

(12) UK Patent Application (19) GB (11) 2 091 611 A

- (21) Application No 8102216
- (22) Date of filing 24 Jan 1981
- (43) Application published 4 Aug 1982
- (51) INT CL³ B28D 1/22
- (52) Domestic classification B3K 8 B5E 3
- (56) Documents cited None
- (58) Field of search B3K B5E
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(54) **Cutting of side connections in pipes**

(57) A method for re-establishing side connections 12 to an underground pipe 10 after the same has been lined with a rigid lining 28 of synthetic resin is disclosed, and in the method a cutter 56 of a unit 24 located in the pipeline senses automatically the

contour of the said connection aperture during the cutting operation thereby effectively and quickly to re-establish the side connection.

Sensing may be achieved by applying a matrix to the side connection aperture prior to the lining operation, or by other means such as detection of a change in cutting noise as the cutter touches the material of the pipe.

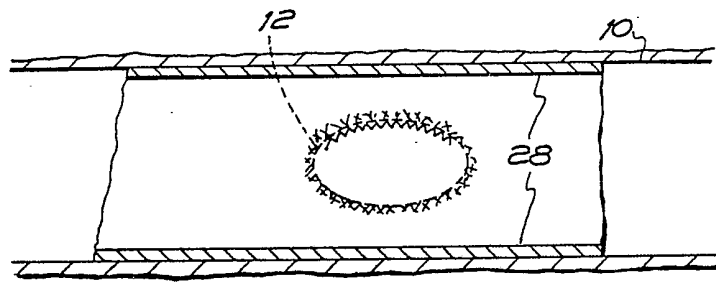


FIG. 2

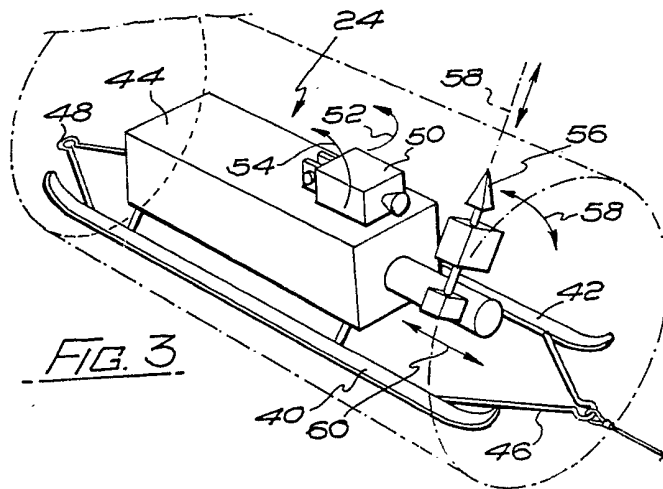
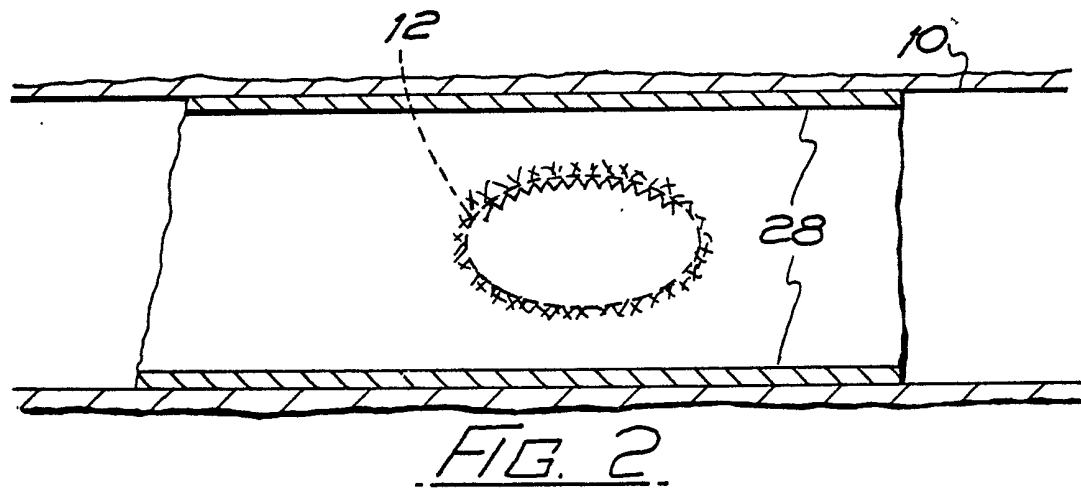
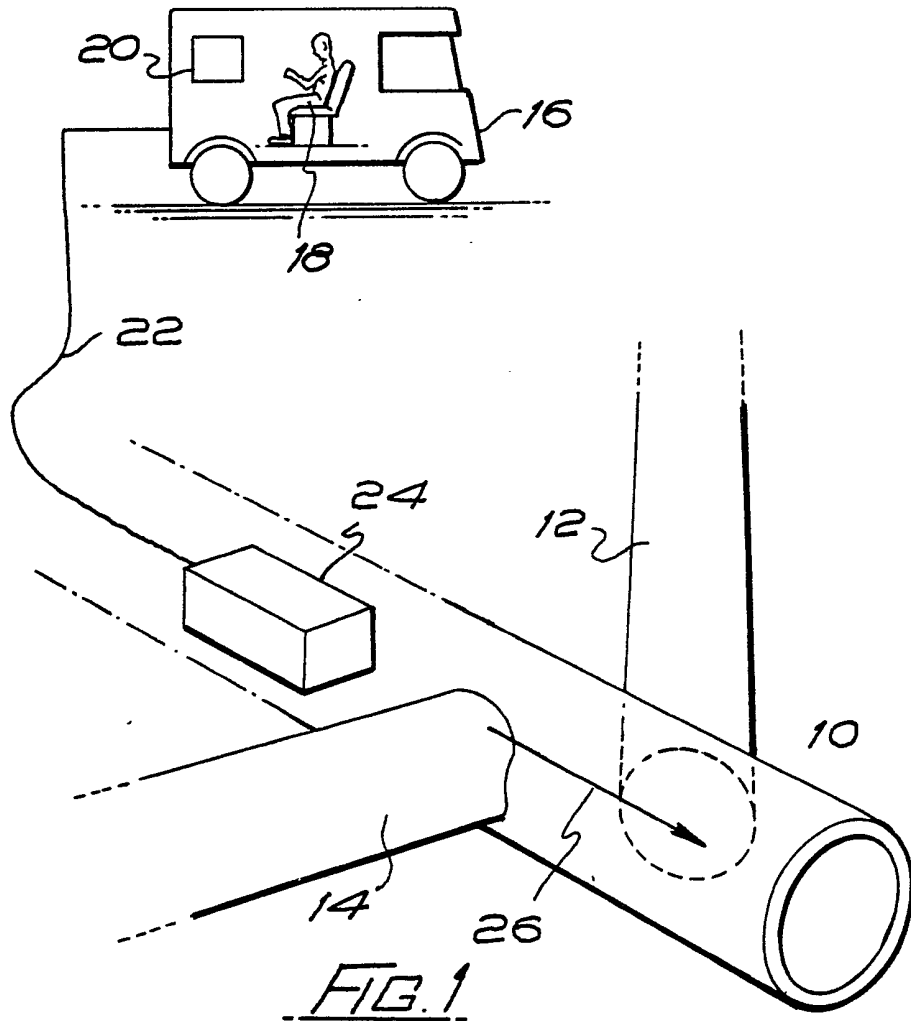


FIG. 3

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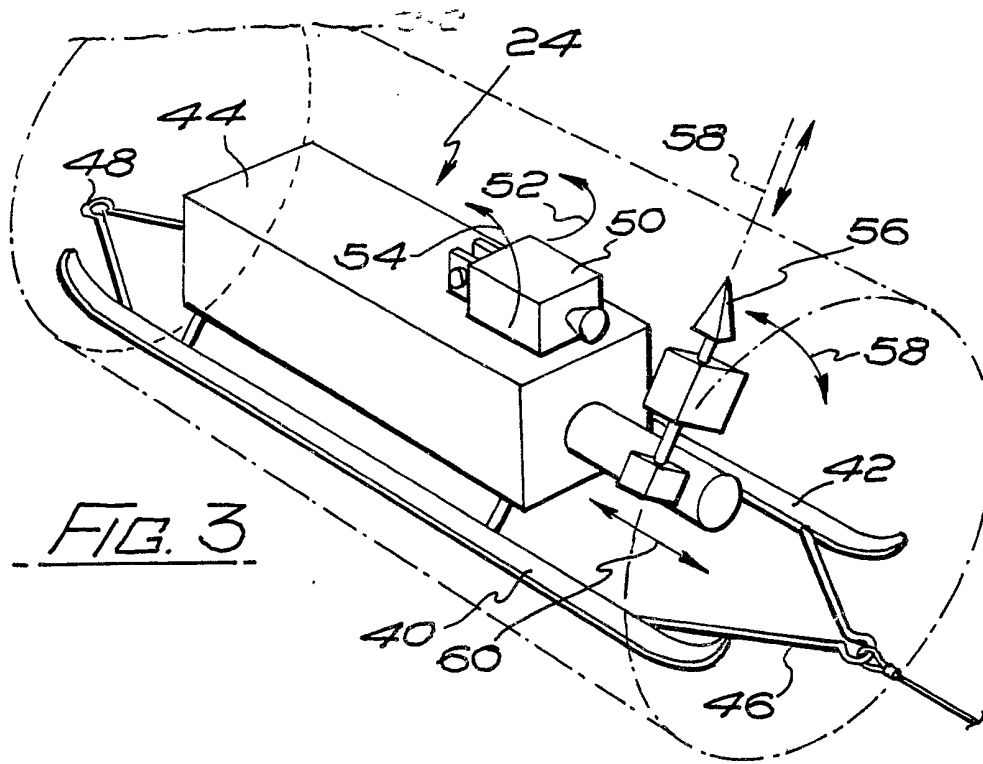


