Abstract: A pipe cleaning apparatus (10) is provided that is arranged for passage along a pipe during use. The apparatus (10) comprises a body (16) having an axis; and one or more cleaning members (20) depending outwardly from the body (16) and arranged for contact with an inner wall of a pipe to be cleaned. The apparatus (10) has flow diverting means (28, 18) oriented obliquely with respect to the axis of the body (16) so as to induce rotation of the body about said axis during passage of the apparatus (10) along a pipe during use.

Title: PIPE CLEANING APPARATUS
Pipe Cleaning Apparatus

The present invention relates to pipe cleaning apparatus and more particularly to a pipe cleaning apparatus for passage along a pipe so as to clean debris or residue from the inside of the pipe.

Such a pipe cleaning apparatus is often referred to as a pig. A pig of this type may be travel along the length of a pipe under the force of fluid pressure.

Conventional cleaning apparatus of this kind typically takes the form of a body arranged to fit within the pipe to be cleaned such that bristles or other cleaning formations depending outwardly from the body to contact the inner surface of the pipe. The frictional contact between the cleaning formations and the inside surface of the pipe cause cleaning or scouring of the pipe during passage of the body along the pipe in use.

A number of factors are known to influence the effectiveness of cleaning using a pig, such as, for example, the stiffness and length of the bristles; the degree of contact maintained between the bristles and inner surface of the pipe; and, the number or type or bristles arranged to pass over any given portion of the inner pipe surface.

It has been previously proposed to provide a plurality of cleaning members or sets of bristles along the body of a pig such that multiple cleaning actions are achieved by a single passage of the pig along the pipe. However the maximum length of a pig body is restricted due to the need for the pig to be able to pass along a non-linear pipe sections.

Thus the number of cleaning members which can be accommodated on a single body is limited by the dimensions of the pig body.

In addition, the unidirectional passage of a conventional pig along a pipe can lead to non-uniform cleaning due to a number of factors. For example a pig may have slight freedom of movement laterally within the pipe and may thus oscillate or jostle within the pipe as it passes therethrough with the result that opposing sides of the pipe may intermittently be cleaned to a greater or lesser degree. A pig may also be urged into one side of a pipe as it passes around bend or curves in the pipe, resulting in greater friction with one half of the pipe wall and lesser friction with the opposing half.
It is an object of the present invention to provide a pipe cleaning apparatus which offers an improved cleaning action.

According to the present invention, there is provided a pipe cleaning apparatus arranged for passage along a pipe during use, the apparatus comprising: a body having an axis; and one or more cleaning members depending outwardly from the body and arranged for contact with an inner wall of a pipe to be cleaned, wherein the apparatus has flow diverting means oriented obliquely with respect to the axis of the body so as to induce rotation of the body about said axis during passage of the apparatus along a pipe during use.

The rotation of the body may provide for an improved cleaning action due to the bi-directional motion of the body and cleaning members. The cleaning member may pass over the inside surface of the pipe both in the direction of travel and also in a direction perpendicular thereto. Thus the cleaning apparatus according to the present invention may be considered to have both a liner and rotational cleaning action.

In one embodiment, the cleaning members provide at least in part the flow diverting means. The cleaning members and/or flow diverting means may be twisted about the axis or body and may follow a substantially helical or spiral path about the axis or body.

In one embodiment, the invention may offer the advantage that a greater length or number of cleaning members may be accommodated along the body than when cleaning members are provided in straight lines. The duration of the contact between the cleaning members and any given point of the inside of the pipe may be increased.

The body may have a duct, bore or other form of fluid passage therein. The body may define a fluid passage aligned with the body axis. The fluid passage may open to the rear of the body. The fluid passage may be arranged to provide for fluid communication between the rear of the body and a radially outer surface of the body. The body may have a circumferential wall and one or more ducts or apertures may be provided therein. The ducts or apertures may be in communication with the fluid passage.

