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L. RANNEY

2,670,180

METHOD AND APPARATUS FOR ADVANCING SUBTERRANEAN PIPE

Filed May 27, 1949

3 Sheets-Sheet 1

Fig. 1.

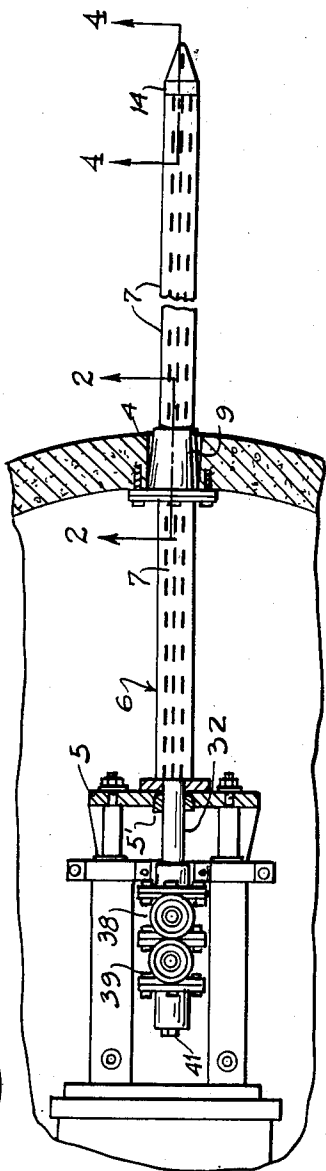


Fig. 3.

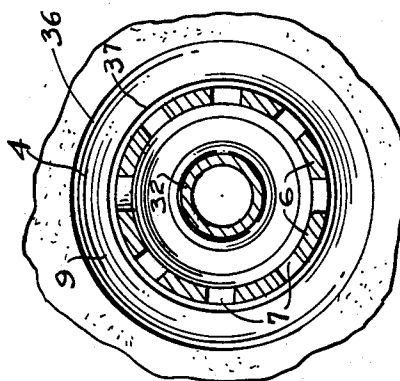
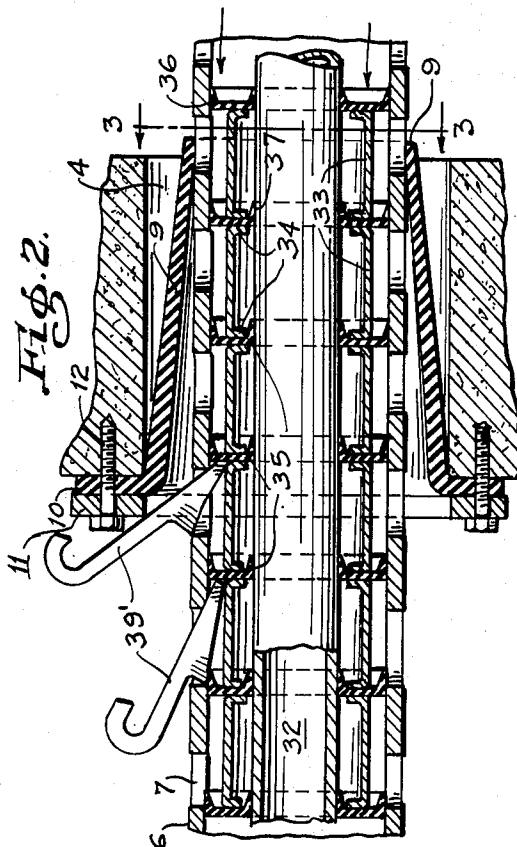


Fig. 2.