FIG. 3

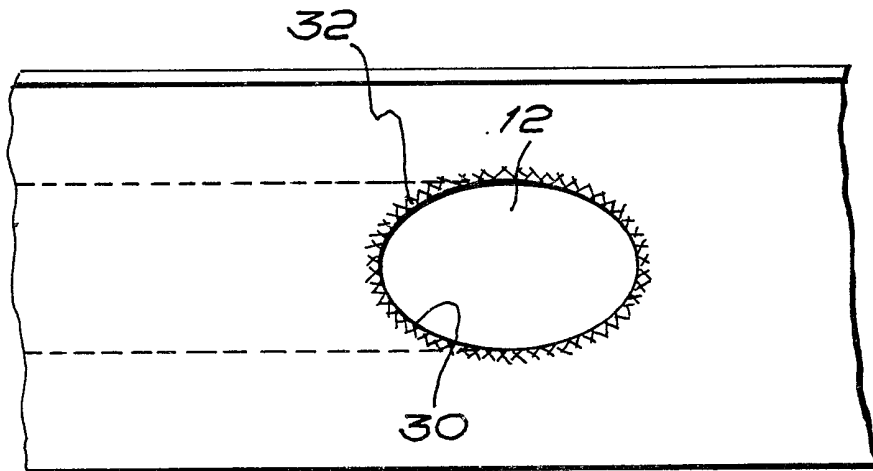


FIG. 4

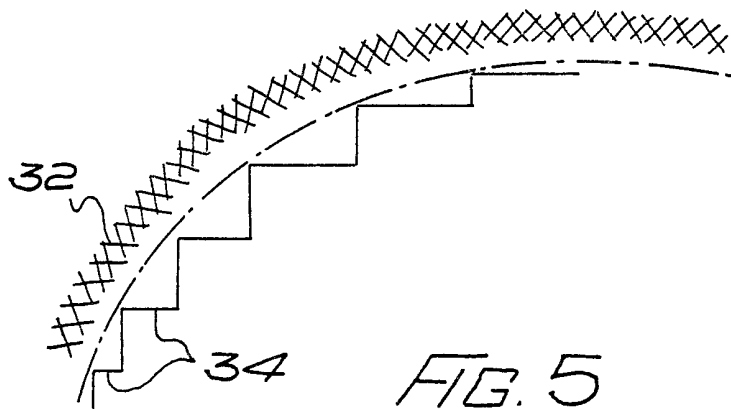


FIG. 5

SPECIFICATION

Cutting of side connections

This invention relates to a machine for the cutting of apertures in underground pipes, and in particular is concerned with the re-establishment of side connections to a pipe which has been lined by a lining process as described in either of our U.S. patents Nos. 4064211 and 4009063.

Generally speaking, in the said U.S. patents, an underground pipeline or passageway is lined by means of a flexible lining comprising a resin absorbent material, which is soaked in curable resin, and the lining whilst still flexible, is shaped to the passage interior, and is allowed to cure to form a hard lining, thereby to complete an effective lining operation.

As can be appreciated, in lining a pipeline in the above fashion, the lining material will extend over pipes, forming side or branch connections, and these must be re-established in order that the pipeline can function as it did prior to the lining operation. As can also be appreciated, the re-establishment of the side connections will entail cutting out or cutting away the portion of the lining which covers each side connection, and as the pipelines which are lined by the process in either of the above U.S. patents are invariably located underground, the matter of re-establishing the side connections is one of substantial difficulty.

