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(54) **BORING MACHINE**

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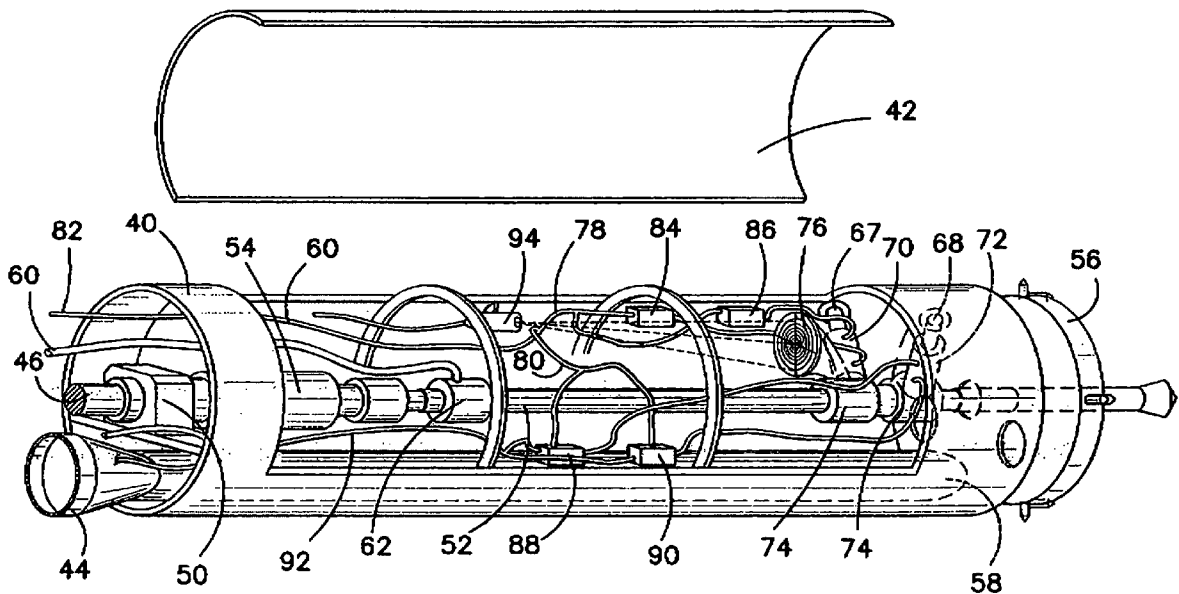
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(57) **ABSTRACT**

A micro tunnelling machine has a tunnelling head with a boring bit which is forced in a horizontal direction by a hydraulic thruster. The direction of the head is laser guided. The beam strikes a target in the head and a camera relays an image of the target to an operator located at the tunnel entrance. The operator adjusts the direction by admitting water and draining water from a pair of rams inside the head which move the boring bit up and down or left and right.

A semi automatic version is disclosed in which a microprocessor adjusts the direction until the operator assumes control.



