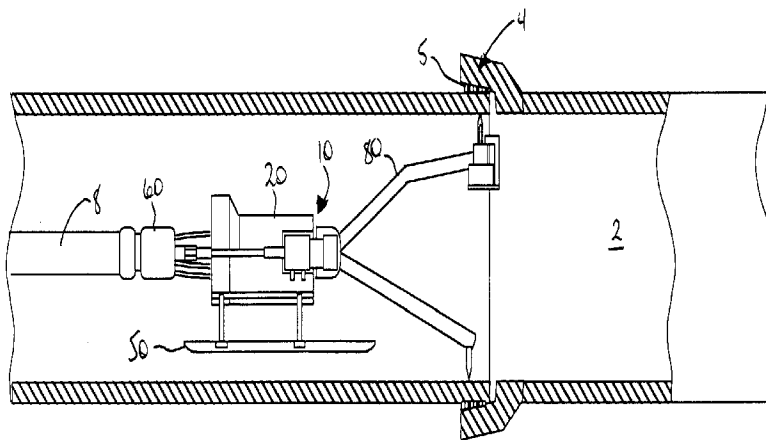




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(54) **DISPOSITIF SERVANT A REPARER LES TUYAUX**
(54) **DEVICE FOR REPAIRING PIPES**



(57) Dispositif utilisé pour réparer un tuyau par l'intérieur. Il comprend un corps et un dispositif de perforation qui y est installé. Le corps est muni de patins pour glisser sur la paroi du tuyau. Le dispositif de perforation possède des bras supérieur et inférieur, qui pivotent de la position fermée où ils occupent une surface radiale pas beaucoup plus grande que celle correspondant au diamètre du corps et une position ouverte où ils s'appuient sur des points essentiellement opposés de la paroi du tuyau pour stabiliser le dispositif de perforation à l'intérieur du tuyau. Dans la variante privilégiée utilisée pour réparer les joints de tuyaux, une tête de marteau hydraulique est appuyée sur la paroi du tuyau lorsque les bras sont en position ouverte et perce un trou destiné à recevoir le mécanisme de l'embout pour l'agent d'étanchéité installé sur le bras supérieur, qui se met en position au-dessus de la tête de marteau pour injecter un agent d'étanchéité dans le joint de tuyaux par le trou déjà percé et rendre le joint étanche.

(57) A device for repairing a pipe internally includes a body and a drill assembly mounted on the body. The body is provided with runners for gliding along the pipe wall. The drill assembly has upper and lower arms, pivotable between a closed position in which the arms occupy a radial area not substantially greater than a diameter of the body and an open position in which the arms bear against substantially opposing points of the pipe wall to stabilize the drill assembly within the pipe. In the preferred embodiment for repairing pipe joints a hydraulic drill head bears against the pipe wall when the arms are in the open position and drills a hole for a sealant nozzle mounted on the upper arm, which swings into position over the drill head to inject a sealant into the pipe joint through the drill hole and seal the joint.

Abstract

A device for repairing a pipe internally includes a body and a drill assembly mounted on the body. The body is provided with runners for gliding along the pipe wall. The drill assembly has upper and lower arms, pivotable between a closed position in which the arms occupy a radial area not substantially greater than a diameter of the body and an open position in which the arms bear against substantially opposing points of the pipe wall to stabilize the drill assembly within the pipe. In the preferred embodiment for repairing pipe joints a hydraulic drill head bears against the pipe wall when the arms are in the open position and drills a hole for a sealant nozzle mechanism mounted on the upper arm, which swings into position over the drill head to inject a sealant into the pipe joint through the drill hole and seal the joint.

Field of Invention

This invention relates to an apparatus for repairing pipes. In particular, this invention relates to a portable device for insertion into a cast iron pipe or the like for facilitating the location and repair of damaged or worn areas, particularly pipe joints, from within the pipe.

Background of the Invention

Underground pipelines are commonly used as fluid conduits for conveying fuels such as natural gas to residential, commercial and industrial users. Many existing pipelines are composed of sections of cast iron pipe connected by spigot joints, in which an end or "spigot" of one pipe section is interference-fitted into a "bell" or flared end of the next adjoining section, and the cavity between the bell and the spigot is filled with jute and lead for a gas-tight seal.

Over time some of the joints develop leaks due to ground settlement, vibration, yearly temperature cycles, corrosion etc., and must be repaired or replaced. Typically such pipelines are far too small for a person to enter, and as such repairs have conventionally required excavation of the pipeline. This is a costly and time-consuming process.

It is therefore advantageous to be able to effect repairs from inside the pipeline.

For example, an apparatus capable of carrying out pipe repairs from inside a pipe is disclosed in United States Patent No. 4,986,314 to Himmler. A working head provided with a tool holder is rotatably mounted on the front of a self-propelled trolley which can be inserted into a pipeline. A television camera allows the operator to locate damaged areas, and the tool holder can be fitted with the appropriate tool to effect repairs. The working head is rotatable circumferentially, to permit repairs on any part of the pipe wall. However, in this device the trolley is quite large and is provided with a locking device that enables the trolley to support and resist the force of the working head when grinding, cutting etc. inside a pipe, which requires a large cross-sectional

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body size that commensurately reduces the effective cross-sectional area of the pipeline when the device has been inserted. Accordingly, the device of U.S. Pat. No. 4,986,314 requires that the pipeline be shut down before repairs are undertaken. Moreover, this device will not fit through a typical opening in the pipeline, so the pipe must first be broken before the device can be introduced. These are significant disadvantages in the repair and maintenance of a fuel pipeline, particularly a natural gas pipeline.

The present invention provides a device for repairing pipes internally, which is particularly useful for the sealing of spigot joints. The device comprises a body supporting a drill assembly having upper and lower stabilizing arms which, when opened within a pipe, bear against diametrically opposite points of the pipe wall to stabilize the device. The upper arm is provided with a drill head for drilling into the pipe and a sealant nozzle mechanism for injecting a sealant through the drill hole. Preferably the drill assembly is rotationally fixed to the body so that it can be rotated within a predetermined arc to select the attitude of entry of the drill bit. A camera transmits images of the pipe interior to the operator, who can thus locate and repair successive pipe joints without the need for excavating.

The cross-sectional area occupied by the device of the present invention is relatively compact so as not to interfere with the flow of gas, which allows the device to be used within a "live" natural gas pipeline. The hydraulic drill assembly eliminates the need for a bulky, trolley-like structure for stability and to oppose the force of drilling. Mounting the drill head on the upper arm of the drill assembly provides significant control and precision in positioning the drill, which is important to ensure the effective dispersion of sealant within the pipe joint. These and other advantages will be apparent from the description of the invention which follows.

The present invention thus provides a device for repairing a pipe having a pipe wall, comprising a body and a drill assembly mounted on the body, the drill assembly comprising upper and lower arms, pivotable between a closed position in which the arms occupy a radial area not substantially greater than a diameter of the body, and an open position in which the arms bear against substantially opposing points of the pipe wall to stabilize the drill assembly within the pipe, a video system including a video camera mounted on the device and a video monitor remote from

the device, for locating a portion of the pipe to be repaired, and a rotating member for rotating a tool against the pipe wall when the arms are in the open position.

The present invention further provides a device for repairing a pipe joint, comprising a body and a drill assembly mounted on the body, the body being provided with runners for gliding along the pipe wall, the drill assembly comprising upper and lower arms, pivotable between a closed position in which the arms occupy a radial area not substantially greater than a diameter of the body, and an open position in which the arms bear against substantially opposing points of a wall of the pipe to stabilize the drill assembly within the pipe, a drill head for urging a drill against the pipe wall when the arms are in the open position to produce a drill hole, a video system including a video camera mounted on the device and a video monitor remote from the device, for locating a portion of the pipe to be repaired, a remotely operated control panel for controlling the device, and a sealant injection mechanism mounted on the upper arm for injecting a sealant into the pipe joint through the drill hole.

