Jan. 19, 1960 J. L. McELVANY 2,921,543

PIPE-LAYING APPARATUS

Original Filed March 8, 1954 2 Sheets-Sheet 1

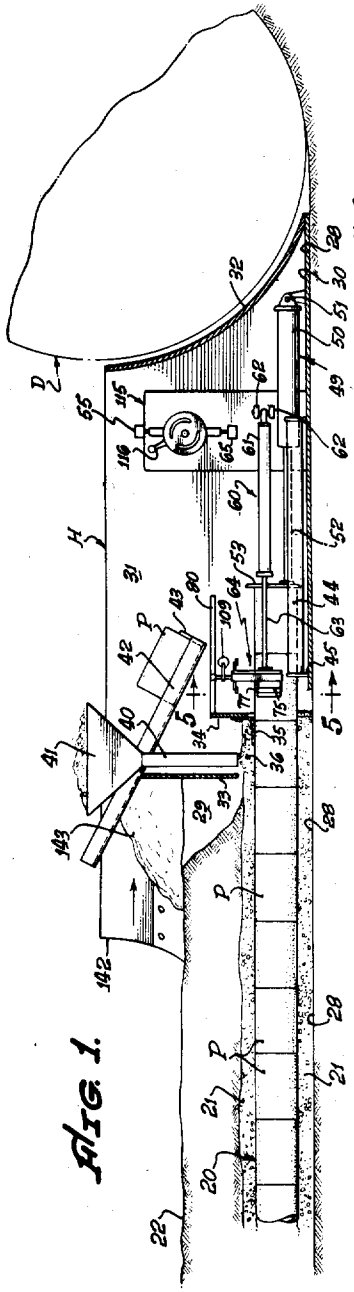


FIG. 1.

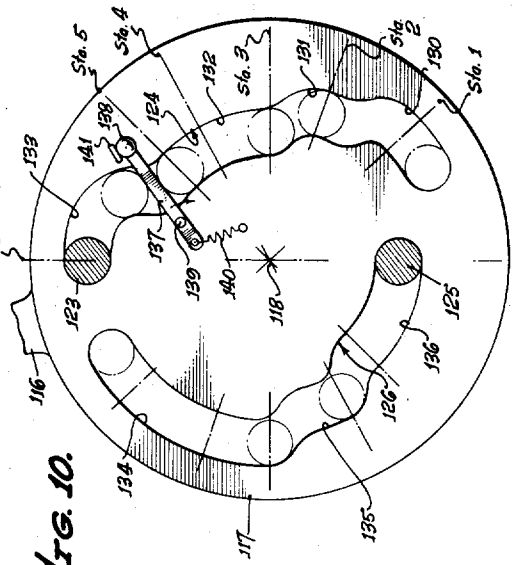


FIG. 10.

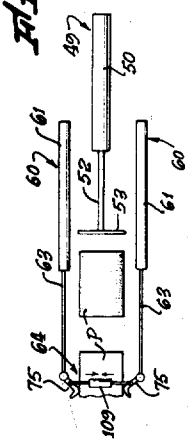


FIG. 2.

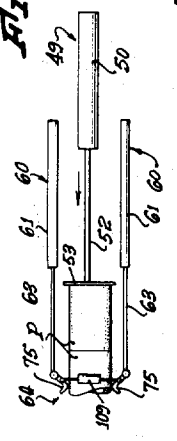


FIG. 3.

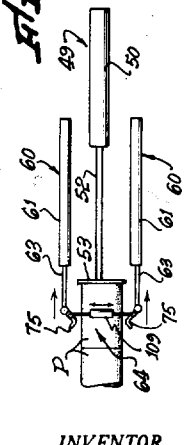


FIG. 4.

INVENTOR.
JAMES L. McELVANY,
BY
ATTORNEY.

Jan. 19, 1960 J. L. McELVANY 2,921,543

PIPE-LAYING APPARATUS

Original Filed March 8, 1954 2 Sheets-Sheet 2

FIG. 5.

