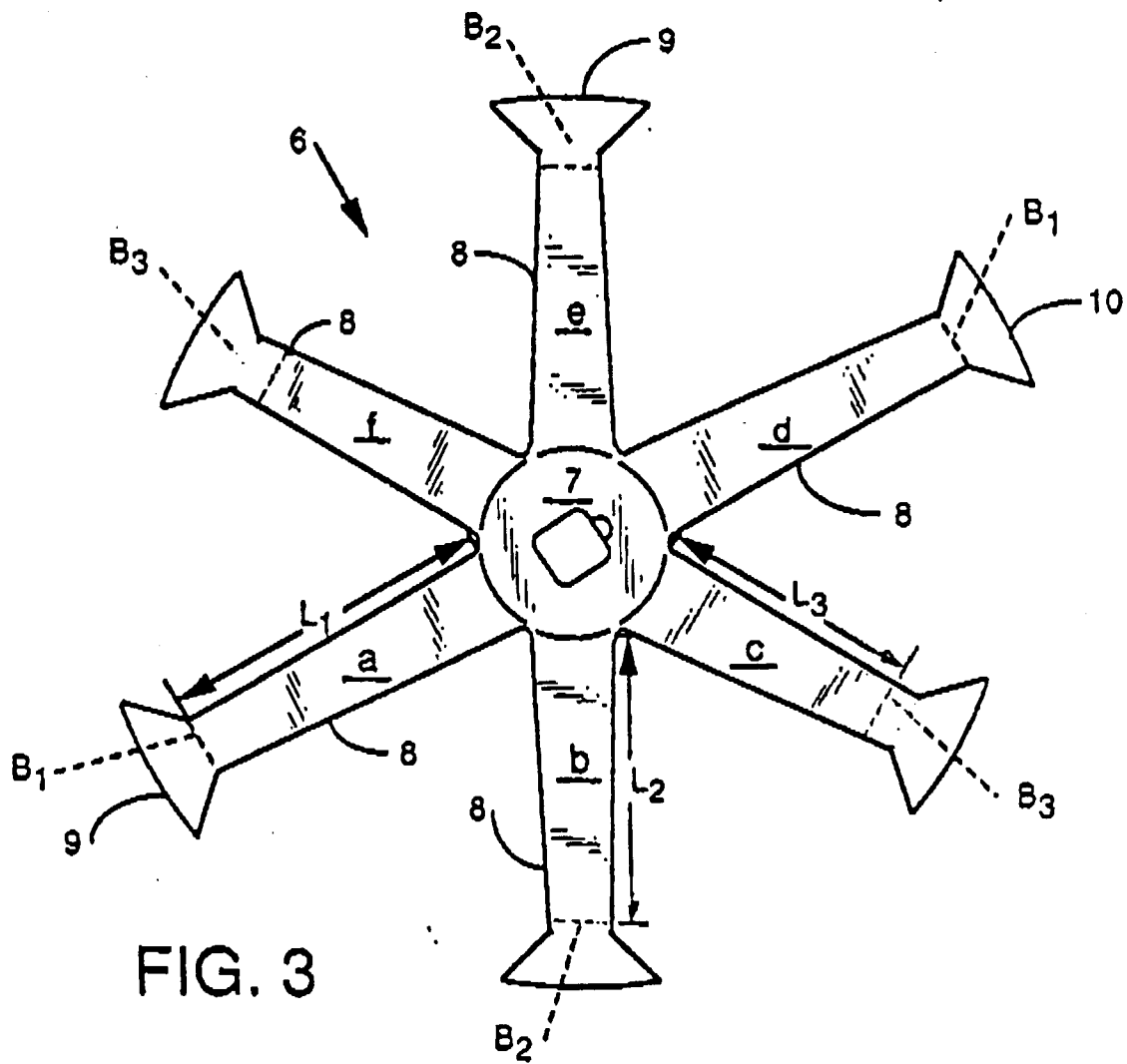
5. Appareil de nettoyage de tubes (1) pour enlever des dépôts durs (13) de la surface intérieure (14) d'un tube (11) selon l'une quelconque des revendications précédentes, dans lequel chaque partie formant lame (9) a une arête de lame arquée (10) qui est disposée de manière à venir en contact avec la surface intérieure (14) sur 0,0762 mm - 0,2286 mm (0,003 - 0,009 pouce) d'un arc de l'arête de lame (10). 25 30