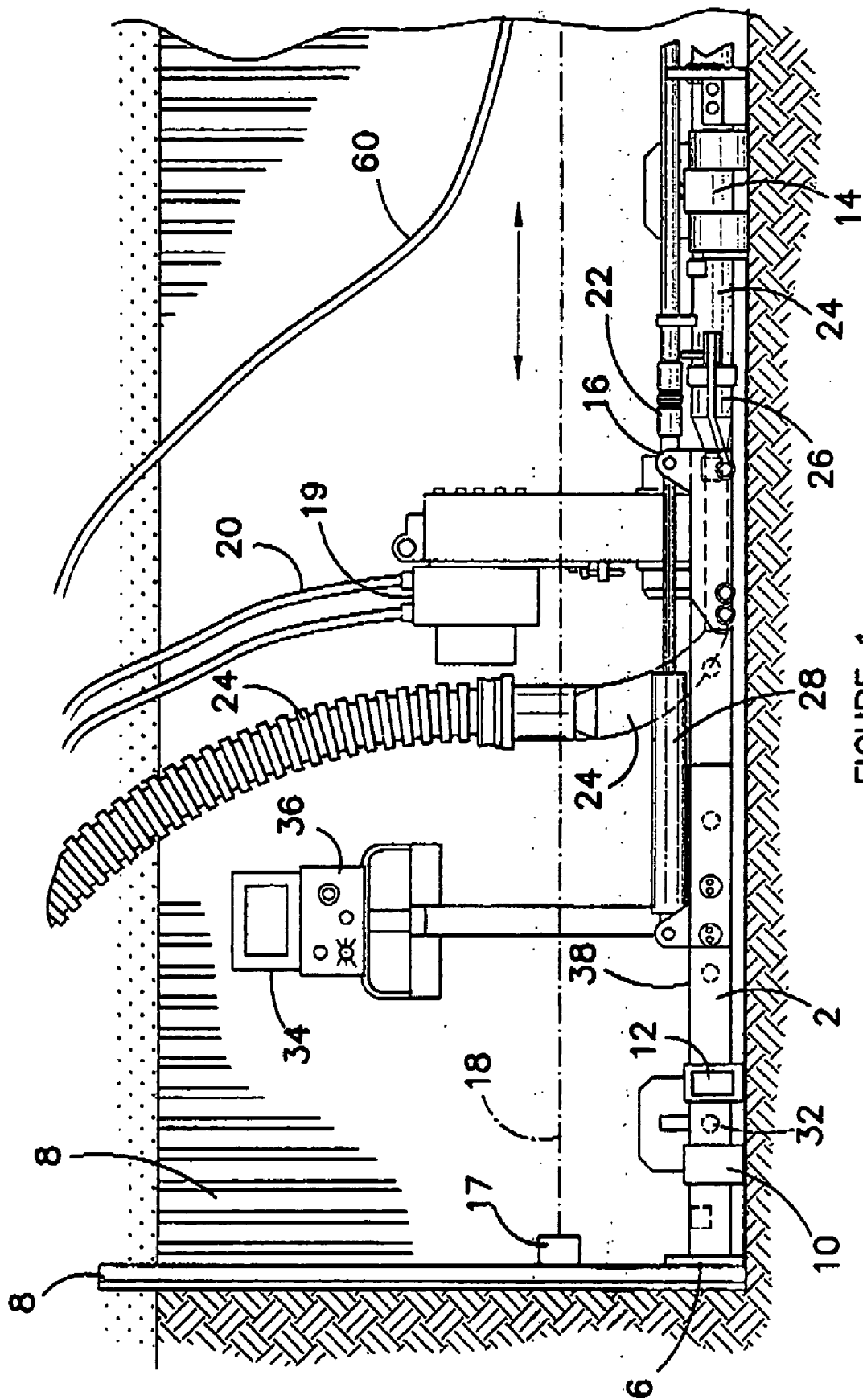
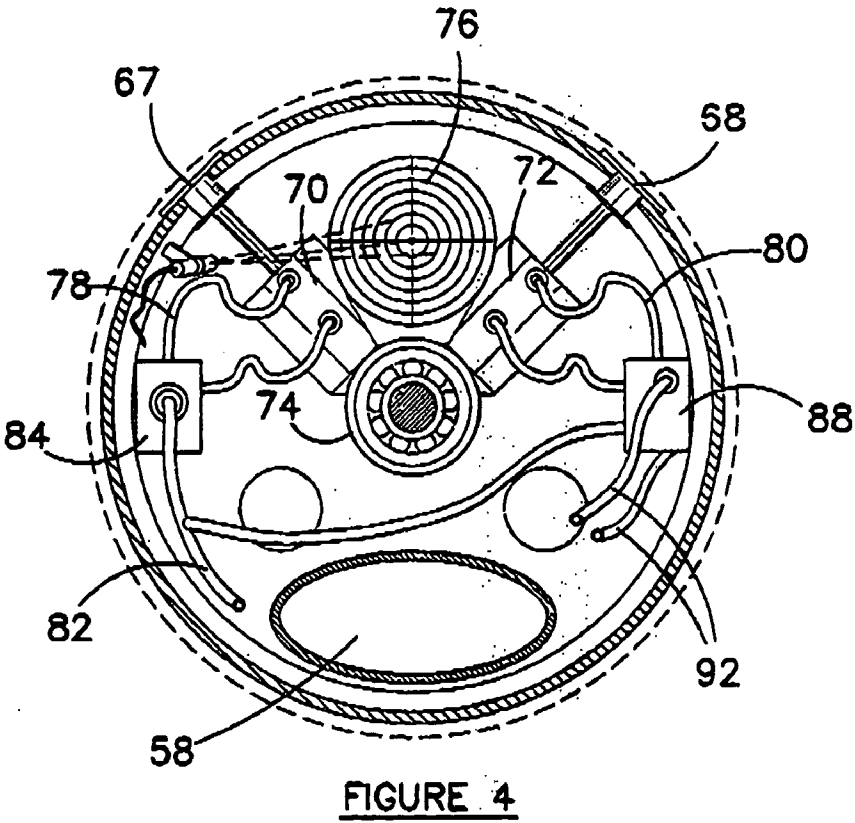