Currently, an equipment is used for the re-establishment of said connections, which equipment is designed to cut away the portion of the lining covering each side connection to be re-established, such device comprising a unit which is for movement along the inside of the passageway, such unit having a T.V. camera which is controllable from ground level by a control means whereby the angle of viewing of the camera may be adjusted, enabling the camera to view each side connection location, and the region viewed by the camera is of course displayed at ground level on suitable display means, for example a T.V. monitor.

The unit also has a cutter which can be manipulated from ground level, and the operator controlling the re-establishment of side connection process simply manipulates the cutter by viewing the display means, thereby to re-establish the side connection. Whilst this procedure operates satisfactorily, it does have a number of problems, the first being that the process is extremely slow and depends upon the efficiency of the operator who has to judge (by viewing the T.V. screen) the cutting operation. Because it is quite possible that there will be liquid deposit of resin and/or water behind each portion of the lining covering a side connection, when the first penetrating cut is made in that portion of the lining, there frequently will be a discharge of said deposit into the pipeline or passageway, which can obscure the T.V. camera, making further cutting work extremely difficult. Also, it is difficult for the operator to judge whether or not he has cut

away sufficient of the lining material to restore the side connection to the size it was before the lining operation.

The present invention seeks to provide a method of re-establishment of side connections whereby the abovementioned disadvantages may be obviated or mitigated, and in accordance with the present invention, the method provides that the cutting unit is moved during cutting by the sensing of its position in relation to the contour of the side connection aperture, to follow that contour automatically.

By this arrangement, once the cutter has commenced the cutting operation there is no need for the operator continuously to monitor the cutting, and if there is discharge from behind the portion of the lining being removed, then such discharge will be of no consequence, as it is not necessary visually to monitor the cutting operation, and in fact the camera unit can be provided with a shutter which covers the lens after the commencement of the cutting operation, to protect the lens from such discharge.

The cutter may be arranged to follow the side connection contour automatically by providing the cutting unit or the control mechanism therefor with a sonic detector, to ensure that when the cutter touches the side connection pipe, the change in cutting tone will be detected, causing the cutter slightly to retract, and continuously to cut only the lining around the said contour. In an alternative arrangement, the region of the side connection prior to the lining operation may be sprayed with metallic powder or other means, enabling the contour to be detected conductively or electro-magnetically.

The cutter will have the same degree of movement as the cutter in the conventional unit, and the minimum movements required are that the cutter should be able to move axially of the passageway, and it should also be able to swing about an axis extending in the direction of or parallel to the axis of passageway.

The invention also provides equipment capable of carrying out the method as aforesaid.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, wherein:—

Fig. 1 is a diagrammatic perspective view of an underground pipeline to be lined, and to have the side connections subsequently re-established;

Fig. 2 shows in sectional elevation a portion of the pipeline shown in Fig. 1 at a side connection and after the lining of same;

Fig. 3 illustrates diagrammatically a camera and cutter unit usable in accordance with the present invention;

Fig. 4 shows the pipeline of Fig. 1 in sectional elevation, in the region of a side connection; and

Fig. 5 illustrates how the cutter follows the contour of the side connection in the re-establishment of same by cutting away the lining material.

Referring to the drawings, in Fig. 1 there is shown a pipeline 10 which is located

underground, and which is required to be lined with a flexible, resin impregnated lining in the manner as described in U.S. patent specifications Nos. 4064211 or 4009063 to rehabilitate the pipe, which may be in a state of disrepair, or to change the use of the pipe. The pipe may for example be a sewer pipe, and is shown as having side connections 12, 14. Fig. 1 also shows that there is located at ground level a control vehicle 16 in which an operator 18 sits. The vehicle is provided with a television monitor 20, for the inspection of the pipe as will be explained, and a control line 22 extends from the vehicle 16 to a camera and cutting unit 24 located in the pipe 10. This unit 24 is in use pulled or propelled through the pipe 10, for example as indicated by the arrow 26.

Fig. 2 shows in cross-section a portion of the pipe 10, in the region of the side connection 12, after the pipe 10 has been lined by means of a lining 28 which is of rigid, cured synthetic resin, having embedded therein a resin absorbent material such as a felt, the lining 28 extending across and covering the side connection opening. It is this side connection which must be re-established, and conventionally it is re-established by controlling a cutter when in the pipe 10, from the vehicle 16 by observing on the television 20, and by manipulating the cutter to reinstate the side connection 12. The present invention is concerned with a means for more effectively and positively re-establishing a side connection.