Brief Description of the Drawings

In drawings which illustrate by way of example only a preferred embodiment of the invention,

Figure 1 is a schematic side elevation of a device embodying the invention within a pipe with the drill assembly in a closed position,

Figure 2 is a schematic side elevation of a device embodying the invention within a pipe with the drill assembly in an open position for drilling,

Figure 3 is a perspective view of the body and umbilical cable adaptor of the device of Figure 1,

Figure 4 is an exploded perspective view of the body and umbilical cable adaptor of Figure 3,

Figure 5 is a side elevation of the body and umbilical cable adaptor of

Figure 3,

Figure 6 is a cross-sectional side elevation of the body and umbilical cable adaptor of Figure 3,

Figure 7 is a side elevation of a preferred embodiment of the drill assembly for the device of Figure 1,

Figure 8 is a top plan view of the drill assembly of Figure 7,

Figure 9 is a front elevation of the drill assembly of Figure 7,

Figure 10 is a top plan view of a preferred embodiment of the drill head,

Figure 11 is a cross-section of the drill head of Figure 10 taken along the line 11-11,

Figure 12 is a cross-section of the drill head of Figure 10 taken along the line 12-12,

Figure 13 is a top plan view of a preferred embodiment of the sealant nozzle mechanism for the device of Figure 1,

Figure 14 is a cross section of a the sealant nozzle mechanism of Figure 13, and

Figure 15 is a schematic view of a control system for the device of the invention.

Detailed Description of the Invention

A preferred embodiment of the device 10 of the invention is illustrated in Figures 1 and 2. The device 10 comprises a body 20 containing the electrical devices used in the operation of the device 10, and a drill assembly 80. The device 10 is adapted to be inserted into a cast iron pipe 2 or the like, to be fed along the pipe 2 until an area

requiring repair is reached. In the preferred embodiment adapted for repairing spigot joints 4, the device 10 drills into the pipe wall creating an access into the joint 5 within the clearance between the spigot and the bell, and injects a sealant into the joint 5. An umbilical cable adaptor 60 is provided to releasably couple the device 10 to an umbilical cable 8 supplying the hoses and electrical wires required to operate the device 10.

In the preferred embodiment of the device 10 of the invention the body 20 comprises a smooth stainless steel housing 22 with a back plate 24 forming a sealed enclosure containing a brushless drill motor 26. Front plates 34, 36 are bolted to the front end of the housing 22. The back plate 24 is provided with couplings 25 for the various hydraulic lines used by the device 10, a sealant hose, and a conduit containing electrical cables for the drill motor 26, gear motor 40 and lights 31, which connect through the umbilical cable 8 attached to the cable adaptor 60 to an operator control station 9.

The cable adaptor 60 likewise includes an adaptor housing 61 having a front plate 62 with a main coupling 64 and suitable openings 66 for the conduits and wires that feed the hydraulic oil, sealant and power to the body 20 from the umbilical cable 8, and a rear sleeve 67. The main coupling 64 connects to the back plate 24 of the body 20 at hinge 69, providing a limited-angle hinge action, as best seen in Figure 6, for accommodating entry into the pipe 2. The umbilical cable adaptor 60 allows the device 10 to be quickly and easily connected to and disconnected from the umbilical cable 8, which facilitates assembly, maintenance and repair and allows the same umbilical cable 8 to be used for devices 10 of different sizes.

The umbilical cable 8 is a semi-rigid conduit containing the hydraulic and sealant hoses and electrical wires necessary to operate the device 10. The umbilical cable 8 preferably comprises a protective nylon jacket containing a fibreglass rod surrounded by a PVC coating extending through the length of the cable 8, which imparts sufficient rigidity to the cable 8 to allow the device 10 to be fed down a pipe 2 without the cable 8 becoming entangled or bunching up within the pipe 2.

A miniature DC motor 40 with integral high-ratio planetary gearhead is mounted adjacent to the drill motor 26 and coupled to a crescent gear 42 which rotates

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a hollow shank 44 supporting the drill assembly mount 46. The drill assembly mount 46 can thus be rotated from a neutral position in which the drill assembly 60 is oriented substantially vertical, relative to the body 20, to a variable attitude in either direction of the neutral position, preferably in the range of approximately $\pm 45^\circ$. This allows the operator some flexibility in determining the point of entry into the pipe wall and facilitates drilling multiple holes if necessary for larger pipes 2. The drill assembly 80 attaches to pins 46a, 46b projecting from the side of the drill assembly mount 46 by bolts 47 and thus projects forwardly on one side of the housing 22, leaving an unobstructed view for the miniature video camera 30 which is mounted by clip 30a into a recess 28 on the other side of the housing 22. Preferably the video camera 30 is permanently attached to the umbilical cable 8, and is mounted to the body 20 when the device 10 is coupled to the cable 8 with the video cable concealed within a groove 27 in the housing 22.

Preferably also the device 10 includes two sets of lights 31, one set underneath the drill assembly mount 46 and one set on the upper arm 84 of the drill assembly 80, operated independently by separate switches at the operator control station 9: a first set for illuminating the inner wall of the pipe 2, the pipe joint 4 and front portions of the drill assembly 80 from the camera side of the housing; and a second set for illuminating the pipe wall and joint 4 from in front of the drill head 100, which preferably includes light pointers used to precisely locate the drill head 100 for drilling.

The drill motor 26 rotates a shaft 32 which extends coaxially through the hollow shank 44 and out of the drill assembly mount 46 to rotate the rotating member, in the preferred embodiment a drill head 100, as described below, through a flexible shaft 48 composed of a suitably strong material such as fibreglass or a semi-rigid polymer. The flexible shaft 48 may also be formed from a steel spring or the like.

The body 20 comprises a pair of retractable skis or runners 50 which support the body 20, preferably such that the axis of the shaft 32 is approximately aligned with the nominal axis of the pipe 2. The height at which the body 20 is supported thus varies according to the inside diameter of the pipe 2 intended to be repaired. The runners 50 should be rigid and suitably strong, and as smooth as possible to avoid friction against the pipe wall or becoming snagged in debris within the pipe 2.

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The runners 50 are preferably formed from stainless steel, but certain other materials may also be suitable. The runners 50 are preferably symmetrically spaced approximately 120° about the vertical centre of the body 20.

The runners 50 are fixed to the housing 22 by struts 52, the length of which is selected according to the desired height of the body 20 within the pipe 2, which are pivotally secured to the runners 50 at one end and pivotally secured to the housing 22 at the other end. This allows the runners 50 to retract forwardly into grooves 23 formed axially along the housing wall, as shown in Figure 5. The runners 50 are moved between the extended and retracted positions by a runner actuator comprising hydraulic cylinder 51 mounted inside the housing 22.

The drill assembly 80, illustrated in Figures 7 to 9, comprises a caliper-shaped clamp comprising upper and lower stabilizing arms 84, 86, which respectively mount onto pins 46a and 46b projecting laterally from the drill assembly mount 46. A drill assembly actuator comprises hydraulic cylinder 88 mounted between the arms 84, 86 to actuate movement between the open and closed positions. The cylinder 88 is preferably formed in or mounted on the lower arm 86, with its piston 89 pivotally connected to the upper arm 84 by a slotted shackle 82, as shown in Figure 7. The arms 84, 86 are thus pivotable by the operator between the closed position shown in Figure 1 and the open position shown in Figure 2.

An upwardly projecting stabilizing pin 92 is provided adjacent to the end of the upper arm 84, and a downwardly projecting stabilizing pin 94 is provided adjacent to the end of the lower arm 86, so that when the arms 84, 86 are extended to the open position the pins 92, 94 bear on substantially diametrically opposite points of the inner wall of the pipe 2 to stabilize the drill assembly 80. In the closed position the arms 84, 86 occupy a radial area not substantially greater than the diameter of the body 20, and preferably smaller than the diameter of the body 20. This allows the device 10 to be inserted into a small opening in the pipe and to avoid accumulations of debris and corrosion as the device 10 is being fed along the pipe 2.