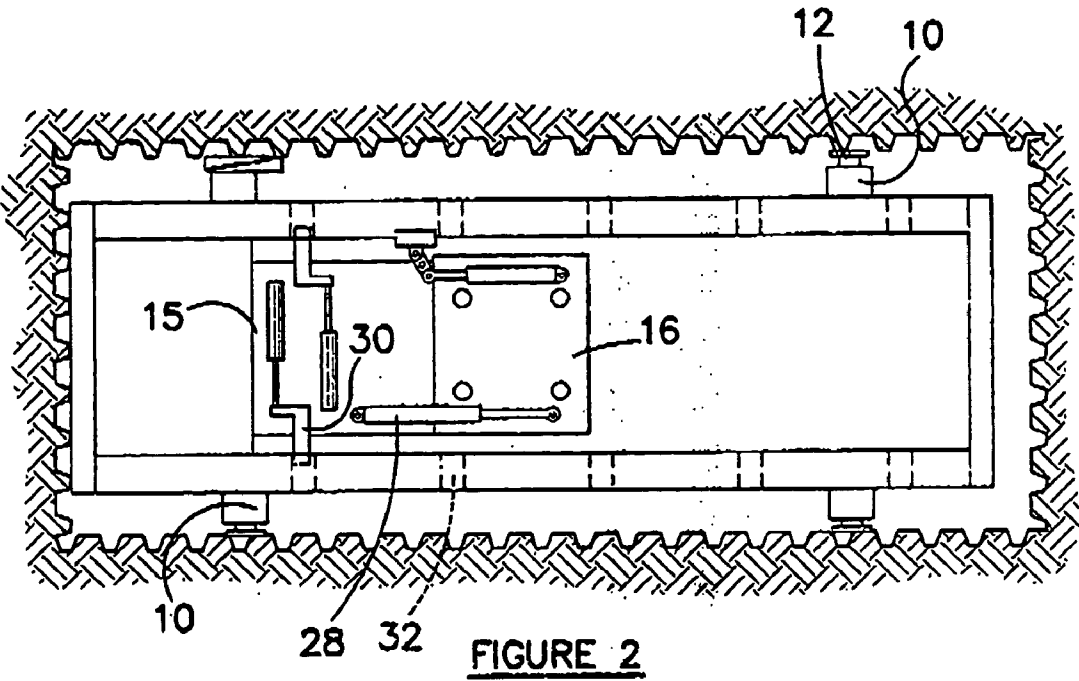