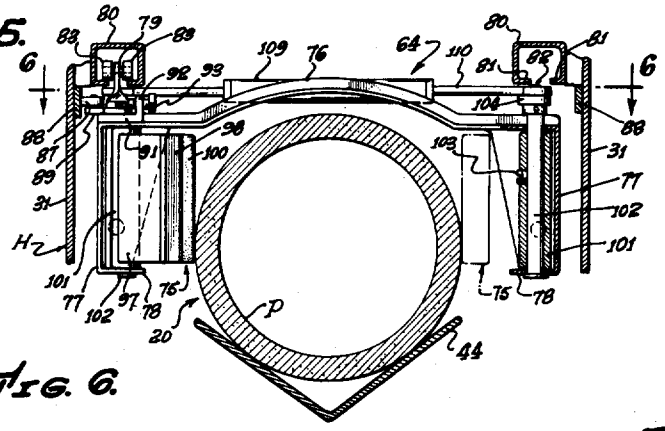


FIG. 6.

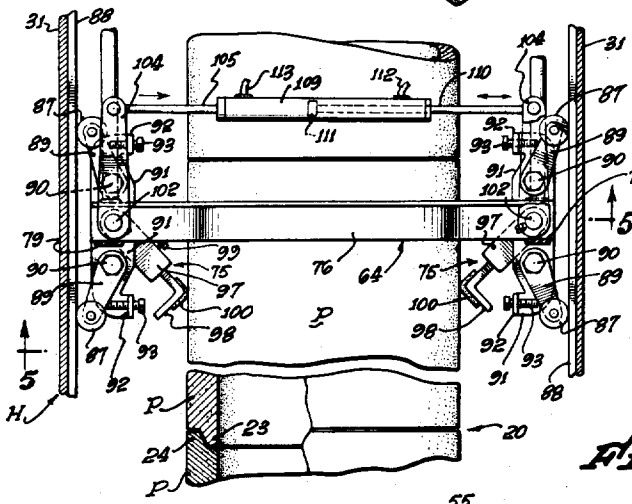


FIG. 7.

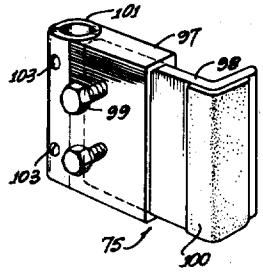


FIG. 8.

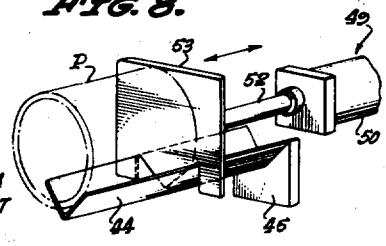
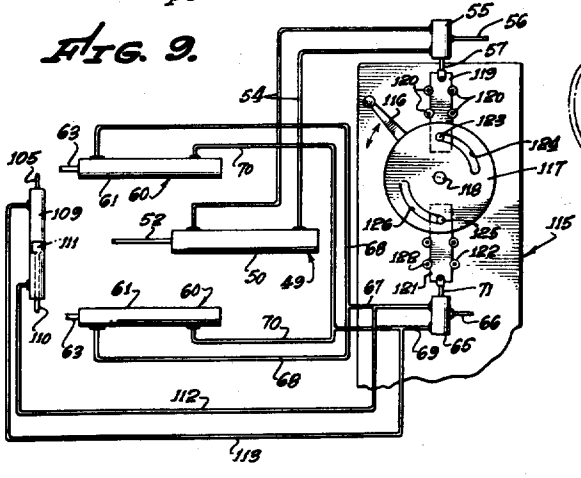


FIG. 9.



JAMES L. McELVANY,
INVENTOR.

BY

ATTORNEY.

United States Patent Office 2,921,543 Patented Jan. 19, 1960

2,921,543

PIPE-LAYING APPARATUS

James Leon McElvany, El Centro, Calif.

Original application March 8, 1954, Serial No. 414,758, now Patent No. 2,830,548, dated April 15, 1958. Divided and this application November 27, 1957, Serial No. 699,370

5 Claims. (Cl. 111—5)

This invention relates to means for laying drainage pipe underground and is directed particularly to the problem of laying drainage pipe in water-soaked soil.

This application is a division of copending application Serial No. 414,758 entitled Pipe-Laying Method and Apparatus filed March 8, 1954, now Patent No. 2,830,548 issued April 15, 1958 by James Leon McElvany.