In one embodiment, the body permits passage of air from an internal passage of the body to the flow diverting means and/or cleaning members located on an outer portion of the body.
The body may have one or more ducts extending from the internal passageway radially outwardly so as to allow fluid flow to the flow diverting means and/or cleaning members. The one or more ducts may protrude radially into the internal passageway. This may provide a partial blockage or obstruction within the internal passageway for diversion of at least a portion of the flow through the internal passageway to the flow diverting means and/or cleaning members. This may assist in generating rotational movement of the cleaning apparatus.

The flow diverting means and/or cleaning members may comprise a plurality of individual components attached to the body. The body may have a mounting flange or other mounting formation for attachment of the flow diverting means and/or cleaning members thereto. The mounting flange may extend about the body in a helical fashion.

The cleaning members may be provided as a plurality of individual brush members arranged to be attached in a side-by-side or adjacent arrangement about the body. Thus the brushes may be provided in a modular format so as to allow for removal and replacement of individual brushes. The cleaning members may comprise a mounting or support portion, in which a plurality of bristle are held.

The apparatus may comprise flow control means which may be provided in a nose section of the apparatus. The flow control means may comprise a flow restriction such as a port or valve. In one embodiment the flow control means may additionally or alternatively comprise a frangible portion of the apparatus which is arranged to yield under certain flow conditions. For example the frangible nose portion may detach under application of pressure above a predetermined level or else the flow control means may be selectively actuable to prevent or reduce rotation of the body.

In one embodiment, one or more further flow control or flow obstruction members may be provided. Such members may be provided towards the front and/or rear of the flow diversion means and may depend outwardly from the body. A front flow obstruction member may be provided in a nose region of the apparatus and may comprise an annular or disk-like member. The flow control or obstruction member may comprise a resilient material and may comprise a seal. The front flow obstruction member may be planar in form and may be oriented substantially perpendicular to the axis of the device
when at rest and/or bluff to the direction of travel of the device. Typically the front flow
obstruction member is mounted forward of the cleaning members and/or flow diversion
means.

A rear flow control or flow obstruction member may be provided rearward of the cleaning
members. Either or both further flow control or flow obstruction members may be formed
so as to obstruct flow in one direction in preference to a second direction. A rear flow
obstruction member may be arranged to permit flow from the apparatus in a rearward
direction but prevent or inhibit flow in the reverse direction. The or each flow obstruction
member may have an opening therein to permit fluid flow through the centre of the flow
obstruction member in either direction.

The or each flow obstruction member may be formed of a pair of adjacent members
having openings or vents therein. The openings in one member may be offset from the
openings in the adjacent member. One of said members may have one or more ridges
or ribs therein for contact with the other member so as to space said members and to
define one or more flow channels therebetween. The or each member may be angled
away from the direction of travel of the apparatus and may be curved. The or each
member may take the form of a cone or skirt formation depending from the body.

The apparatus may comprise one or more further cleaning members. This may
comprise the front and/or rear flow obstruction members.

In one embodiment, the apparatus may comprise a nose and/or tail section which may
be connected to said body portion so as to allow relative rotation therebetween. The
nose and/or tail section may be connected to the body portion by a bearing. The nose
and/or tail section may comprise respective front and rear further cleaning members.
Thus the cleaning members on the body portion may be arranged to rotate during use
whereas the front and/or rear cleaning members may pass along a pipe during use
substantially without rotation or else with significantly less rotation compared to the body
portion.

Working embodiments of the present invention are described below in further detail with
reference to the accompanying drawings, of which:
Figure 1 shows a three-dimensional view of an apparatus according to a first embodiment of the present invention from the front;

Figure 2 shows a three-dimensional view of the apparatus of figure 1 from the rear;

Figure 3 shows a cross-sectional view of the apparatus of figure 1 through the body portion;

Figure 4 shows a plan view of the apparatus of figure 1 from the rear;

Figure 5 shows an exploded three-dimensional view of the rear cleaning or flow obstruction member;

Figure 6 shows a longitudinal sectional view of the apparatus of figure 1 taken though the axis of the apparatus;

Figure 7 shows a three-dimensional view of an apparatus according to a second embodiment of the present invention; and,

Figure 8 shows a longitudinal sectional view of the apparatus of figure 7 taken though the axis of the apparatus.