FIGURE 1



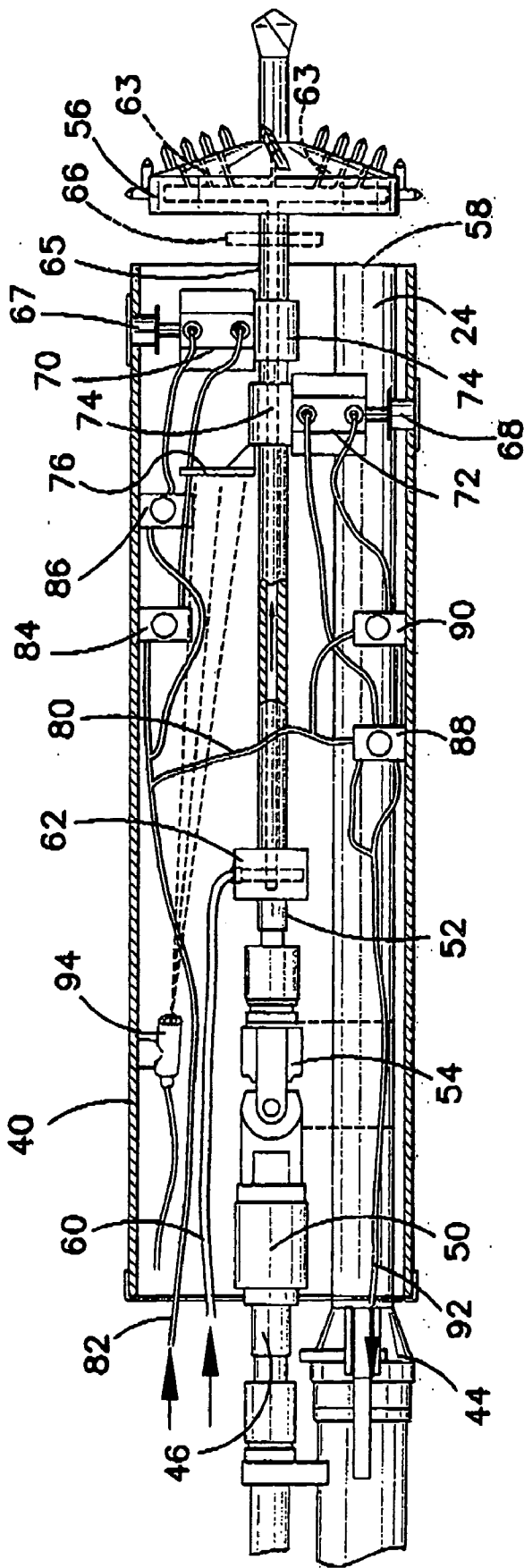
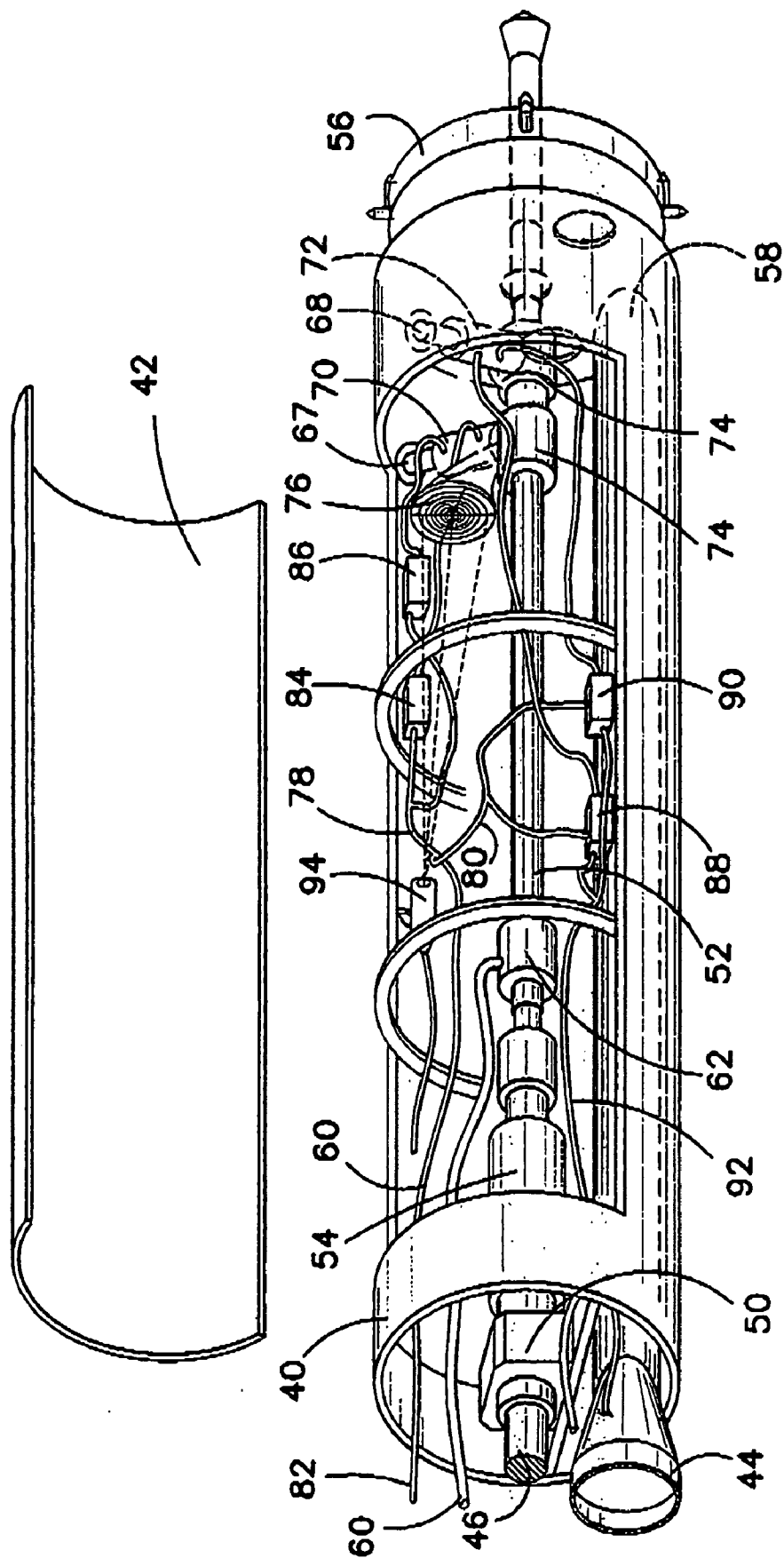