The invention has special utility for meeting a drainage problem such as exists, for example, in the Imperial Valley in southern California. This region, which is largely below sea level, has in recent geological time been a part of the gulf of lower California and a table of salt water lies close to the surface of the ground in many parts of the region. It has been found that land which would otherwise be nearly useless can be reclaimed for agriculture by laying drainage pipe to draw off the water to some lower area. When such drainage pipe is installed it is possible to remove excessive salt from the soil by repeated irrigation. Alfalfa is one of the valuable crops that can be grown, the climate permitting several crops of alfalfa to be harvested throughout the year. Since alfalfa roots penetrate deeply into the soil and since salt water is fatal to alfalfa, it is especially important in preparing soil for alfalfa to place the drainage pipe a substantial distance under the surface of the soil.

It has been found that good results may be obtained by a drainage system composed of pipe made in short sections of some ceramic or cement mixture. Such pipe sections are commonly called "tiles." In a tile drainage system the tiles interlock end to end with unsealed joints to permit the ingress of water and are imbedded in a bed of gravel to permit free drainage of water from the adjacent soil. A tile system of this character is especially desirable in comparison with open drainage ditches because the drainage pipe does not interfere with cultivation and also because no maintenance is required to keep the drainage system in good condition.

In relatively dry soil it is a simple matter to dig a trench, pour a thin layer of gravel into the bottom of the ditch, lay the pipe sections end to end on top of the gravel, add more gravel to surround the pipeline, and then refill the remaining depth of the trench with soil. The difficulty, however, is that the soil in this region is wet all the time and the trench must be dug in wet mud. To make the problem even more difficult, in many instances the trench extends through a region of quicksand.

Heretofore the problem of laying a drainage line under these conditions has been approached by using a power-actuated trench digger of the wheel type with a narrow housing trailing immediately behind the trench digger. The housing which is of a width to completely fill the trench is open along the bottom and has vertical side walls that extend above ground level. A shallow layer of gravel is deposited in the bottom of the trench at the front end of the moving housing and a workman standing inside the housing lays the successive tiles or pipe sections by hand on the gravel. At the trailing end of the moving housing more gravel is added to a level above the laid pipe sections thus completely imbedding the pipe in a bed of gravel. The trench is then filled in behind the moving housing, usually by means of a bulldozer.

This prior method has certain disadvantages which are apparent in even moderately damp soil and which make the method impractical and inoperative in excessively wet soil and quicksand. The difficulty is that the pipe sections do not remain in the correct positions in which they are placed by the workman inside the housing. Even when each of the sections appears to remain in its proper place it will be found that the pipe sections actually move out of place to develop serious gaps. Gravel and earth fall into the gaps to block up the interior of the pipe and thus make the whole system inoperative.

The present invention is based on the discovery that defective positioning of the laid pipe arises from two different causes. One cause is that mud surges upward through the open bottom of the traveling housing into the space on each side of each newly laid pipe section between the pipe section and the adjacent side wall of the moving housing. The intruding mud has an adhesive effect between each side of the pipe section and the adjacent housing side wall, which adhesive effect tends to cause the pipe section to be dragged along with the housing. In this manner a correctly positioned pipe section will shift longitudinally to develop a serious gap between two successive pipe sections in the laid pipe.

The other cause for defects in the drainage line is upheaval force at the bottom of the trench against the underside of the pipe that occurs when the trench cuts through excessively wet soil or quicksand. The more fluid the soil the greater the freedom for the hydrostatic pressure of the column of mud on each side of the housing to be transmitted to the mud immediately under the open housing at the bottom of the trench. This upward hydrostatic thrust or upheaval force at the bottom of the trench tends to throw each successively laid pipe section upward and commonly results in such upward tipping of a laid pipe section as to create a fatal gap in the pipeline. Unfortunately the upheaval action can occur after the pipe section is covered with gravel prior to the introduction of soil to completely fill the trench.