The drill assembly 80 provides a rotating member for working a rotary tool against the pipe wall. In the preferred embodiment illustrated for repairing a pipe

joint 4, the rotating member comprises a drill head 100 rotating a drill bit 102. The drill head 100, illustrated in Figures, 10 to 12, is mounted on the upper arm 84 oriented such that the drill bit 102 is directed upwardly and aligned substantially along the direction of motion of the upper arm 84.

The drill head 100 comprises a miniature right-angle gear box 104 driven by the flexible shaft 48, mounted on top of a drill actuator comprising a two-stage telescoping hydraulic cylinder 106 which, when actuated, urges the drill bit 102 against the pipe wall. Preferably the shaft 48 drives the bit 102 at a 3:1 speed reduction (torque multiplication), providing the drill bit 102 with the torque necessary to bore into cast iron and other hard materials. A pair of tension springs 110 provides a retractive force operating in conjunction with the hydraulic cylinder 106, to assist in retracting the drill bit 102 after drilling.

As shown in Figures 8 and 9, the upper stabilizing pin 92 is preferably supported on a brace 93 affixed to the upper arm 84 near the position of the drill head 100, on the side of the device 10 opposite to the camera 30. The upper pin 92 is thus offset from the vertical centre of the body 20, leaving the camera 30 with an unobstructed view. The lower stabilizing pin 94 is offset commensurately toward the opposite side of the vertical centre of the body 20. In this fashion the stabilizing pins 92, 94, although offset to opposite sides of the vertical centre of the device 10, are in substantial diametric opposition from one another with the drill head 100 generally centred horizontally therebetween.

In the preferred embodiment the drill assembly 80 includes a sealant injection nozzle mechanism 120, shown in Figures 13 and 14, mounted on the upper arm 84 adjacent to the drill head 100. The sealant injection nozzle mechanism 120 includes a sealant injection nozzle 130 comprising a cylindrical head 131 with a frustoconical bearing face 132 having a nipple 134 approximating the size of the drill bit 102 projecting above the bearing face 132 and surrounded by a gasket 136. A seating hole 138 bored in the head 131 is slightly larger than the drill bit 102, allowing the nozzle 130 to be seated over the drill bit 102 after the hole has been drilled. Sealant enters the nozzle 130 through a sealant hose (not shown) coupled to an oblique bore 140 communicating with a sealant outlet port 142 centred in the nipple 134.

The sealant nozzle 130 is affixed to or formed as part of a tubular arm 144 mounted in telescoping relation over a support arm 146, which in turn is pivotally mounted on the upper arm 84 of the drill assembly 80. As shown in Figure 13, the sealant nozzle mechanism 120 can swing from a rest position adjacent to the drill head 100 (shown in phantom lines) into a working position directly over the drill head 100 (shown in solid lines). The lower limit of the sealant nozzle 130 is thus disposed slightly higher than the tip of the drill bit 102 when the drill head 100 is fully retracted, so that the nozzle 130 can clear the tip of the drill bit 102 allowing the sealant nozzle mechanism 120 to swing between the rest position and the working position. A hydraulic cylinder 122 is mounted to the upper arm 84 with its piston 124 articulatively connected to the support arm 146 through linkage 126, allowing the operator to control the position of the sealant nozzle mechanism 120. In the working position the sealant nozzle 130 is thus urged into position against the drilled hole by the drill actuator 106.

The sealant pumps 11 are preferably controlled by a multi-position rotary switch, allowing sealant to be injected at any desired pressure, preferably in the range between 10 and 90 PSI, controlled in 10 PSI increments.

A preferred embodiment of the control system for the device 10 is illustrated schematically in Figure 15. The control system for the device 10 is a modified version of the control system described in United States Patent No. 5,527,169 issued June 18, 1996, which is incorporated herein by reference.

The operation of the invention will be described in the context of the repair of a pipe joint 4. The umbilical cable 8 is attached to the adaptor 60, the hydraulic and sealant hoses and electrical wires are connected to the designated couplings 25 and fed through designated openings 24. The video camera 30 is mounted into the recess 28. If necessary the operator sets the arms 84, 86 to the closed position illustrated in Figure 1 and retracts the runners 50 into the grooves 23.

The operator then inserts the device 10 into a pipe 2 through an existing opening or through an opening drilled for this purpose, and activates the video camera 30 and lights 31. The operator feeds the device 10 along the inside of the pipe 2 by manual or mechanical feeding of the umbilical cable 8, watching the monitor 12 as the

device 10 progresses down the pipe 2. The cable is fed carefully to ensure that the device 10 remains substantially upright as it progresses along the pipe 2. A suitable device for feeding the umbilical cable down a pipe is described in published Canadian patent application no. 2,177,127 filed May 22, 1996, which is incorporated herein by reference, however any suitable manual or mechanical means for feeding the device into the pipe 2 may be employed and the invention is not intended to be limited in this respect.

When a pipe joint 4 is located, the operator feeds the device 10 to a position at which the drill head 100 is immediately beneath the spigot. The operator rotates the drill assembly 80 if necessary to select the appropriate drilling target (which is generally near the top of the spigot) and opens the arms 84, 86 until the pins 92, 94 bear against substantially opposing points on the interior of the pipe wall, thus anchoring the drill assembly 80 in position. The operator starts the drill motor 26, rotates the drill bit 102 through flexible shaft 48 and gear box 104. The operator actuates the drill actuator 106, forcing the drill bit 102 against and into the pipe wall, penetrating the spigot 4. The length of the drill bit 102 is selected to ensure that only the spigot is drilled and penetration into the bell 6 is avoided.

The operator fully retracts drill actuator 106 and deactivates the drill motor 26. The operator then swings the sealant nozzle mechanism 120 into the working position, with the sealant nozzle 130 over the drill bit 102. The operator again extends the drill actuator 106, and when the drill bit 102 is fully inserted into the seating hole 138 the tubular arm 144 begins to extend until the bearing face 132 of the sealant nozzle 130 contacts the pipe wall, with the nipple 134 projecting into the drill hole in the spigot 4 and the gasket 136 providing a seal therebetween. The operator then activates the sealant injection pumps 11 to inject sealant into the joint 5.

When the operator detects on the video monitor 12 seepage or spillage of sealant from the joint 4, the sealant injection pump is deactivated and the drill actuator 106 is retracted. The sealant nozzle mechanism 120 is retracted back to the rest position. The arms 84, 86 are pivoted to the closed position and the device 10 can be fed further down the pipe 2 for additional repairs or, if the repair operation is complete, the umbilical cable can be drawn onto a reel (not shown) and the device 10 thus drawn out

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of the pipe 2. As the device nears the access opening the runners 50 are retracted into the grooves 23 in the housing 22, and the device 10 is drawn through the access opening and cleaned off for future use.

A preferred embodiment of the invention having been thus described by way of example only, it will be apparent to those skilled in the art that certain modifications and adaptations may be made without departing from the scope of the invention, as set out in the appended claims. For example, it will be appreciated that the device 10 of the invention can be fitted with rotary tools other than a drill bit 102, for locating and effecting repairs inside the pipe 2 such as grinding, clearing debris and the like, and the description of the device 10 in the context of a device for repairing pipe joints 4 is illustrative of the operation of the device and not intended to be limiting.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A device for repairing a pipe having a pipe wall, comprising

 a body and a drill assembly mounted on the body,

 the drill assembly comprising upper and lower arms, pivotable between a closed position in which the arms occupy a radial area not substantially greater than a diameter of the body, and an open position in which the arms bear against substantially opposing points of the pipe wall to stabilize the drill assembly within the pipe,

 a video system including a video camera mounted on the device and a video monitor remote from the device, for locating a portion of the pipe to be repaired, and

 a rotating member for rotating a tool against the pipe wall when the arms are in the open position.
2. The device of claim 1 in which the rotating member is a drill head and the tool is a drill bit.
3. The device of claim 2 in which the drill head comprises a telescoping drill actuator for urging the drill bit against the pipe wall.
4. The device of claim 1 in which the upper arm is pivotally mounted on the side of a drill assembly mount projecting from the body.
5. The device of claim 4 in which the lower arm is pivotally mounted on the side of a drill assembly mount projecting from the body.
6. The device of claim 5 in which the drill assembly is pivotable between the open and closed positions by a hydraulic actuator mounted between the upper arm and the lower arm.