FIGURE 3



BORING MACHINE

FIELD OF THE INVENTION

[0001] This invention concerns micro-tunnelling machines of type used to bore underground drainage passages.

BACKGROUND OF THE INVENTION

[0002] Infill housing frequently requires the provision of services which cross boundaries and which must be precisely located. When the drainage is one of the services, the fall or incline must be incorporated into the final selected direction. Additionally, where line of sight is available to find the radial angle from the bore entrance to the target site, optical instruments provide accuracy. If an obstruction is encountered, an excavation may be needed to investigate. Alternatively the change in direction is planned. Every effort is made to reduce the expensive boring stage to a minimum. The use of laser technology by drainers is well established, but laser guided micro-tunnelling machines are expensive and not widely used.

[0003] U.S. Pat. No. 3,857,449 discloses a pipe thruster which uses a laser beam as a directional reference. The guidance system relies upon detecting the deviation of the machines thrust axis from the optical path of the beam.

[0004] Australian Patent No. AU-A-12360/88 describes a guidance control system for a laser guided boring machine for boring underground drains. The laser target has five light sensitive portions which emit voltages which when amplified are compared to predetermined threshold values and an output signal actuates a pair of 24v motors. The motors drive linear actuators which adjust the direction of the boring bit.

[0005] Trials and contract boring show that if the electronic components of the device fail, they tend to do so in locations where service and repair is slow or unavailable. It has also been found that when the strata are uniform, surprisingly infringement corrections are required in practice, but this was only discovered when a non-automatic version was constructed and tested.

SUMMARY OF THE INVENTION

[0006] The apparatus aspect of this invention provides a guidance system for the boring head of a micro-tunnelling machine of the type which bores in a selected direction and inclination using laser beam guidance having the endmost part of the drive to the boring bit adjustable in two directions at 90° wherein,

[0007] the endmost part of the drive has a target for the laser beam, means to convey an image of the target and the laser strike position thereon to an operator situated remotely from the boring head and input means for the operator to adjust the direction of the endmost part of the drive.