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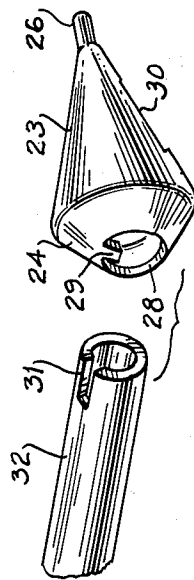
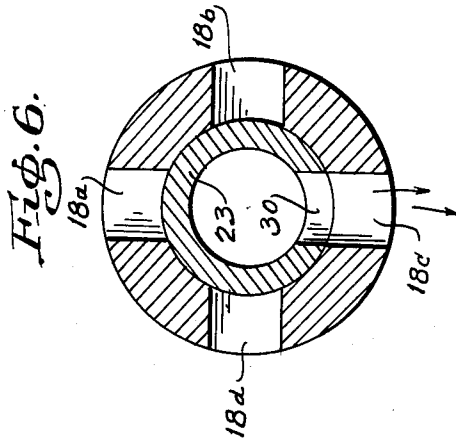
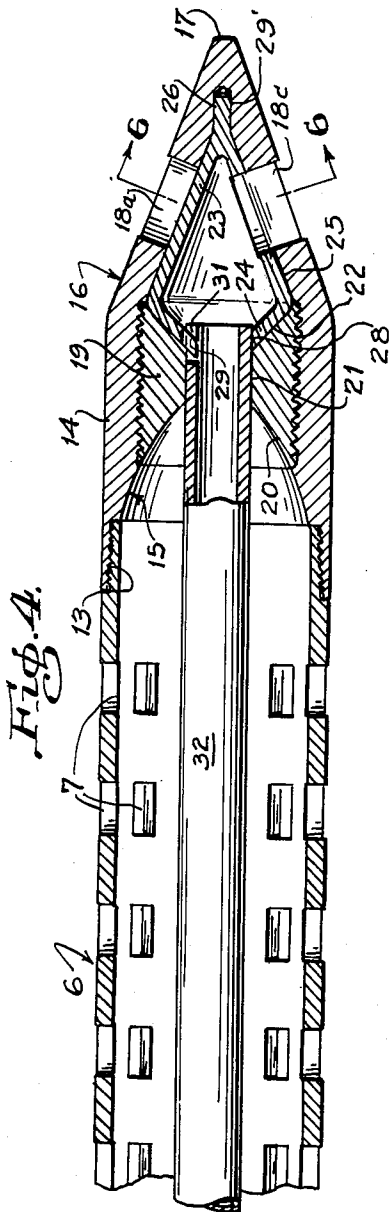
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METHOD AND APPARATUS FOR ADVANCING SUBTERRANEAN PIPE

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3 Sheets-Sheet 2



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2,670,180

METHOD AND APPARATUS FOR ADVANCING SUBTERRANEAN PIPE

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Fig. 8.

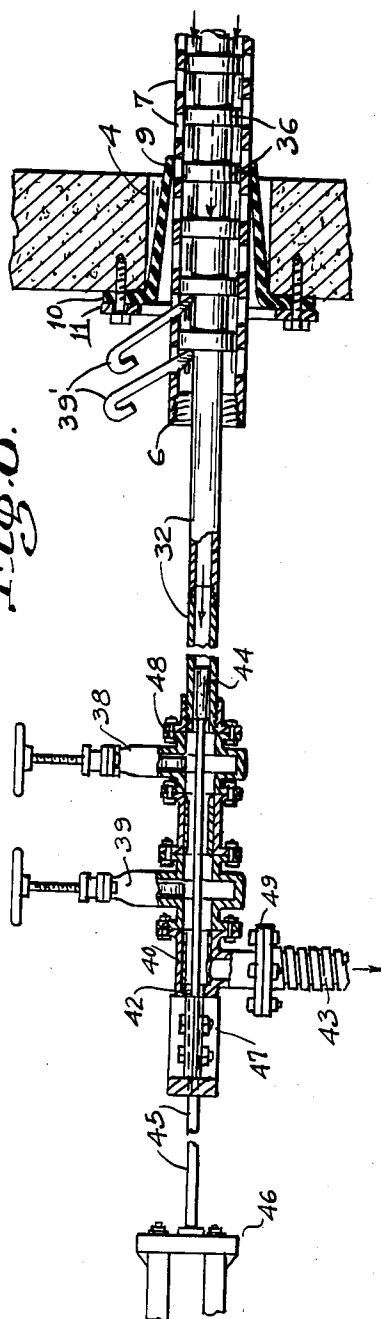
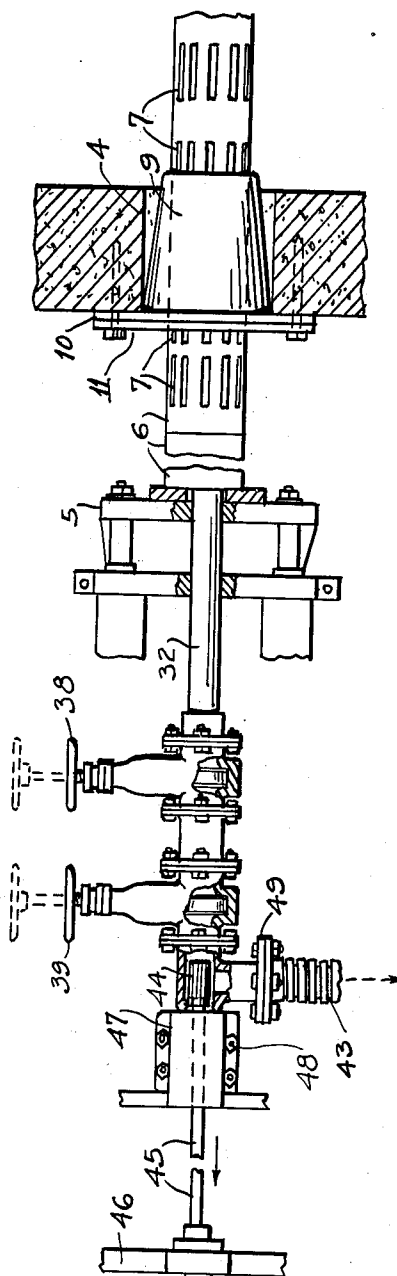