7. The device of claims 1, 2 or 3 in which the drill bit is rotated by a flexible shaft actuated by a motor contained within the body.
8. The device of claim 7 in which the drill bit is rotated by a gear mechanism coupled to the flexible shaft to increase the torque on the drill bit.
9. The device of claim 7 in which a sealant injection mechanism is mounted on the upper arm.
10. The device of claim 9 in which the sealant injection mechanism is pivotally mounted and adapted to pivot between a rest position adjacent to the drill head and an operating position in which sealant injection nozzle is disposed above the drill head.
11. The device of claim 10 in which a lower end of the sealant injection nozzle is provided with a seating bore adapted to receive the drill bit, and the drill actuator raises the sealant injection mechanism causing the sealant injection nozzle to bear against the pipe wall.
12. The device of claim 11 in which the sealant injection mechanism comprises a telescoping tube which extends as the drill actuator is actuated.
13. The device of claim 12 in which the drill actuator comprises a two-stage telescoping hydraulic cylinder.
14. The device of claims 1 or 2 in which the upper arm and lower arm are each provided with stabilizing pins which contact the pipe wall when the drill assembly is in the open position.
15. The device of claims 1 or 2 in which the body is provided with runners for gliding along the pipe wall.
16. The device of claim 15 in which a pair of runners are spaced about a vertical centre of the body.

17. The device of claim 16 in which the runners are retractable into grooves formed in the body.

18. The device of claims 1 or 2 the drill assembly is rotatable about an axis of the drill assembly.

19. The device of claim 18 in which the drill assembly is mounted on a hollow shank through which a shaft for rotating the rotatable member is disposed.

20. A device for repairing a pipe joint, comprising

a body and a drill assembly mounted on the body,

the body being provided with runners for gliding along the pipe wall,

the drill assembly comprising upper and lower arms, pivotable between a closed position in which the arms occupy a radial area not substantially greater than a diameter of the body, and an open position in which the arms bear against substantially opposing points of a wall of the pipe to stabilize the drill assembly within the pipe,

a drill head for urging a drill against the pipe wall when the arms are in the open position to produce a drill hole,

a video system including a video camera mounted on the device and a video monitor remote from the device, for locating a portion of the pipe to be repaired,

a remotely operated control panel for controlling the device, and

a sealant injection mechanism mounted on the upper arm for injecting a sealant into the pipe joint through the drill hole.

21. The device of claim 20 in which the drill head comprises a telescoping drill actuator for urging the drill bit against the pipe wall.

22. The device of claim 21 in which the upper arm is pivotally mounted on

the side of a drill assembly mount projecting from the body.

23. The device of claim 22 in which the lower arm is pivotally mounted on the side of a drill assembly mount projecting from the body.

24. The device of claim 23 in which the drill assembly is pivotable between the open and closed positions by a hydraulic actuator mounted between the upper arm and the lower arm.

25. The device of claim 20 in which the drill head is rotated by a flexible shaft actuated by a motor contained within the body.

26. The device of claim 24 in which the drill head is rotated by a gear mechanism coupled to the flexible shaft to increase the torque on the drill bit.

27. The device of claim 20 in which the sealant injection mechanism is pivotally mounted and adapted to pivot between a rest position adjacent to the drill head and an operating position in which sealant injection nozzle is disposed above the drill head.

28. The device of claim 27 in which a lower end of the sealant injection nozzle is provided with a seating bore adapted to receive the drill bit, and the drill actuator raises the sealant injection mechanism causing the sealant injection nozzle to bear against the pipe wall.

29. The device of claim 28 in which the sealant injection mechanism comprises a telescoping tube which extends as the drill actuator is actuated.

30. The device of claim 29 in which the drill actuator comprises a two-stage telescoping hydraulic cylinder.

31. The device of claim 20 in which the upper arm and lower arm are each provided with stabilizing pins which contact the pipe wall when the drill assembly is in the open position.

32. The device of claim 20 in which the runners are retractable into grooves formed in the body.
33. The device of claim 20 the drill assembly is rotatable about an axis of the drill assembly.
34. The device of claim 33 in which the drill assembly is mounted on a hollow shank through which a shaft for rotating the drill is disposed.