The present invention provides an apparatus suitable for cleaning pipes or any other kind of conduit for which a pig may conventionally be used.

Turning to figures 1 and 2, there is shown a pipe cleaning apparatus 10 having a first end 12 and a second end 14, which may be referred to hereinafter as respective front and rear ends. The terms 'front' and 'rear' are used with reference to the direction of travel of the apparatus during use.

The apparatus comprises a body portion 16 which is generally tubular in shape. A spiral or helical flange formation 18 protrudes outwardly of the generally cylindrical outer surface of the body. The flange formation is elongate in form and winds continuously about the body. The flange formation has a plurality of fixing formations for attachment of cleaning members 20 thereto. In this embodiment, the fixing formations take the form
of holes which can be aligned with corresponding fixing formations 22 on the cleaning members.

The cleaning members 20 take the form of a plurality of brush members which have a support structure 24 and a plurality of bristles 26 depending therefrom. The supports 24 house the bristles 26. The bristles 26 may be folded part way along their length and the folded end of the bristles may be trapped within the support structure such that the free ends of the bristles protrude therefrom.

The support structures 24 have a generally U-shaped channel therein for location on the flange 18. Holes in the support structure are provided in the side walls of the channel for alignment with the holes in the flange such that a screw or bolt or other fixing member can be used to fasten the support structure to the flange such that the bristles 24 depend radially outwardly from the body 16. Thus it will be appreciated that the brush members are modular in design and can be added to or removed from the body member individually as required.

Both the flange 18 and the brush members are of substantially uniform height such that the bristles of each brush member 20 terminate at approximately the same distance from the body 16. The combined flange 18 and cleaning members 20 define a helical flow path or channel for communication of a fluid between opposing ends of the body portion.

The body 16 and support structures 24 may be made of metal but other materials may be suitable such as for example plastics, dependent on the strength requirements of the apparatus and the characteristics of the pipe to be cleaned. The bristles may comprise metal or plastic strands, again dependent on the type of cleaning to be undertaken.

In figure 1, it can be seen that a plurality of ports 28 are provided towards the front end of the body 16. The ports 28 are tubular in shape and extend through the wall of the body to allow passage of fluid from the inside of the body 16 to the outside of the body wall.

At the front end of the body 16 there is provided a nose section 30. As can be seen in figure 6, the nose section 30 comprises a central bore 32 into which an end of the body is insertable. The body and bore 32 of the nose section preferably form a close fit. The nose section is fixed to the body by fixing means such as bolts 34 and/or welding. The
body may be formed, for example by casting, such that it has integral mounting formations for the nose section thereon.

The nose section 30 comprises front 36 and rear 38 nose cone members, between which are held first 40 and second 42 contact members. The first and second contact members are fixed between the nose cone portions by bolts 44 which pass through bores in the nose cone portions and correspondingly aligned openings in the retaining members.

The contact members are annular in form and may be mounted about the end of the body portion. The contact members may have a diameter dimension which is greater than the combined length of the flange and cleaning members 20 such that the contact members protrude radially from the body to a greater extent than the cleaning members 20 when in an at rest condition. The contact members may be slightly greater in diameter than the pipe to be cleaned such that the contact members deform slightly away from the direction of travel of the apparatus 10 as it passes along a pipe during use.

The contact members may be formed of a resilient material which may comprise a polymer such as a plastic or rubber. The contact members may act as a seal between the nose of the apparatus and the pipe wall during use.

The nose section 30 is shown as being generally hollow in figures 1 and 6. However it is intended that flow control means may be provided within the nose which may be located in the internal cavity thereof. The flow control means may comprise a plug or bung member which blocks the internal cavity of the nose so as to prevent flow therethrough. The plug or bung may be held within the nose by friction or else may be formed of a resiliently deformable material such that upon application of excessive pressure, the plug or bung member may yield to allow flow of fluid through the nose.