The general object of the invention is to provide an apparatus to meet the problem of installing a tile drainage line in wet soil with special reference to these two causes for separation and mis-alignment of the pipe sections. This broad object is accomplished in major part by continuously applying force to the successively laid pipe sections in such manner as to keep the installed pipe under continuous longitudinal compression until the installed pipe is weighed down by the final step of filling the trench. In the preferred practice of the invention, the broad object is further promoted by employing a moving housing that has a bottom wall arrangement effective to prevent the operation of upheaval forces. In this regard a feature of the invention is the concept of providing a moving gravel-packing zone for the deposition of gravel under and around the pipe as fast as the bottom of the trench is exposed by the traveling bottom wall of the housing. When gravel is deposited in the trench under the successively laid pipe sections as fast as the bottom of the trench is exposed by movement of the bottom wall of the housing, the gravel acts as a spacing means between the bottom of the trench and the underside of the successively laid pipe sections and is effective to transmit upheaval forces to the underside of the newly laid pipe. The newly laid pipe withstands upheaval force of any magnitude that may be encountered because the pipe sections being mechanically interlocked are effec-

tively immobilized by the longitudinal compression of the pipeline. Thus the uninterrupted application of longitudinal force against the progressively lengthened pipeline precludes any possibility of undesirable gaps occurring between the laid pipe sections.

A special object of the invention is to provide means for applying longitudinal force to the successively added pipe sections in such manner that the periods of force application to the successive pipe sections overlap and to do so in such manner as to provide room for continually adding new pipe sections to the longitudinally stressed pipeline. This special object is accomplished by using a combination of a first force-applying means that engages the front end of each newly added pipe section and a second force-applying means that grips the newly added pipe sections from their opposite sides. The initial longitudinal force on each successive pipe section is applied at the forward end of the pipe section by the first force-applying means and subsequently the second force-applying means grips the same pipe section from its opposite sides. For a brief period of time each pipe section is engaged by both the first and second force-applying means and then the first force-applying means is shifted forward to permit the introduction of a new pipe section against which the first force-applying means can be moved.

A still further object of the invention is to provide an efficient centralized master control for the two force-applying means. In the preferred practice of the invention the two force-applying means take the form of pneumatic rams and the master control governs the valves of the pneumatic rams for the desired cycle of operation by the rams against the successively added pipe sections.

The above and other objects and advantages of the invention will be apparent in the following detailed description of the presently preferred practice of the invention taken with the accompanying drawings.

In the drawings, which are to be regarded as merely illustrative:

Fig. 1 is a diagrammatical view of the presently preferred embodiment of the apparatus of the invention in the process of laying a drainage line of pipe;

Figs. 2, 3 and 4 are diagrams illustrating different stages in the cycle of the operation of the two force-actuating means for maintaining the pipeline under longitudinal compression during the laying operation;

Fig. 5 is a fragmentary transverse section taken as indicated by the line 5—5 of Fig. 1 and the angular line 5—5 of Fig. 6;

Fig. 6 is a plan view of a yoke that carries clamp means to grip the successive pipe sections from opposite sides, the yoke being viewed as along the line 6—6 of Fig. 5;

Fig. 7 is a perspective view of one of the two clamp means;

Fig. 8 is a perspective view of a pusher plate and an associated central ram for applying pressure against the end of a pipe section;

Fig. 9 is a diagrammatical view of the centralized control or master control system for the force-applying components of the apparatus; and

Fig. 10 is a face view of the master cam disc in Fig. 9.

Fig. 1 shows a line of pipe, generally designated by numeral 20, comprising a series of pipe sections P laid end to end in a bed of gravel 21 buried in soil a substantial distance below the ground level 22. The individual pipe sections P are made of a cement mixture and are adapted for interlocking engagement with each other. As best shown in Fig. 6, each pipe section has an inner circumferential flange 23 at one end and an outer circumferential flange 24 at the other end. The two circumferential end flanges 23 and 24 are bevelled and engage each other in the established pipeline as shown.

The preferred embodiment of the apparatus shown in Fig. 1 for practicing the new process comprises mechanism and structure carried by a narrow vertical housing, generally designated H, that is connected in tandem to a conventional ditch digger D. The ditch digger D, which may be of the wheel type, digs a trench having a bottom surface 28 and two side surfaces 29, the trench being relatively narrow. The housing H is dragged slidingly along the trench by the ditch digger with a bottom wall 30 of the housing resting on the bottom surface 28 of the trench and with two vertical side walls 31 of the housing positioned close to the two side surfaces 29 of the trench.