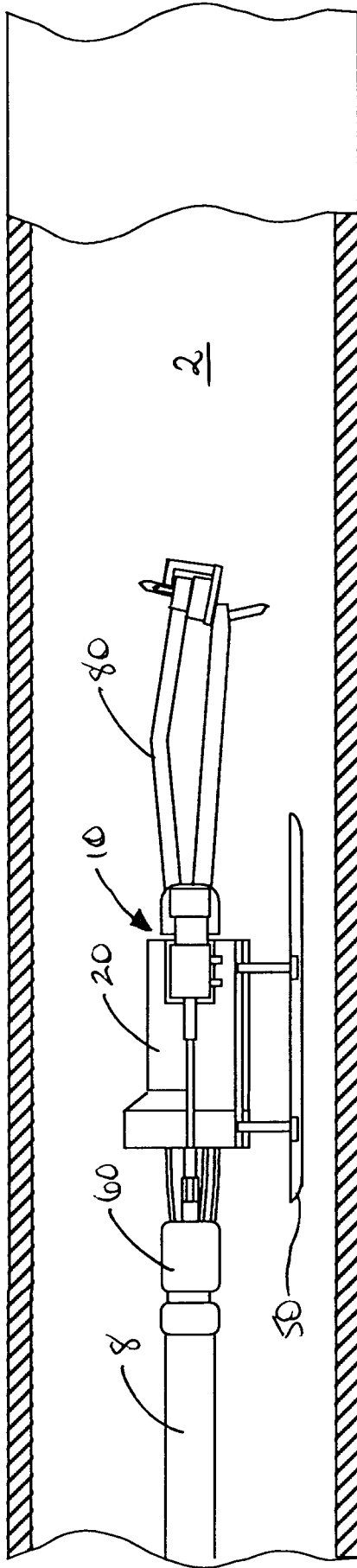


Fig. 1

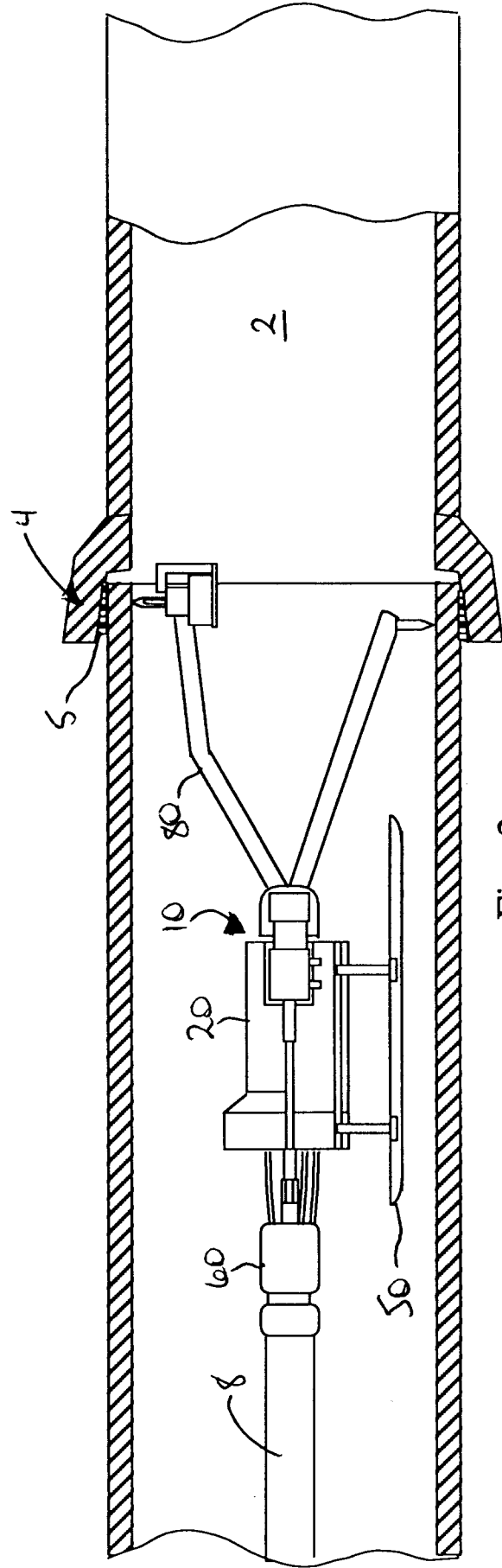
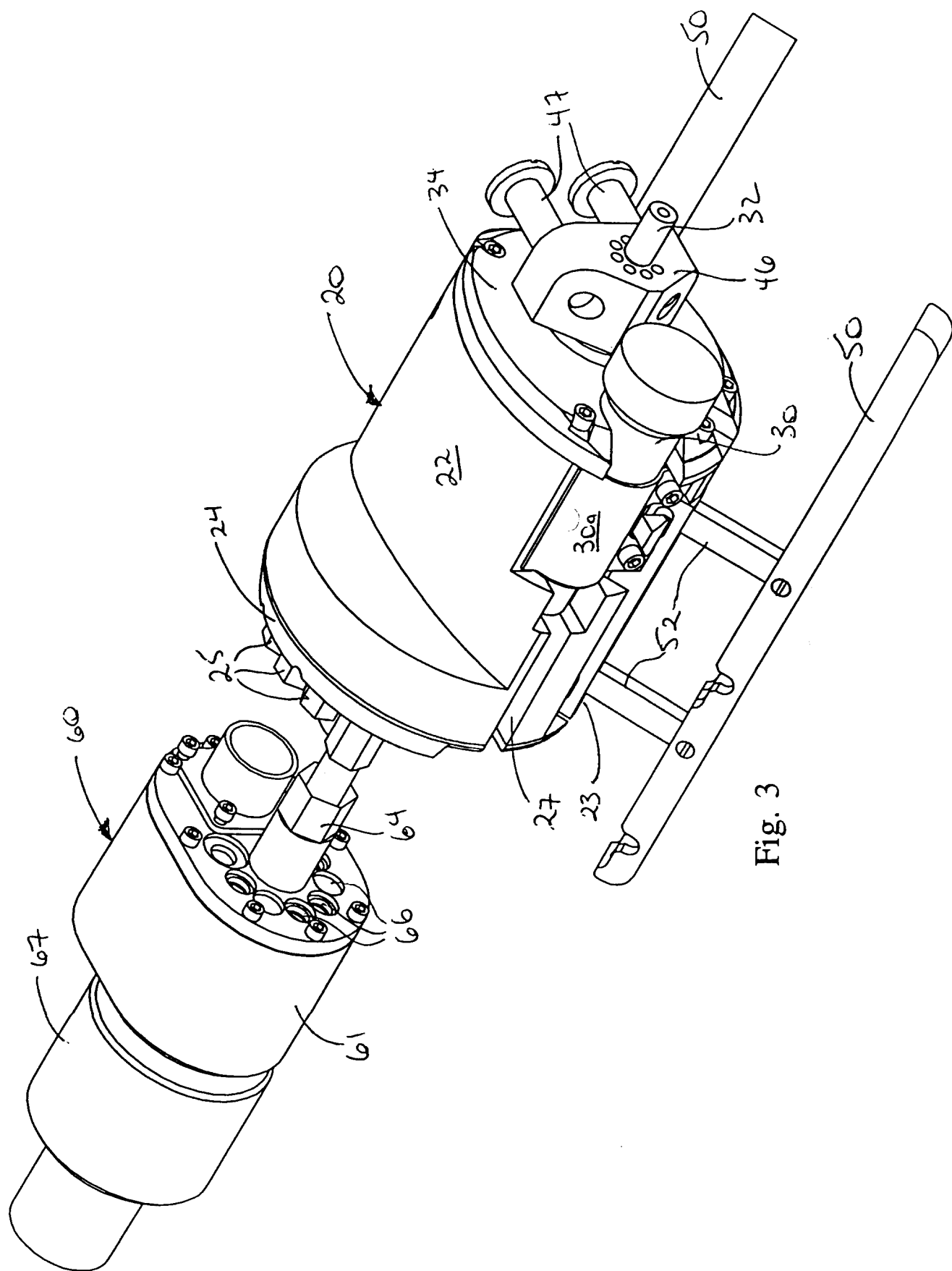