Prior to the placement of the lining 28, the camera and cutter unit 24 is drawn through the pipe 10 so as to survey the same and ascertain the position of the side connections, such as 12 and 14, along the length of the pipe 10. In accordance with the embodiment of the invention as depicted in Fig. 4, in addition to effecting the survey, in the region of each side connection, such as side connection 12 as shown in Fig. 4, the pipe in the region of the connecting aperture 30 has applied thereto a metallic or magnetic powdered compound 32, which may be in the form of a matrix, prior to replacement of the lining, so that such matrix can be detected or sensed during the subsequent cutting operation. This process is carried out for each side connection aperture.

When the survey has been completed, and each side connection aperture has been treated as indicated, the lining is placed in position and the resin allowed to cure.

To complete the operation, the said connections are re-established and to do this the cutter and camera unit 24 is again introduced into the pipe and is pulled or propelled therealong. At each side connection aperture, the unit 24 is stopped and the cutter thereof is caused to remove the portion of the lining covering the aperture, such as aperture 30, in an automatic and effective fashion by sensing the matrix 32, and following the contour of the matrix 32 by the automatic sensing.

Fig. 5 shows how the cutter removes in sensing the matrix 32. It moves in a series of steps 34

whilst penetrating the lining material, the steps occurring by virtue of the fact that the cutter is caused to retract slightly and automatically as it approaches the matrix 32, and the net result is that the cutter follows the contour of the aperture 30, and effectively and neatly removes the portion of lining material covering that aperture. In an alternative arrangement, the latter may be adapted to move back and forth across the opening 30, in the nature of a camming movement, to cut the lining material. Although the embodiment described shows the cutter as sensing a matrix containing conductive or magnetic particles, other sensing arrangements can be used. For example, the automatic sensing may be by means of audio detection. This is achieved in that as the cutter approaches the material of the pipe around the contour 30, there will be a change in the cutting noise as compared to when the cutter is cutting through the lining material only, and this change in noise can be detected to hold the movement of the cutter so that it follows the contour of the aperture 30 and therefore effects a neat and accurate removal of the portion of the lining covering aperture 30.

Fig. 3 illustrates diagrammatically a form of cutter and camera unit 24, which can be used in the process of the invention.

The unit is provided with a pair of skids 40, 42 which support a chassis 44 having the appropriate drive motors (not shown), and a pull shackle 46 is located at one end of the unit and is mounted on the skids 42, whilst a similar shackle 48 is provided on the unit and mounted at the other end of the skids 40, 42. A T.V. camera 50 is mounted on chassis 44, and is for viewing of the interior of the pipe 10 before and after lining is inserted, and this camera can pivot about 2 orthogonal axes, as shown by arrows 52 and 54, whereby any location of the pipe or lining can be viewed by the camera.

At one end of the chassis 44, is provided the cutter 56, which can be driven about the axis 58 to effect the cutting operation. Additionally, the cutter unit 56 can be pivoted about the axis of the pipe 10 or an axis parallel thereto as shown by arrow 58, and to give the cutter universal movement, the cutter can be moved axially of the pipe as indicated by arrow 60.

The various drives for the cutter and camera are mounted in the chassis 44 and therefore are not shown. These drives are controlled from the control vehicle 16 by the operator 18, and movement of the cutter is automatic as explained hereinbefore when the cutter is following the contour 30 of the side connection 12 or any other side connection.

It is preferred that the cutter should first penetrate the lining material at the centre of the aperture 30, or as near as possible to such centre, at the commencement of the cutting operation to re-establish the side connection, and then should be allowed to move radially outwardly until the side connection contour is sensed.

The method of the invention is extremely effective in accuracy and in saving time.

CLAIMS

1. A method of re-establishing side connections in a pipeline or passageway which has been lined with a rigid lining, by removing a section of the lining, wherein a cutting unit is placed in the pipeline or passageway and a cutter thereof is moved during the cutting of the portion of the lining covering side connection by the sensing of the cutters position in relation to the contour of the side connection aperture, to follow that contour automatically.

2. A method according to claim 1, wherein the sensing of the position of the cutter is achieved by detection of the cutting noise the frequency of which changes when the cutter touches the side connection contour, and such change in frequency is used to control the movement of the cutter

around the contour.

3. A method according to claim 1, wherein the side connection contour is treated with a material which can be sensed, such as a conductive or electro-magnetic material, prior to the insertion of the lining, and such material is used as the sensing means to control the movement of the cutter.

4. Apparatus for re-establishing side connections in pipelines or passageways which have been lined with a rigid lining by cutting away a section of the lining at said side connections, comprising a cutting unit for positioning in the passageway, and control means for controlling the movement of the cutter so that it follows the contour of the side connection opening during cutting.