The housing H is of a height to extend a substantial distance above the ground level 22, as shown, and has a forward wall 32 to conform to the contour of the ditch digger. The housing also has a rear wall 33 which terminates at the gravel bed 21 and extends upward above the ground level 22. Spaced forward from the rear wall 33 is a relatively short vertical partition 34. The partition 34 is apertured to clear the pipeline 20 and the aperture is preferably provided with a flap or curtain 35 which tends to close the aperture and thereby, in effect, makes the aperture conform to drainage pipe of different diameters. This vertical partition 34 with its curtain 35 cooperates with the rear wall 33 of the housing to form what may be termed a gravel-packing compartment 36. Gravel is continuously supplied to this compartment by a gravel duct 40 that extends downward from an upper gravel hopper 41. The lower end of the gravel duct 40 is preferably slightly higher than the lower end of the rear wall 33 so that sufficient gravel will be fed to the gravel compartment to fill the compartment to the level defined by the lower edge of the rear wall.

It is contemplated that the hopper 41 will be kept supplied with gravel as the housing H moves along behind the ditch digger D and that successive pipe sections P will be delivered to the interior of the housing as required to extend the drainage pipeline 20 at the rate of forward movement of the housing. For this latter purpose a suitable chute 42 of V-shaped cross sectional configuration may be mounted in the interior of the housing H, the chute 42 being inclined at a sufficient angle to cause successive pipe sections P to slide downward thereon by gravity to come to rest against an end stop 43. A workman on the ground beside the trench delivers successive pipe sections P to the upper end of the chute 42 and an operator who carries out the new pipe-laying method rides inside the housing H and adds the successive pipe sections to the pipeline.

The successive pipe sections P are taken from the chute 42 by the operator inside the housing H and are deposited on a V-shaped longitudinal pipe guide 44 having longitudinally spaced supports 45 (Fig. 8). The successive pipe sections P are moved rearward on the pipe guide 44 into engagement with the pipeline 20 in accord with the rate of forward progress of the housing H. The pipe guide 44 is spaced above the level of the bottom wall 30 of the housing to hold the successive pipe sections thereon in longitudinal alignment with the pipe 20. As each successive pipe section P in contact with the forward end of the pipeline moves rearward from the end of the pipe guide, each pipe section is temporarily supported at its front end by the pipe guide and is supported at its rear end by interlocking engagement with the pipeline. Each new pipe section P is held securely in interlocking engagement with the pipeline by virtue of rearward force applied to the pipe section by the two force-applying means.

One of the two force-applying means comprises a forward central ram, generally designated 49, which includes a horizontal air cylinder 50 mounted on a forward bracket 51. A suitable piston (not shown) inside the air cylinder 50 is connected to a rearwardly extending piston rod 52 which carries at its rear end a suitable pusher plate 53 (Fig. 8) for contact with the ends of the suc-

cessive pipe sections P. The pusher plate 53 may be slidingly supported by the V-shaped pipe guide 44, the lower edge of the pusher plate being cut to conform to the configuration of the pipe guide as shown.

As indicated in Fig. 9 the opposite ends of the air cylinder 50 are connected by two air lines 54 with a suitable three-way valve 55. The three-way valve 55 has the usual relief or discharge port (not shown) and is connected by a supply line 56 with a suitable source of compressed air (not shown). In a well known manner the three-way valve 55 has a longitudinally movable operating member 57 which has one limit position for driving the ram piston in one direction, an intermediate neutral position and an alternate limit position for driving the ram piston in the other direction.

The second of the two force-applying means for acting on the successive pipe sections P may comprise a pair of side rams, generally designated by numeral 60, positioned on each side of the pipe guide 44. Each of the side rams 60 includes an air cylinder 61 that has the usual piston (not shown) from which a piston rod 63 extends rearward to a mobile yoke, generally designated by numeral 64.

As indicated in Fig. 9 the two air cylinders 61 may be controlled by a three-way valve 65 that has the usual relief or discharge port (not shown) and is connected by a supply pipe 66 with a suitable source of compressed air (not shown). An air line 67 from one end of the three-way valve 65 is connected by branch air line 68 with one end of each of the two air cylinders 61 and an air line 69 from the other end of the three-way valve is connected by two branch air lines 70 with the other ends of the two air cylinders 61. The three-way valve 65 has a longitudinally movable operating member 71 which has one limit position for moving the pistons in the air cylinders in one direction, an intermediate neutral position and an alternate limit position for moving the two pistons in the opposite direction.