Fig. 2



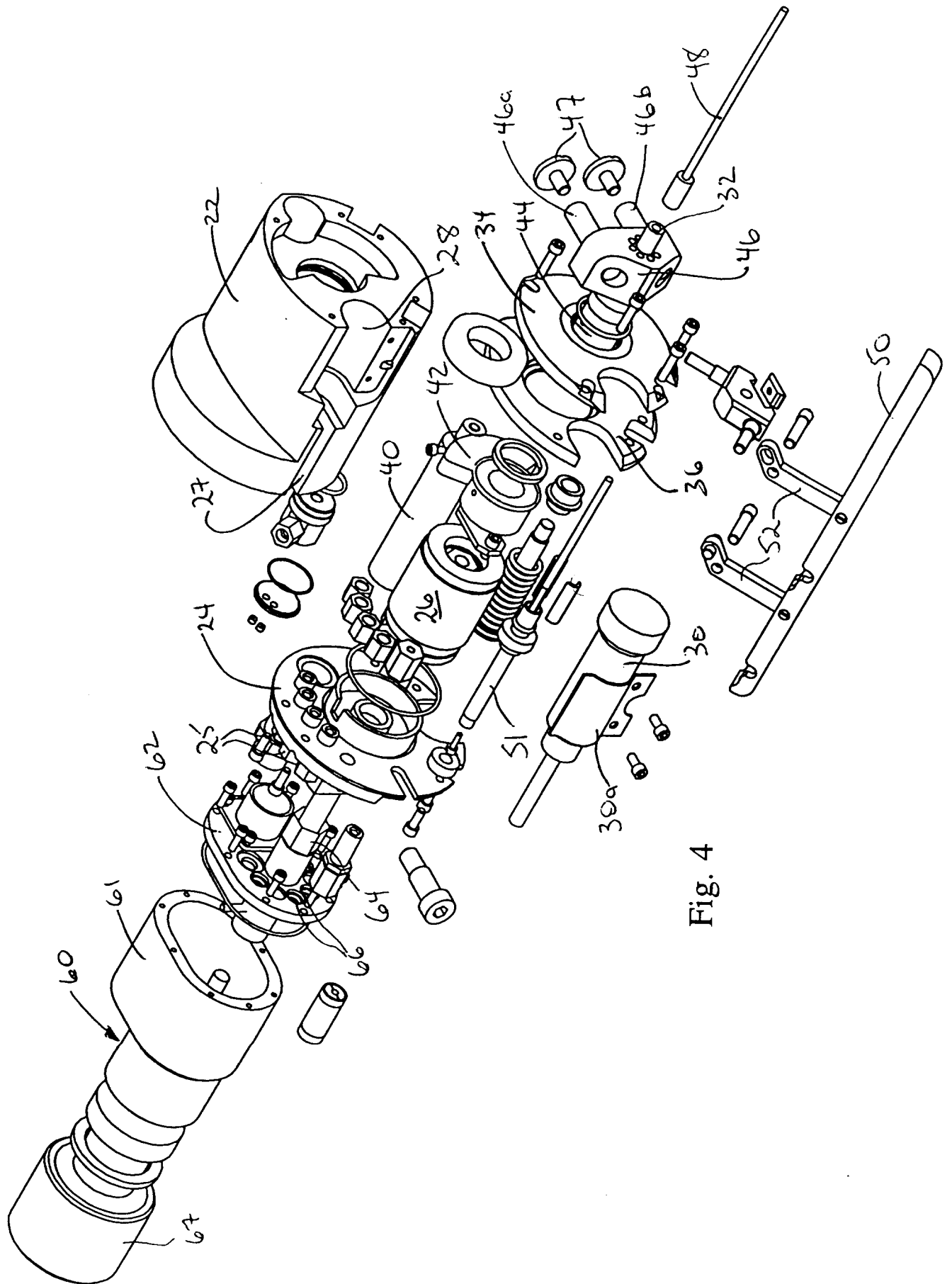


Fig. 4

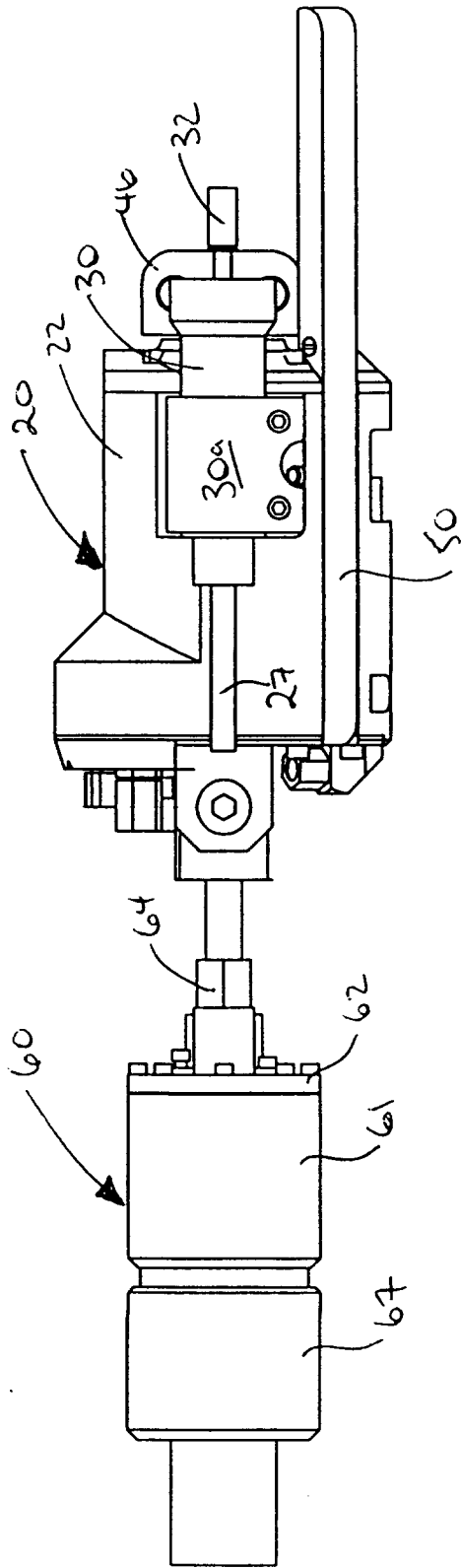


Fig. 5

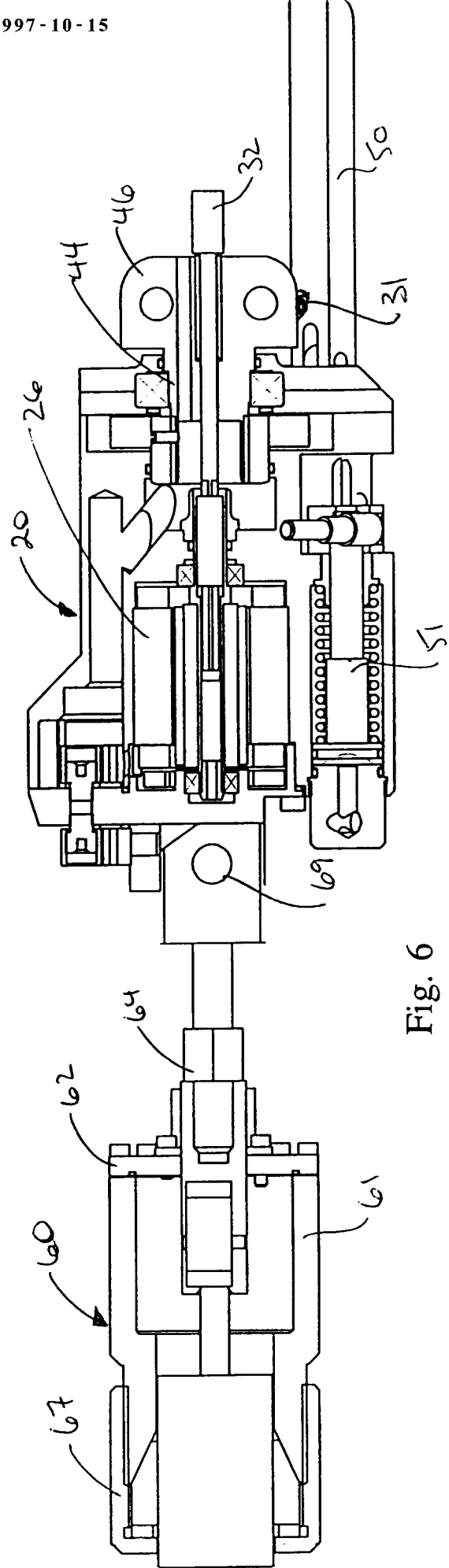
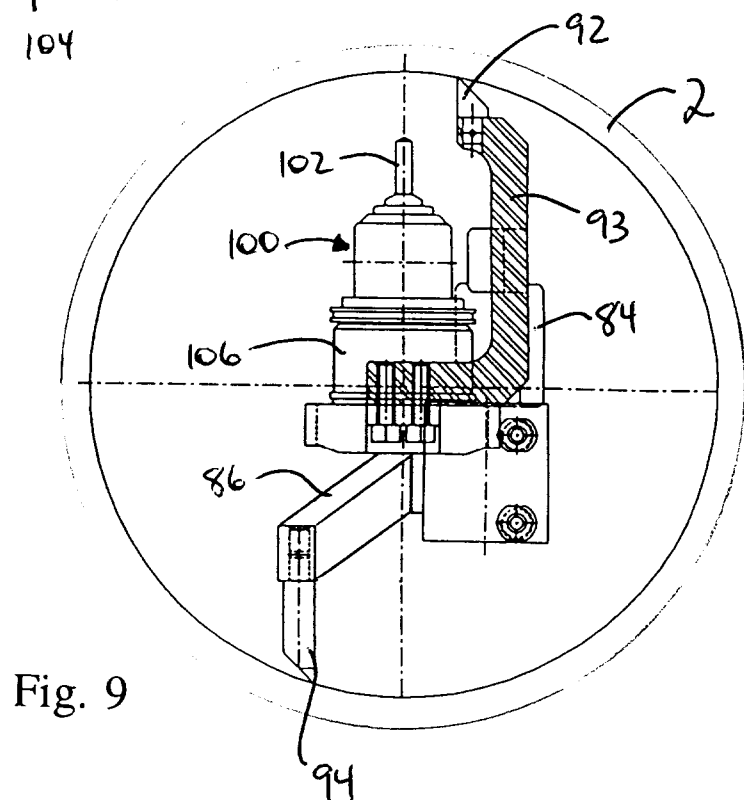