Fig. 7.



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METHOD AND APPARATUS FOR ADVANCING
SUBTERRANEAN PIPELeo Ranney, Morro Bay, Calif., assignor to
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Application May 27, 1949, Serial No. 95,653

2 Claims. (Cl. 255—1.8)

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This invention relates to methods and devices for the driving of underground pipes.

In my Patents Nos. 2,126,575 and 2,126,576 I have described a method of introducing subterranean pipes particularly for the construction of water collection systems in aquifers.

In such operations pipe is forced into the earth in an initially generally horizontal direction. The pipe is perforate and has a digging head at its forward end. The digging head is hollow and is provided with a port. An internal imperforate pipe is positioned inside the perforate pipe and is connected to the digging head. The rear end of the perforate pipe, i. e., the end remote from the digging head, is closed, as by a suitable packer through which the internal pipe passes. The internal pipe may discharge into any suitable fluid collecting system. The exterior of the perforate pipe may also be packed off against the earth at the point of entry into the earth.

In such operations, especially when the formation into which the pipe is driven contains fluid, such as water, under pressure, the fluid enters through the perforations into the outer pipe and through the digging head nozzle and into the internal pipe. Since the rear end of the external pipe is closed by the external packer, the flow is through the digging head and through the internal pipe. In this manner a mixture of loose sand and fluid, i. e., water, is withdrawn from the formation ahead of the digging head.

The removal of the sand in the stream of fluid entering from the formation into the inner pipe is selective, that is, the finer grains are suspended in the fluid and pass therewith, while the larger grains or the more consolidated material remains in place. The net result is an increase in porosity and permeability in the formation surrounding the advancing tube.

In such a procedure the direction of progress of the pipe through the formation may, in certain circumstances, be an important problem.

The deviation of the pipe from a predetermined line is influenced by several factors. Thus, gravity tends to induce the pipe to plunge downward in the direction of the pull of gravity. Of course, variations in the formation, such as the direction of dip, will tend to cause the pipe to deviate from a horizontal line, or variations in the nature of the formation, or the existence of boulders will cause the pipe to deflect.

However, I have found that one of the most important considerations is the withdrawal of sand which causes a weakening of the formation

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in the direction of maximum withdrawal and therefore has a directional effect.

I have devised a means for employing the above principle of action to control the direction of movement of the pipe.

Summarizing my invention, I provide a pipe system which may be advanced non-rotatively into the formation in a desired direction and selectively remove portions of the earth in the direction of desired advance, and in a preferred embodiment I provide at the forward end a digging head having a port for passage of sand and fluid from the formation into the digging head and for flow through the pipe system. I also provide means for positioning the port at a selected position around the axis of said digging head in a predetermined geographical relation to the horizontal, whereby the digging head will deviate in an axial direction in a predetermined manner.

In my preferred embodiment I seal the exterior of the pipe in such manner that the formation fluid is forced to pass through the selectively positioned port in the digging head and through the pipe and is prevented from passing around the pipe.