Additionally or alternatively, the nose may comprise a flow restriction to limit the flow of fluid therethrough. Thus the nose may be provided with an internal aperture having dimensions smaller than the diameter of the body so as to limit fluid flow therethrough. This may serve to prevent a build up of unwanted pressure behind the apparatus during use.
Additionally or alternatively, the nose portion may comprise valve means therein to
control the flow of fluid therethrough. The valve may be closed during normal operation
and may be selectively openable to prevent or control the build up of excessive pressure
to the rear of the apparatus.

Details of the rear of the apparatus 10 are shown in figures 1, 2 and 4 to 6. A rear or tail
formation 46 is provided at the rear of the apparatus. The tail formation 46 has a central
bore 48 into which an end of the body 16 is insertable. The body and bore 48 of the tail
section preferably form a close fit. The tail section may be fixed to the body by fixing
means such as bolts or welding. The body may be formed, for example by casting, such
that it has integral mounting formations for the tail section thereon.

The tail section 46 generally comprises a tail cone 50 and a pair of flow control members
52 and 54. The flow control members 52 and 54 and tail cone 50 have central apertures
for mounting on an end of the body 16. The flow control members 52 and 54 and tail
cone 50 have corresponding apertures 58 are fixed to the body by bolts 56 which pass
through the apertures 58 when aligned. The flow control members 52 and 54 are
sandwiched between the tail cone 50 and a mounting formation 60 on the body 16.

Each of the flow control members 52 and 54 generally takes the form of dish or bowl
shaped body which is curved in profile and which has apertures therein as described
above. Each of the flow control members 52, 54 also comprises a plurality of flow
control apertures 62 and 64 respectively which are spaced about the central aperture.

When mounted for use, the member 52 is positioned in front of member 54 such that
member 54 trails member 52 in the direction of travel of the apparatus. The flow control
apertures 62 are of generally larger dimensions, such as for example width dimensions,
than the corresponding dimensions of the apertures 64 in member 54.

As can be seen in figure 5, the surface of the member 54 which faces member 52 has
one or more circumferential ridges 66 therein. In this embodiment, two spaced ridges
are shown at different radii from the centre of the member. The ridges 66 protrude
towards the member 62 and maintain the spacing of the members so as to permit the
passage of fluid therebetween. The member 54 also has a series of radially oriented
slits 68 therein spaced about its periphery.
As can be seen in figure 4, the flow control members 52 and 54 are mounted for use such that the flow control apertures 62 and 64 are offset. Thus the degree of overlap is smaller than the area of the apertures themselves to provide a flow restriction as a fluid passes through those apertures. The apertures can be offset or aligned to suit the required flow conditions.

The tail cone 50 is tapered towards the central bore 48 so as to serve as a funnel for fluid entering the rear of the apparatus.

In this embodiment, the body 16 and the members 32, 36, 38, 40, 42, 46, 50, 52 and 54 are all aligned substantially coaxially about a central axis 70 (Fig. 6) of the apparatus which may be considered to be the axis of revolution of the pig.

With reference to figure 3, it can be seen that the cleaning members 20 are mounted adjacent one or more further cleaning members on the flange in a side-by-side arrangement such that the combined cleaning members, once mounted, form a substantially continuous helix shaped cleaning arrangement.

In figures 3, 4 and 6 it can be seen that in this embodiment a total of six radially extending and generally tubular ducts 28 are provided in the body 16. The ducts terminate within the internal bore of the body 16 and have angled side walls such that they extend into the fluid flow passing through the body as will be described below and serve as scoops to promote the passage of fluid therethrough. The plurality of ducts are spaced equally about the circumference of the body so as to present a maximum flow catchment area to fluid entering the rear of the body 16. It can be seen that the ducts 28 are also spaced longitudinally along the body 16, such that some ducts are located in front of the flange 18, whilst other ducts are located within the first or subsequent turns of the flange (i.e. within the fluid passage formed about the body by the flange and cleaning members 20). The openings of the ducts at their inner end are angled to face the direction of fluid flow through the apparatus.