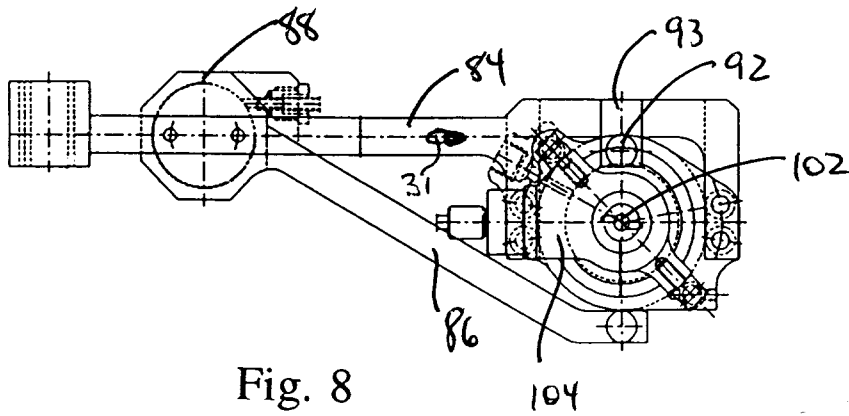
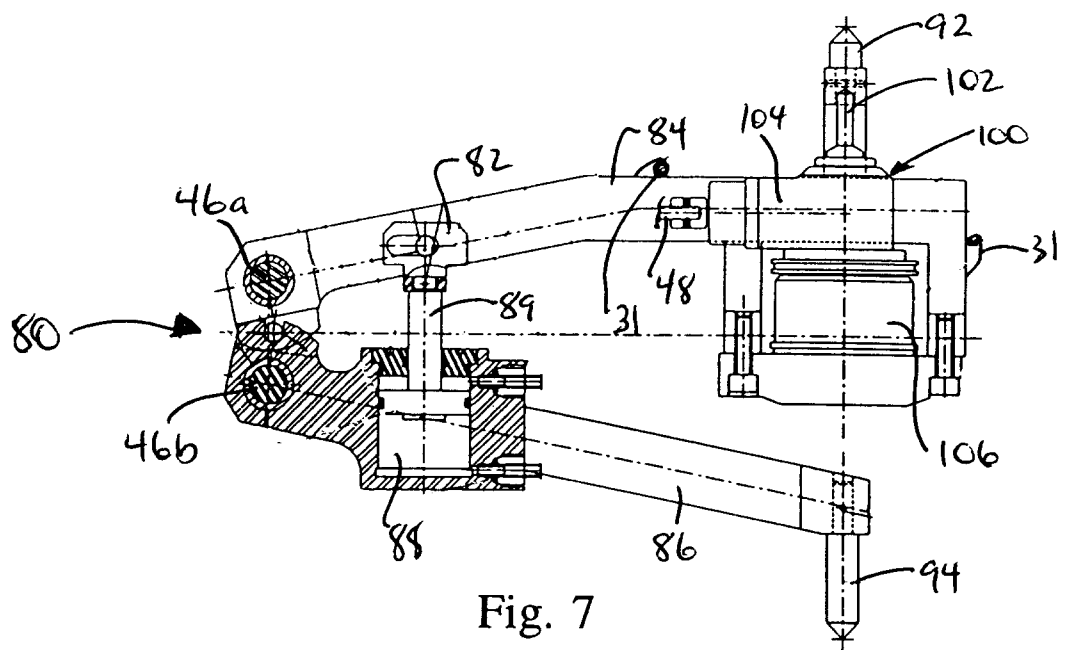
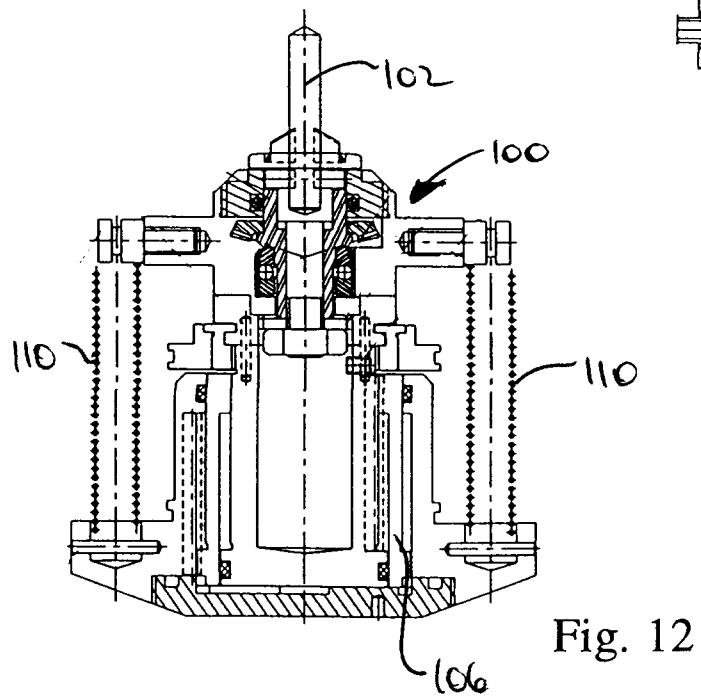
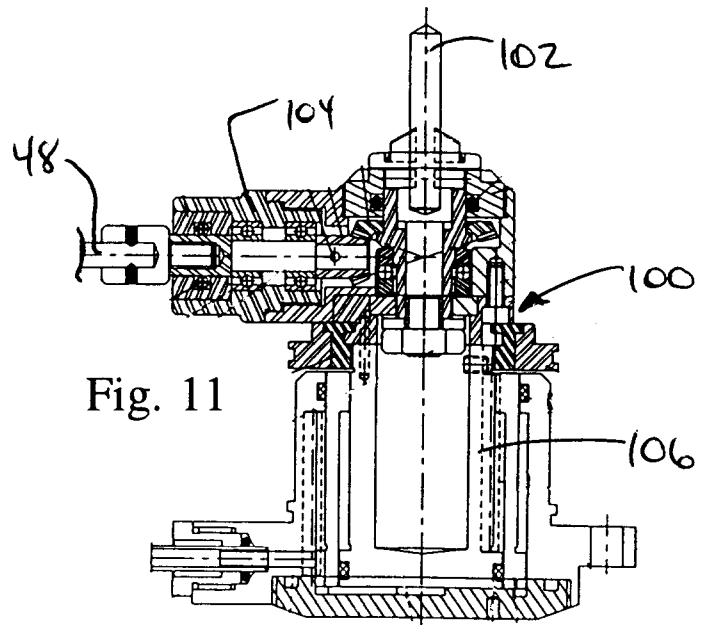
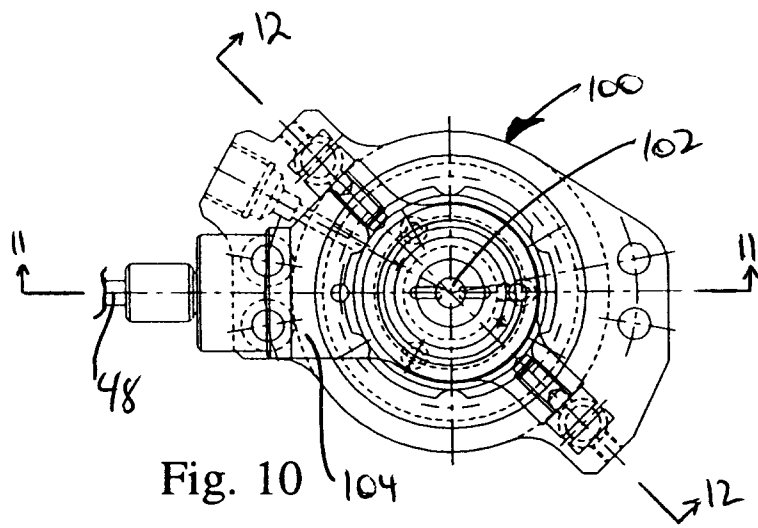