These and other objects of my invention will be further described in the following specification taken together with the drawings, in which

Fig. 1 is a fragmentary plan view of my structure for driving subterranean pipes;

Fig. 2 is a fragmentary section taken on line 2—2 of Fig. 1;

Fig. 3 is a section taken on line 3—3 of Fig. 2;

Fig. 4 is a fragmentary section taken on line 4—4 Fig. 1;

Fig. 5 is an exploded perspective view of the head of the valve element;

Fig. 6 is a section taken on line 6—6 of Fig. 4;

Fig. 7 is a partly sectional view illustrating a method and device for sealing the ends of the pipe system to prevent flow of fluid from the formation while adding pipe; and

Fig. 8 is another stage of the same procedure. As described in said aforementioned patents, a structure is provided in the earth at a level at which the pipe is to enter into the earth. The structure may be cemented at the face of the earth formation into which the pipe is to be driven and may be provided with ports for the passage of pipe through the cement wall. A convenient and conventional method for providing such structure is to sink a concrete caisson to the point in the earth at which the pipe is to be jacked. The cylindrical wall of the caisson

at the point where the pipe is to enter the formation is provided with a port. Such a wall is illustrated at 1 (Fig. 1) with port indicated at 4. At this level is provided a supporting structure for a pair of jack cylinders 2 provided with a piston rod 3 carrying a yoke 5 which abuts the pipe 6 which is to be pushed into the formation.

The pipe 6 is usually slotted with slots 7 throughout its length. A packing member is first provided at the port, as is illustrated more clearly in Fig. 2. The packer is in the form of a hollow truncated cone 9 having an annular flange 10. It may be made of rubber or of any suitable elastomer. It is introduced through the port 4 with the flange 10 against the face of the caisson and is clamped against the face of the caisson by a suitably shaped ring 11 which is held against the face of the flange by means of bolts 12 to seal the flange 10 against the face of the caisson. The pipe 6 and the digging head is passed through the packer, as is shown in Fig. 2.

The forward or digging end of the pipe is threaded at 13 and a hollow digging head 14 is screwed onto the pipe. The digging head 14 has an internal curved shoulder 15 and an outer conical section 16 terminating in a digging point 17. The digging portion is provided with ports 18a, 18b, 18c, and 18d, as shown, disposed 90° apart around the axis of the digging head. A removable plug 19 is screwed into the interior of the digging head at its cylindrical portion. At the forward end of the digging head and concentric with the axis of the digging head is a pilot bore 29'. The entrance end of the plug at 21 is curved at 20 to the same curvature as the curved shoulder 15. The plug has an internal bore 21 coaxial with the axis of the digging head.

The forward end of the plug 19 has a conical portion 22. A hollow valve member is formed with a conical section 23 and a rear conical portion 24 having a central bore 28 and a depending lip 29. The conical portion 22 is parallel to the interior cone 24 of the digging head valve. The conical section 23 is parallel to the conical section 25. The forward end of the valve has a rod 26 which fits into the pilot bore 29' positioned axially of the digging head. The conical portion 23 carries a port 30 which is adapted to register with each of the ports 18a, 18b, 18c, and 18d. The port 30 bears a known axial relationship to the lip 29, as, for example, illustrated, 180° apart. The surfaces 22, 24 and 25 and 23 need not be conical but may be any similar surfaces of gyration such that the internal cone of the hollow valve member may be rotated over the complementing inner surfaces of the digging head, i. e., are in rotative sliding relationship.

The internal imperforate pipe 32 carries a slot 31. It passes through the bore 21 and the lip 29 enters the slot 31. At the rear ends of the pipes 6 and 32 packers are provided to seal the space between the exterior of the imperforate pipe 32 and the interior of the perforate pipe 6. These packers are composed of a series of rings 33 having internal flanges 34. Between the rings are packing elements 35 composed of annuli having ring flanges 36 and 37. The external diameter of the flange 36 is somewhat larger than the internal diameter of the pipe 6 and that of the internal diameter of the flange 37 is somewhat larger than the external diameter of the pipe 32. It will be seen that there is such a packer between each ring. The packers may be made of rubber or any other packing material of sufficient flexibility so that the flanges 36 and 37

may be pressed against the interior wall of the pipe 6 and the exterior wall of the pipe 32 when the pipe 32 is in position. In order to hold the packers in position against the fluid pressure of the formation, keys 39' are inserted into the slots 7 in that portion of the slotted pipe 6 inside the caisson 1.