[0008] Means to convey the image may be a video camera. The target may be a surface against which the laser can be seen in contrast. The target may have a series of concentric rings, cross hairs or equivalent markings to help the operator to centre the direction of the boring bit.

[0009] The video camera may supply a continuous signal to a monitor at the bore entrance or at a convenient location.

It is usual for the operation to require the presence of an operator to add drive extensions to the bore string. It is therefore economic to have the operator guide the bit in between intermittent string extensions. During the fitting of an add-on drive unit, the bit is not revolving.

[0010] The input means for the operator may be switches which control the adjusters which act on the drive shaft mutually at 90°. The switches may be individual, but preferably they are grouped together as slide controls, but more preferably as a joystick.

[0011] The adjustment of drive shaft direction may be achieved by hydraulic pressure supplied by the water feeding the flushing operation of the boring bit.

[0012] Control of waterflow to the hydraulics may be by solenoid operated valves. This is convenient if the hydraulic rams and the valves are grouped together in the boring head making it necessary to supply the head with a water feed conduit, low voltage electrical leads and a large bore slurry removal conduit. The moving parts may therefore be reduced to the drive shaft, the associated rams and the boring bit. This layout simplifies and cheapens the construction of the machine. It is not onerous to watch the monitor and correct the direction of the bore intermittently. Once aligned, the bore tends to maintain course unless changes in the subsoil occur. The machine's static base is installed in the pit and its radial direction, ie. NSEW, is selected and thereafter the frame is locked in position. The sliding frame assures the direction of the static base. The direction of the thrust imposed on the boring head is unchanged during the addition to the string of the add-on drive sections.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] One embodiment of the invention is now described by way of example with reference to the accompanying drawings, in which:

[0014] FIG. 1 is a side view of the machine.

[0015] FIG. 2 is a plan of the base and the slidable frame.

[0016] FIG. 3 is a side sectional view of the boring head.

[0017] FIG. 4 is an end section of the boring head it FIG. 3.

[0018] FIG. 5 is a cut away view of the head shown in FIG. 3.

DETAILED DESCRIPTION

[0019] Referring now to the drawings, once the main excavation and the target excavation have, been made the direction and depth of the bore is established by drain laying practice. The main excavation pit accommodates the steel rails 2 of the base frame, The rails 4 are joined by brace 6 which contacts the steel plate shuttering 8 lining the pit. The base frame has lugs 10 which extend on both sides toward the side of the pit and jacks 12 are inserted to position the frame radially. In addition, the base frame has a ground jack 14 to adjust its inclination. Once installed and adjusted, the rails remain static.

[0020] A sliding frame 16 engages the rails. The sliding direction conforms to the direction of the base frame and therefore is aligned with the bore path. A retractable drilling frame 18 slides on the sliding frame 16. A laser generator 20

is mounted on the steel plate 8 just above the base frame. The laser beam 22 is adjusted to reach the required point at the target site. This arrangement is standard drain layer's technology. The sliding frame 16 has a hydraulic motor 24 which is supplied by a pump (not shown) and located near the pit (by conduits 26). The motor drives a shaft coupling 28 which is located above the slurry pipe 30, which discharges the slurry from the boring operation to a large capacity, vacuum vessel (5000l) on a truck (not shown). The vacuum tube coupling 32 lies alongside the drive coupling 34. A pair of feed rams 36 connected between the sliding frame 16 and the drilling frame 18 push the drilling frame 18 in the feed direction and retract it to the START position. The sliding frame 16 is locked in position in the base frame by locking pins 30 (see FIG. 2) which enter bores 38 in the rails. A video monitor 40 and a control console 42 are mounted on part of the sliding frame 16 in front of the operators platform 44.

[0021] Referring now to FIGS. 3, 3A and 4, the boring head comprises a cylindrical, steel plate shell 46 which has a removable cover 48. The trailing end has a union 50 for the vacuum hose and a union 50 for the drive shaft 54 which couple to the corresponding parts on the sliding frame 16 and to the add-on extension units (not shown) which drainage contractors utilise in the existing art.