Fig. 6





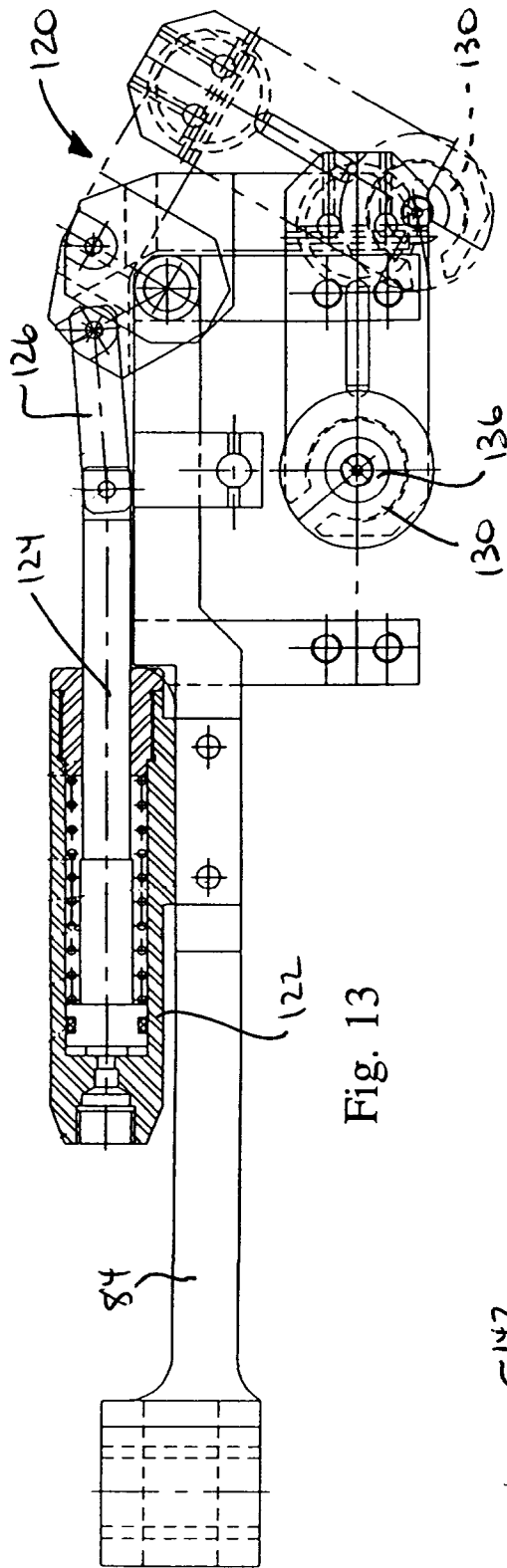


Fig. 13

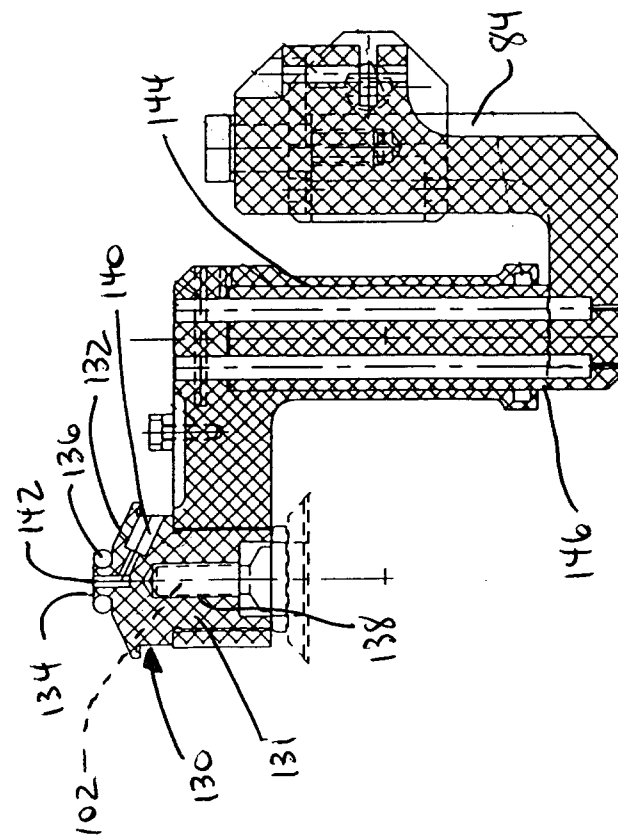


Fig. 14

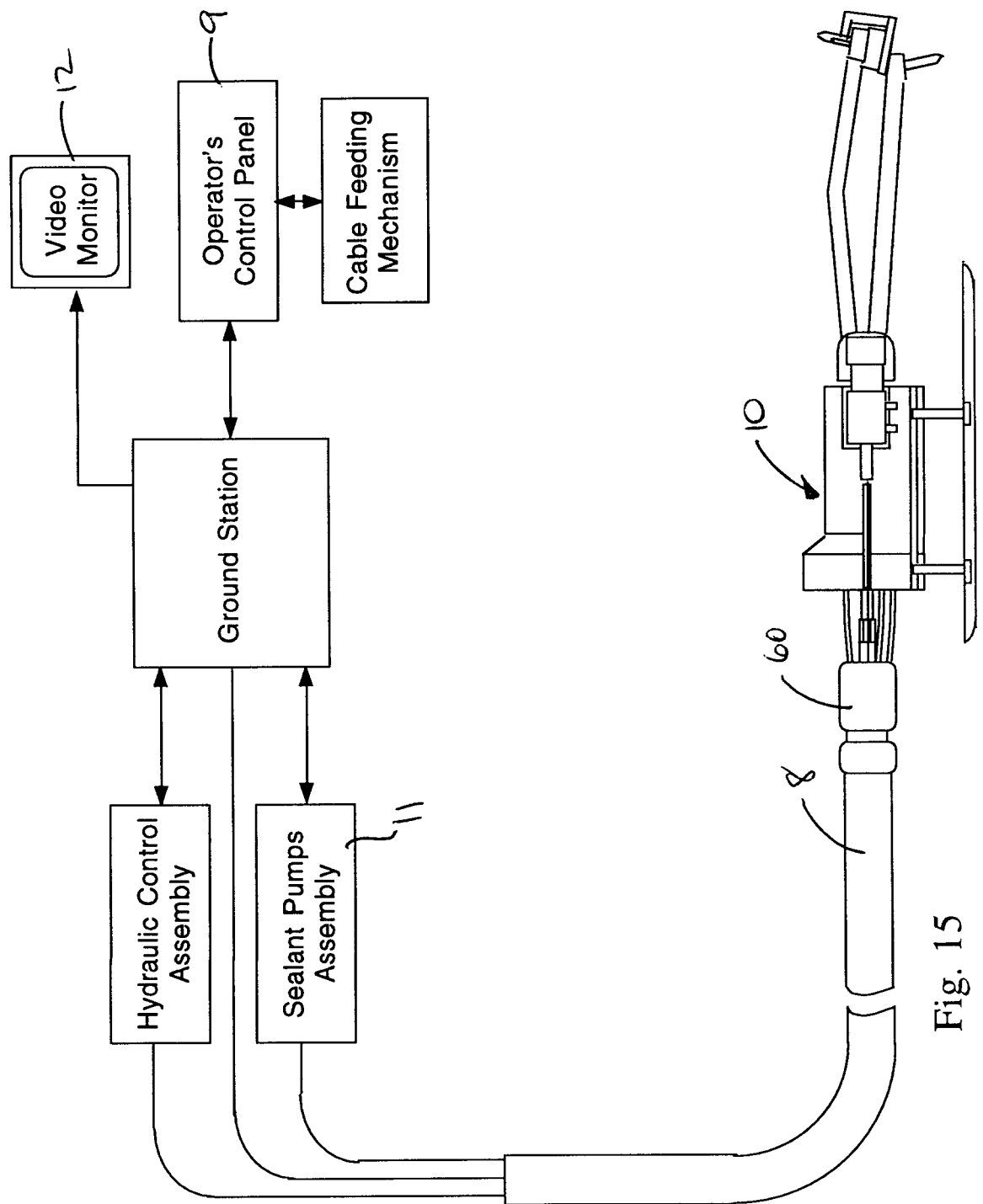


Fig. 15