It will thus be seen that when the digging head is disconnected from the pipe 6 and from the pipe 32 and with the plug 19 unscrewed from inside the digging head, the hollow valve member may be pushed inside the digging head with the rod 26 entering the pilot bore 29' and the surface 23 abutting and sliding over the interior conical surface of 25. The plug 19 may be screwed into position with the cone 24 abutting the conical section 22 of the valve. The digging head may then be screwed onto the slotted pipe 6. The packers may then be introduced into the rear end of the pipe section.

Having introduced the packers and the flanges and the rings into the interior of the pipe, the imperforate pipe 32 carrying valves 38 and 39 on its rear end is introduced and is guided by the curvature of the internal shoulders 15 and the curved portion 20 to enter into the bore 21. The pipe 32 is then rotated until the slot 31 in the pipe coincides with the lip 20 whereupon the slot 31 passes over the lip 29 and the pipe 32 enters the bore 28.

Pipe 32 may be marked with a mark in line with the slot 31 so that when the pipe is introduced into the lip 24 the relative axial relationship of the lip and therefore the port 39 with the mark at the end of the pipe is known. The pipe 32 may then be rotated. This rotates the valve so that the port 30 is in register with one of the ports 18a to 18d, inclusive, whichever one is selected. It will be seen that therefore all of the other ports are blocked and the interior of pipe 32 communicates with the selected port.

The pipe section is then introduced through the packer 9 and abutted against the yoke 5 with the valves 38 and 39 at the end of the pipe 32 open and connected to line 43 for disposal of the fluid. The jack pushes the pipe 6 through the port into the formation. If desired, removable slips 5' may be placed between pipe 32 and the yoke 5 to cause the yoke to advance the pipe 32 simultaneously with pipe 6. Usually, however, the sag of the pipe 32 inside the pipe 6 is sufficient to give a rubbing contact which drags the pipe 32 along with pipe 6 without the use of such slips. When the full stroke of the jack has been extended to push the section of pipe into the formation, the jack is retracted.

During this procedure, assuming that the pipe has entered a formation containing fluid under pressure, as, for instance, in an aquifer, or an oil zone, fluid under pressure enters from the formation into the slots 7 and exerts a pressure against the packer elements 35, causing them to move down the pipe. However, this is prevented by the retaining key 39' which is introduced through the slot and abutted against the packer elements. The keys are used in duplicate and may be removed one at a time and shifted in position to hold the packer inside wall at the end of each section of pipe as it passes through the packer 9. It will thus be seen that the pipe 32 is sealed inside the pipe 6 so that fluid may not be by-passed through the pipe 6 and around the pipe 32 to the interior of the caisson. The pressure of the fluid in the formation also enters into the annular space between the interior of the packer 9 and

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the wall of the port 4, compressing the packer around the pipe 6, sealing the pipe 6 into the ports so no fluid can enter on the exterior of the pipe 6 into the caisson.

The fluid under pressure is thus caused to pass through the selected ports 18a to 18d through the port 31 into the interior of the pipe 32 and discharge from the end of the pipe 32 under the control of the valves 38 and 39.

The fluid passes through pipe 32, by the valves 38 and 39 and through the T box 40, closed by plug 41 in the orifice 42 through the discharge conduit 43 to storage or other disposal. When the section of slotted pipe and internal pipe 32 have been advanced to the face of the caisson, it becomes necessary to add additional slotted pipe and imperforate pipe. While in the case of the production of water the addition of the perforate and imperforate pipe may be accomplished as in the case of the procedures described in the above mentioned patents, the following procedures may be employed when it is desired to prevent the escape of formation fluid during addition of pipe sections.

When the pipe 6 has been advanced into the formation through the port 4 the end of the pipe is adjacent the wall 1 and the packer is at the end of the pipe held in place by the keys 39'. The pipe 32 and the valves 38 and 39 and the plug 41 and pipe 43 are inside the caisson, with both valves 39 and 38 closed, as shown in Fig. 7. The jack yoke is removed from the jack after retraction.