[0022] A bearing box 52 of the drive shaft 54 is centrally supported at the trailing end. The universal coupling 56 is located adjacent the bearing box 52 and the drive shaft 54 extends to the leading end of the head and beyond to the boring bit 58. The space behind the boring bit 58 is subjected to the vacuum generated by the truck mounted installation and the slurry formed during boring enters an aperture 60 in the leading end of the shell 46 and is removed continuously. The water which helps to form the slurry is carried through the shell 46 by conduit 26. The water enters the drive shaft 54 via rotary coupling 62 which takes the water through a coaxial passage to multiple outlets 64 in the boring bit 58.

[0023] The shaft is free to waggle in order to correct the bore direction. The shaft aperture 60 through which the shaft projects is sufficiently large to permit 15° of angular movement. Ingress of slurry is prevented by seal 66. The adjustment of direction is achieved by suspending the shaft from two suspension points 68, 70 via a pair of double acting rams 72, 74 which are fixed to shaft sleeve 76. Between the rams is a light reflecting, aluminum target 80 showing several concentric rings. The rams are each served by conduit 26 from common mains water supply 82. Twin valve assemblies 84, 86, 88, 90 control water input to the rams and water exit from the rams which exhaust into the drain 92. As the exhaust water from the rams is only a small intermittent volume, it drains into the excavated ground.

[0024] Video camera 94 illuminates and shoots the target continuously and sends a signal to the monitor. If the bit needs to rise or fall, both rams extend or retract equally. If the bit needs to move LEFT or RIGHT, one ram extends as the other ram drains. The solenoid operator valves operated on 24v dc from a joystick control on the console 42.

[0025] We have found the advantages of the above embodiment to be:

[0026] 1. Ram adjustment of the shaft direction using feedwater pressure is easy and economical to build and repair.

[0027] 2. Camera reporting of directional accuracy is reliable and utilises operator time which must be paid for anyway.

[0028] 3. Confining the electronics to a camera and monitor allows the operation in locations without diagnostic and repair facilities.

[0029] In a non-illustrated embodiment, the camera image supplies a digital processing unit which compares the actual direction with the required direction and issues signals for correcting the direction if necessary until the operator assumes control and gives overriding instructions. Such a modification provides a default mode which assists if the operator has to leave the monitor temporarily.

What is claimed is:

1. The apparatus aspect of this invention provides a guidance system for the boring head of a micro-tunnelling machine of the type which bores in a selected direction and inclination using laser beam guidance having the endmost part of the drive to the boring bit adjustable in two directions at 90° wherein, the endmost part of the drive has a target for the laser beam, means to convey an image of the target and the laser strike position thereon to an operator situated remotely from the boring head and input means for the operator to adjust the direction of the endmost part of the drive.

2. A guidance system as claimed in claim 1, wherein the means to convey the image is a video camera.

3. A guidance system as claimed in claim 2, wherein the target is a surface against which the laser is visible in contrast.

4. A guidance system as claimed in claim 3, wherein the target has markings to help the operator to centre the direction of the boring bit.

5. A guidance system as claimed in claim 1, wherein the input means for the operator comprises switches for controlling adjusters which act on the drive shaft.

6. A guidance system as claimed in claim 5, wherein the switches are grouped for joystick operation.

7. A guidance system as claimed in claim 5, wherein the adjusters are a pair of rams mutually disposed at an angle and connectable to a source of water pressure and to a water drain.

8. A guidance system as claimed in claim 7, wherein the ram has a water in port and a water out port and ram movement is initiated by connection of the out port to drain.

9. A guidance system as claimed in claim 8, wherein a check valve between the water source and the in port of the ram maintains prevailing pressure.

10. A guidance system as claimed in claim 1, wherein the boring head is 200-800 mm in diameter.

11. A guidance system as claimed in claim 1, wherein the bore rate is 9-95 ft/hr.

12. A guidance system as claimed in claim 5, wherein the input means includes input signals from an imaging system which uses the camera image to compare the bore direction indicated by the target with the laser beam direction and operates switches until the operator assumes manual control.

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