Turning now to figure 6, the operation of the apparatus will be described. The apparatus 10 is located within a pipe of suitable diameter to be cleaned such that the bristles 26
contact the inner wall of the pipe and the nose faces in the direction of intended travel of the apparatus.

Fluid pressure is then provided to the rear of the apparatus to propel the pig along the pipe to be cleaned. The fluid to be used may vary between a liquid or a gas dependent on the intended use of the pipeline. The pressure of the fluid applied to the rear end of the device causes a reaction force in the device which propels the device along the pipe. Fluid is forced into the rear of the device and funnelled by tail cone and into the internal passageway in the body.

The pressurised fluid passes along the body and impinges on the openings of ducts which serve as scoops to divert the fluid flow to the space between the outer surface of the body and the inner wall of the pipe. The flow obstruction formed by sealing members ensures that the fluid passes in a rearward direction once outside the body such that the fluid is channelled along the helical passage by the flange and cleaning members. As the fluid impinges on the angled or curved wall of that channel, it causes a component of the resultant force to act in a direction perpendicular to the axis of the body. That is to say that the action of the fluid along the helical path formed by the flange and cleaning members induces rotation of the apparatus about the axis.

In the embodiment of figures 1 to 6, the fluid passes three times around the body portion within the helical channel prior to exiting the apparatus. However variable arrangements are possible in which the channel completes fewer or more passes or fractions of passes about the body.

The fluid then exits the apparatus to the rear through the apertures in members. It is to be noted that the arrangement of those apertures promotes passage of the fluid rearward in favour of in the reverse direction. This, in conjunction with the shape of the inner ends of the ducts and the tail cone ensures that fluid passes through the device in the correct direction as described above, rather than in the reverse direction.
In view of the fluid flow described above, the apparatus linearly along the pipe in use whilst simultaneously rotating about its axis. This has been found to generated an improved cleaning action over conventional pigs.

In the event that it is intended to reduce the speed and/or rotation of the pig, the flow control means described above in relation to figure 6 may be employed. This may provide a failsafe mechanism or else a control means for setting the apparatus to achieve a desired operational linear and/or rotational speed.

Turning now to figures 7 and 8, a further embodiment 100 of the invention is shown which is substantially the same as the embodiment of figures 1 to 6 except for the differences described below. In the embodiment of figures 7 and 8, the body portion 16 along with the associated flange 18 and cleaning formations 20 is arranged for rotation relative to the nose 30 and tail 48 sections.

Bearing formations 102 and 104 have been introduced in order to allow the body section to rotate independently or at least at a different rate to the nose and tail sections. The nose section 30 is connected to the body 16 by bearing 102 and the tail section 48 is connected to the opposing end of the body by bearing 104.

When the fluid is forced through the apparatus 100 in the manner described above, the rotational component of force applied to the body portion is substantially isolated from the nose and tail sections by the corresponding bearings. Thus the body portion tends to rotate whilst the nose and tail sections travel along the pipe substantially without rotation. This may provide an improved combined cleaning and/or clearing action of the apparatus.

In the embodiment of figures 7 and 8, the body 16 has been elongated to accommodate the bearings 102 and 104. however a more compact design may be achieved in which the length of the body is substantially the same as that for the embodiment of figures 1 to 6.

It will be appreciated that a bearing may be provided at only one end of the body portion in an alternative embodiment, such that either the nose or tail section rotates, whilst the other does not.
It is intended that any features described in relation to any one of the embodiments above are to be considered to be interchangeable as far as practicably possible with corresponding features of any of the alternative embodiments.

It will be appreciated that any reference to "cleaning" of pipes referred to within the present application is intended to refer to the process of passing an apparatus along the pipe to remove or dislodge material deposited on the inner wall of the pipe and/or debris within the pipe. It is not intended that the interpretation of the word "cleaning" be limited by any other chemical or mechanical actions which may be associated with other cleaning processes unless otherwise stated in this application.
Claims:

1. Pipe cleaning apparatus arranged for passage along a pipe during use, the apparatus comprising:
   a body having an axis; and
   one or more cleaning members depending outwardly from the body and arranged for contact with an inner wall of a pipe to be cleaned,
   wherein the apparatus has flow diverting means oriented obliquely with respect to the axis of the body so as to induce rotation of the body about said axis during passage of the apparatus along a pipe during use.