The plug 41 is removed and the plug packer 44 positioned on the end of a long rod 45 inserted through the orifice 42, valve 39 is opened and the packer is pushed through the valve. The packer is long enough to span the valve so that it closes off the pipe as it passes through the valve. Valve 38 is opened and the packer is shoved into position beyond the valve flange and into the pipe 32, as shown in Fig. 8. The plug 44 may be advanced by means of a jack 46 and steadied by one or more split bearing bushings 47 suitably and removably positioned in the caisson 1.

The flanges 48 are split, the bearings 47 separated and removed from the rod, and the connection 43 separated at the flanges 49 and the assembly of valves slid backward along the rod. With the jacks 46 removed, the assembly is slid off the end of the rod. If the pressure in the tube 32 is high, a suitable gripping means, such as jacks 5, with suitable removable slips such as 5', but of proper size to grip the rod 45, is inserted between the end of the tube 32 and the valve 38, after it has been slid back sufficiently, to hold the rod 45 against movement when the jack 46 is withdrawn.

A second joint of pipe 32 with a flange 48 at the inner end thereof is then slid over the end of the rod 45, it being held suitably to permit the passage of the pipe over the end of the rod 45. Thus the holding means 5, placed adjacent the end of the pipe 32 near the plug 44, will hold the rod 45 against movement and permit the new section of pipe to be slid over the end of 45 and the jack 46 can be placed against the end of the rod 45 and the holding means removed by removal of slips 5'. The pipe sections are then joined, as by screwing the pipes together, and the pipe 32 extended. The intermediate holding means is then placed to engage the rod 45 at the end of the newly added section of pipe 32. The holding jack 46 at the end of the rod 45 is then removed and a section of pipe 6 passed over the end of the rod until it comes up to the inter-

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mediate rod support 5, with the end of the rod 45 projecting beyond the end of the new section of pipe 6. The holding jack 46 is then placed at the end of the rod 45. The intermediate rod support is removed by removal of the yoke of the jacks or by the removal of the slips 5' and the backing plate between the end of 6 and the yoke. The plate may be split for this purpose and the new section pipe 6 advanced until it abuts the pipe 6 projecting from the port 4. The pipes are joined as by welding or by means of a screw joint. The intermediate holding means 5 is then placed on the rod 45, the holding jack is removed, and the valve assembly slid over the rod 45 with the end of the rod 45 projecting beyond the port 42. The holding jack 46 is placed at the end of the rod 45 and the intermediate rod holding means 5 is withdrawn, and the flanges 48 on the valve 38 and on the inner end of pipe 32 are joined, and the plug 44 is then withdrawn between the valves 39 and 38. Valve 38 is closed and the plug withdrawn completely. Valve 39 is closed or left open and the plug 41 placed in position and the jack yoke 5 placed in position by replacement of the yoke 5 if originally removed or by the replacement of the slips 5' and the backing plate between the end of the new section of 6 and the yoke 5, if they only had been removed.

Assuming, for the purpose of illustration, that the port 18c is the one in registry with the port 30, as illustrated in Fig. 6, there will be a selective withdrawal of sand from underneath the digging head 4 and underneath the port 18c, and this will weaken the formation underneath the digging head, causing the digging head to plunge in the direction of the port 18c. If, now, it is desired to change the direction of the deviation of the bore hole, for example, suppose it is desired to deviate the pipe to the right, the pipe 32 inside the caisson is rotated 90° in a counter-clockwise direction. This brings port 31 into registry with port 18b. The formation will therefore be selectively withdrawn from the side of the digging head adjacent the port 18b and the formation will thus be weakened at that portion and the digging head will deviate to the right. It is preferable to make this rotation of 32 with the packer 44 in position and the valve system 38, 39 removed as described above.

If it is desired to deviate the digging head to the left, the pipe 32 is rotated through the angle necessary to move the port 30 into registry with the port 18d and the selective withdrawal of formation through the port 30 and into the pipe 32 will cause the digging head to deviate to the left. In like manner, if it is desired to deviate the digging head in an upward direction, the pipe 32 is rotated to bring the port 30 into registry with the port 18a and a selective withdrawal of the formation from above the digging head will cause the head to deviate in an upward direction as the pressure is exerted by the jacks to move the pipe into the formation.