6. Appareil de nettoyage de tubes selon l'une quelconque des revendications précédentes, dans lequel l'élément racleur ou chaque élément racleur (6) comprend un élément (6) découpé dans de l'acier à ressorts. 35

7. Appareil de nettoyage de tubes selon la revendication 6, dans lequel les languettes (8) de l'élément racleur (6) sont pliées de manière à former un cercle, les parties formant lames (9) s'étendant radialement vers l'extérieur, à partir de la tige, sur une distance supérieure au diamètre intérieur du tube à nettoyer. 40 45

8. Méthode de nettoyage d'un tube pour enlever des dépôts de la surface intérieure de la paroi de tube, qui consiste à introduire dans le tube un appareil de nettoyage de tubes selon l'une quelconque des revendications 1 à 7, les parties formant lames (9) des languettes (8) étant contraintes vers l'extérieur pour venir en contact avec la surface intérieure du tube, et déplaçant l'appareil de nettoyage dans le tube. 50 55





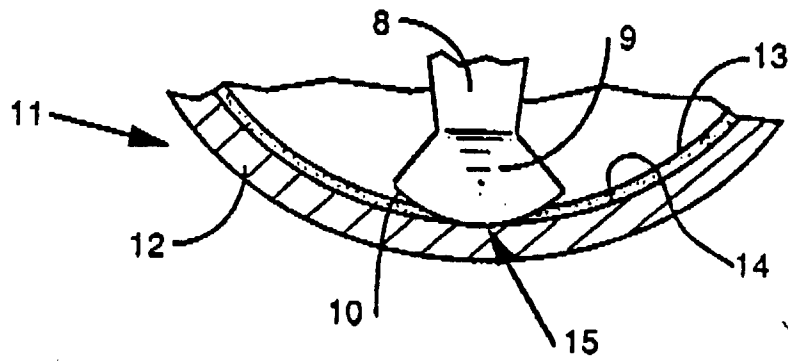


FIG. 5

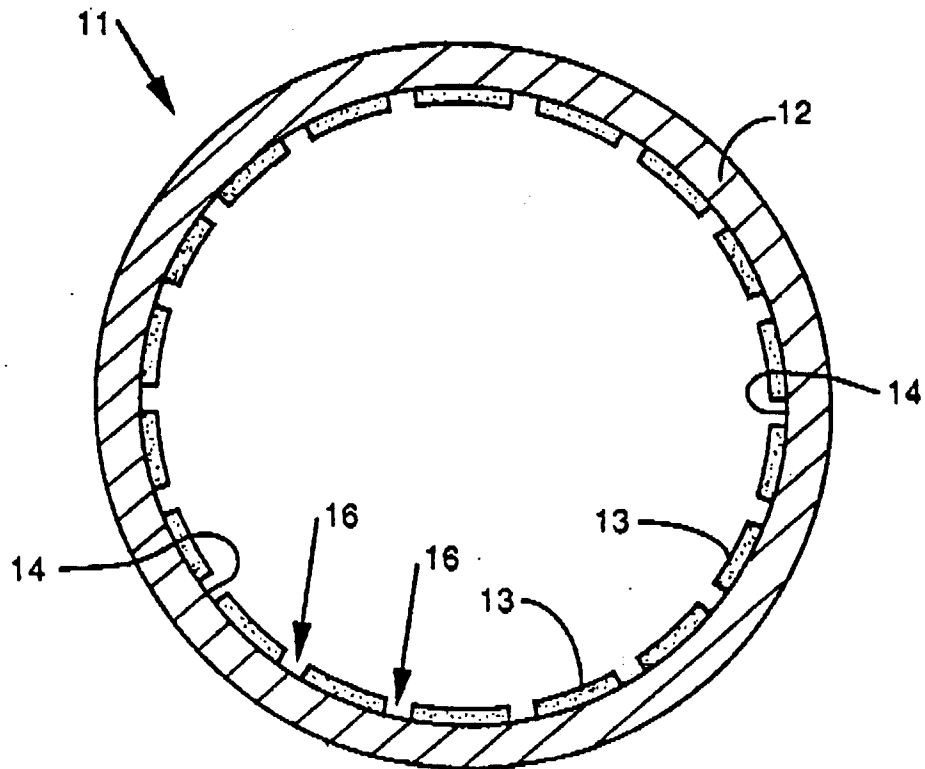


FIG. 6