2. Pipe cleaning apparatus according to claim 1, wherein the cleaning members provide at least in part the flow diverting means.

3. Pipe cleaning apparatus according to claim 1 or 2, wherein the flow diverting means comprises one or more members depending outwardly from the body.

4. Pipe cleaning apparatus according to any preceding claim, wherein the flow diverting means follows a substantially helical path about the axis or body.

5. Pipe cleaning apparatus according to any preceding claim, wherein the flow diverting means comprises a flange formation and the one or more cleaning members mounted thereon.

6. Pipe cleaning apparatus according to any preceding claim, wherein the body has an internal fluid passage therein, said fluid passage being open to the rear of the body.

7. Pipe cleaning apparatus according to claim 6, wherein the body has one or more ducts therein for communication between the fluid passage and a space outside of the body so as to allow fluid to pass at least part way along the length of the body within the internal passage prior to exiting the body via the ducts.

8. Pipe cleaning apparatus according to claim 7, wherein the ducts are located downstream of the flow diverting means on the body so as to allow fluid passing through the ducts subsequently to the flow over the flow diverting means.
9. Pipe cleaning apparatus according to claim 6 or 7, wherein the ducts protrude radially into the internal passageway of the body so as to provide an at least partial blockage or obstruction within the internal passageway for diversion of at least a portion of the flow through the internal passageway through the ducts.

10. Pipe cleaning apparatus according to any preceding claim, wherein the flow cleaning members comprise a plurality of modular cleaning components which are independently attachable to and removable from the body.

11. Pipe cleaning apparatus according to any preceding claim, wherein the cleaning members comprise a plurality of individual brush members arranged to be attached in a side-by-side or adjacent arrangement about the body.

12. Pipe cleaning apparatus according to any preceding claim, further comprising flow control means to control the rate of fluid flow through the body and/or over the flow diverting means.

13. Pipe cleaning apparatus according to claim 12, wherein the flow control means comprises a flow restriction in the body such as a port or valve.

14. Pipe cleaning apparatus according to claim 12, wherein the flow control means comprises a frangible portion of the apparatus which is arranged to yield under application of pressure above a predetermined level.

15. Pipe cleaning apparatus according to any preceding claim, further comprising a flow obstruction member located upstream and/or downstream of the flow diversion means.

16. Pipe cleaning apparatus according to claim 15, wherein the flow obstruction member depends outwardly from the body and takes the form of a seal member for contact with the inner wall of the pipe to be cleaned.
17. Pipe cleaning apparatus according to claim 15 or 16, wherein the flow obstruction member is formed so as to obstruct flow in one direction in preference to a second direction.

18. Pipe cleaning apparatus according to any one of claims 15 to 17, wherein the flow obstruction member comprises a pair of adjacent resiliently deformable members of size greater than the diameter of the pipe to be cleaned such that the deformable members are maintained in a deformed condition within the pipe during use.

19. Pipe cleaning apparatus according to any one of claims 15 to 18, wherein the or each flow obstruction member has a central opening and one or more further openings located about the central opening, wherein the flow obstruction member is arranged to permit fluid flow through the central opening in a first direction and flow through the one or more further openings in an opposing direction.

20. Pipe cleaning apparatus according to any one of claims 15 to 18, wherein flow obstruction member serves a secondary cleaning member function.

21. Pipe cleaning apparatus according to any preceding claim, wherein the apparatus comprises a nose and/or tail section attached to said body portion by a bearing arrangement so as to allow relative rotation between the nose and/or tail section and the body.

22. Pipe cleaning apparatus substantially as hereinbefore described with reference to figures 1 to 6.

23. Pipe cleaning apparatus substantially as hereinbefore described with reference to figures 7 and 8.
Fig. 1