Since the position of the slot 31 is always known because of the mark positioned upon the pipe 32 at the inside of the caisson, which is always in line with the slot 31, the position of the slot 31 may be at all times determined from the position of that mark on the pipe 32 on the interior of the caisson. Additionally, since the initial position of the open port as the pipe enters the ground is known and by rotation of the pipe 32 the ports are first closed to stop the flow of formation fluid and then opened to start the flow, the number of stoppages and resump-

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tion of flow as the pipe is rotated is a further check on the position of the open port.

I have described the above apparatus and process in which the direction of advance is in a generally horizontal direction. However, as will be recognized by those skilled in the art, the same principle may be applied when the pipe is introduced to travel in either a vertical direction or in any direction deviated from the horizontal or vertical and in any desired azimuthal direction. The opening of the selected port causes the pipe to deviate in the direction of the open port which thus has a predetermined position with respect of a vertical and a horizontal geographic plane, i. e., in a predetermined azimuthal direction and in a predetermined vertical and horizontal deviation, both in respect of the geographic vertical and the geographic horizontal direction, and also, of course, in respect of the axis of the boring head and pipe 6. Thus, by positioning the open port at such predetermined position, I may non-rotatively advance the pipe in a predetermined deviated direction from the vertical or horizontal plane and in a predetermined azimuthal direction.

It will, of course, be understood by those skilled in this art that if the initial direction of entrance through port 4 is not horizontal, the cement face of the formation and the port 4, as well as the jacks 5, may be faced in the initial direction whether it be vertical, horizontal, or at any degree of inclination or in any geographic direction desired.

The apparatus described above, in that it provides means for selectively positioning the port in the digging head at predetermined positions around the axis of the digging head, makes possible directional non-rotative advance of pipes underground where there is insufficient formation fluid or no formation fluid to cause the removal of material from the earth in the manner described above.

In such case I create or augment the fluid pressure in the formation by introducing fluid under pressure from an extraneous source through pipe 32 discharging the fluid in the formation through the selectively opened port, as described above. Pumping is continued. As fluid is pumped into the formation the fluid migrates out from the digging head, and the pressure and volume of the formation fluid is increased. In this manner fluid at considerable pressure accumulates in the formation in the region of the digging head at the pressure created by the pumping operation. When the desired pump pressure has been reached, the pump may be by-passed and the pipe 32 connected to a fluid receiving sump, for example, the pipe 32 is vented to atmospheric. The fluid in the formation under the stored pressure vents through the formation and the open port and into the pipe 32 carrying with it material from the formation in the same manner and to the same effect as in the case of the flow of natural formation fluid described above.

The fluid employed in such case may be the same as is present in the formation where the purpose of this procedure is to augment the natural flow. But it need not be the same and may be any fluid such as water, oil, solvent material or a gaseous fluid such as air, carbon dioxide, natural or illuminating gas where the use of such material is not undesirable as a contaminant or undesirable because of safety reasons or for other practical reasons.

Where a gas is used either to augment the fluid in the formation or to add pressure to the fluid in the formation, the gas may be used alone or in mixture with other solutions in the fluid. Thus, when using water, I may also employ CO₂, the CO₂ dissolving in the water at the high pressure employed. As a further example, when using petroleum oil as the liquid, I may employ natural gas and form a solution or foam of the gas and oil under the pump pressure. Upon the release of pressure the expanding gas acts to impart kinetic energy to the fluid. The flow of the oil and water in the formation is thus augmented as in the case of naturally occurring oil field reservoirs.

The artificially induced or augmented flow of fluid, liquid, or gas, or jointly liquid and gas, carries with it material from the formation through the open port and into the pipe 32 with the effect previously described.

The steps of pressurizing and releasing may be repeated in cycles at sufficient frequency and for a sufficient number of times to remove the desired amount of material in order to permit the progress of the digging head and pipe system in the desired manner as described above.

When the permeability of the formation is so low, i. e., the formation is so tight, that the employment of the above method of augmentation of formation fluid pressure or volume is impractical or when for any other reason it is not desired to follow the above procedure in more permeable, but still relatively tight, formations, I may employ the following procedure.

I pump the fluid, gas, liquid, or gas and liquid through pipe 32 and raise the fluid pressure in the formation to any desired magnitude that my pumping system may permit. I may thus, particularly if the weight of the over-burden is not too excessive, lift the formation and create cavities and fissures in the formation around the digging head. These cavities are thus filled with fluid under the pump pressure often approximately equal to the weight of the over-burden. When the pressure in the pipe 32 is vented, as described above, the fluid enters at high velocity, aided by the squeezing effect on the fluid of the lifted over-burden, carrying material from the formation in a manner similar to that described above.

In the above technique I may control the entry point of the fluid from the formation into the pipe 32 by positioning the port 30 of the valve member 23 over the selected ports 18a to 18d. In this respect the action of the formation fluid under the artificially created formation fluid pressure is similar to the naturally occurring formation fluid in the process described above.

Because I am able to position the open port at any desired position axially about said pipe, as described above, and to in effect rotate said ports about said digging head by opening and closing the ports 18a to 18d in sequence, by rotation of the pipe 32 and the valve 23, I can also employ my structure to cause a jet cutting or erosion action to occur about the digging head and thus non-rotatively advance the pipe system and remove detritus or material from the formation in the manner described above.

Thus when the earth material through which the digging head is to pass imposes a large resistance to the advance of the digging head, fluid may be pumped into and through the pipe 32 to discharge through one of the ports. By rotating the valve member 23, the earth material

may be worn away on all sides of the digging head or selected regions by selectively opening the ports in the chosen region. I can thus create a cavity located at the desired geographic position with respect to the axis of the digging head and cause the advance of the digging head and pipe into such cavity and in a desired direction.

By rotating the pipe 32 and non-rotatively advancing the pipe 6, ports 18a to 18d act as a circumferential spiral jet to cut a circumferential spiral kerf which may be of the desired diameter and so permit the advance of the pipe into the cavity with reduced resistance.

Where the formation is unconsolidated as, for example, where the formation is a mixture of gravel and sand and is too permeable to permit of the creation of a body of fluid in the formation adjacent the digging head under a desirably high artificially created fluid pressure, I may pump liquid through any of the selected ports and wash the sand away from the digging head in the vicinity or direction of the open port. The fluid transports the sand to more remote regions of the formation to pack the formation more firmly in such more remote regions but weakens the formation in the direction and region of the open port. Thus, the digging head advances in the weakened direction to advance in the desired direction. For example, if port 18c is open, the fluid exiting from 18c will flow downward and then the flow pattern is around the digging head and in a generally upward direction. This washes sand out from underneath the digging head, i. e., in the direction of the port 18c and deposits the sand in the gravel in the direction of 18a, 18b, and 18d. The earth is weakened in the direction of 18c and strengthened in the direction of 18a, 18b, and 18d. The earth is not only more consolidated in the regions where the added sand is deposited, but the reduction in the bulk density of the earth in the direction where the sand is removed and its increase in the direction where it is deposited results in the diminution of skin friction in the regions of the lesser density and increase in the regions of greater density. This deflects

the digging head in the direction of the port 18c.

While I have described a particular embodiment of my invention for the purpose of illustration, it should be understood that various modifications and adaptations thereof may be made within the spirit of the invention as set forth in the appended claims.

I claim:

1. An apparatus for forcing pipe under-ground, comprising a pipe, a hollow digging head at one end of said pipe, a plurality of ports spaced around the axis of said head and pipe, selective opening and closing means for said ports, means operable from the other end of said pipe for actuating said selective opening means to open selectively one only of said ports, means for forcing said pipe into the earth, and means for withdrawing fluid from the formation through an open port and through said pipe.

2. An apparatus for forcing pipe under ground, comprising a hollow digging head at one end of said pipe, a plurality of ports spaced around the axis of said pipe, means for selectively closing all but one of said ports, said means including a closure means for all but one of said ports, and including also means operable from the other end of said pipe for actuating said closure means to selectively close all but one of said ports, and to selectively establish fluid communication between the outside and inside of said hollow digging head through said selected open port, and means for conducting fluid passing through the said open port to a remote location.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
405,200	Chapman	June 11, 1889
1,994,884	Chew	Mar. 19, 1935
2,121,858	Chew	June 28, 1938
2,126,575	Ranney	Aug. 9, 1938
2,126,576	Ranney	Aug. 9, 1938
2,198,386	Hlester et al.	Apr. 23, 1940
2,212,491	Appleby	Aug. 27, 1940
2,492,151	Holm et al.	Dec. 27, 1949