The yoke 64 is adapted to be reciprocated longitudinally of the housing H by the two piston rods 63 and carries a pair of clamp means, each generally designated by numeral 75, that are adapted to grip the successive pipe sections P from the opposite sides of the pipe sections in a releasable manner. The yoke 64, which in this instance is of welded steel plate construction, comprises an arched transverse frame member 76 and two legs 77. The two legs 77 extend downward from the opposite ends of the frame member 76 and are formed with lower flanges 78. The two pistons 63 are connected directly to the two legs 77, respectively.

The yoke 64 may be supported by suitable guide means and for this purpose is preferably provided with a suspension bracket 79 on each side to movably support the yoke from a pair of side rails 80 mounted on the two vertical side walls 31 of the housing H. As best shown in Fig. 5 each of the side rails 80 is of hollow rectangular construction with a pair of inwardly turned bottom flanges 81 defining a longitudinal bottom slot 82. Each of the suspension brackets 79 is in a form of a metal bar that is twisted as shown in Fig. 5 to extend upward into the corresponding bottom slot of the corresponding side rail 80 and the upper end of each suspension bracket carries a pair of rollers 83 that rides on the rail flanges 81.

Preferably the yoke 64 is further provided with a pair of spaced side rollers 87 on each side that roll along a flat metal bar 88 mounted on the side wall of the housing below the corresponding side rail 80. As shown in Fig. 6 each of the four side rollers 87 may be mounted on a corresponding arm 89 which is pivoted by a bolt 90 on a corresponding fixed arm 91. Each of the four fixed arms 91 has an upwardly turned flange 92 through which is threaded a suitable adjustment screw 93 in abutment with the corresponding pivoted arm 89. It is apparent that the four adjustment screws 93 may be sufficiently tightened against the four corresponding pivoted arms 89 to cause the four side rollers 87 to maintain guiding contact with the two side bars 88.

Each of the two clamp means 75 comprises a hollow body 97 (Fig. 7) which serves as a socket to releasably hold an angular shoe 98 which is held in place by a pair of cap screws 99. Each angular shoe 98 is preferably provided with a liner 100 which may, for example, be a piece of belting and which serves the purpose of making non-slipping contact with the periphery of a pipe section P. It is contemplated that angular shoes 98 of different lengths will be available for use interchangeably in the two hollow bodies 97 to permit the two clamping means to grip pipe sections P of different diameters.

Each of the hollow bodies 97 has a cylindrical portion 101 by means of which it is mounted on a corresponding vertical rocker shaft 102, the hollow body being held against rotation on the rocker shaft by a pair of screws 103. Each of the two rocker shafts 102 is mounted vertically in one of the legs 77 of the yoke 64 with the lower end of the rocker shaft journalled in the lower flange 78 of the leg and with the upper end of the rocker shaft journalled in the transverse frame member 76 of the yoke. Keyed to the upper end of each of the rocker shafts 102 is an operating arm 104 which is adapted for actuation by remote control in a suitable manner.

In the construction shown in the drawings, one of the operating arms 104 is connected by a rod 105 to an air cylinder 109 and the other operating arm is connected to a piston rod 110 that extends to a piston 111 inside the air cylinder. A pair of air lines 112 and 113 is connected to opposite ends of the air cylinder 109 for remote control of the air cylinder. For this purpose, as indicated in Fig. 9, the two air lines 112 and 113 may be connected respectively to the previously mentioned air lines 67 and 69 that control the two side rams 60.

It is contemplated that the operation of the two clamp means 75 will be correlated with the operation of the two side rams 60 with the two clamp means opening slightly in advance of the forward retraction of the two yoke-controlling piston rods 63 and closing slightly in advance of the rearward extension movement of the two piston rods. Since the clamp-controlling air cylinder 109 is substantially smaller than the two yoke-controlling air cylinders 61 the desired correlation is inherent in the system. If necessary, however, the air lines 112 and 113 may be relatively large for relatively rapid communication between the three-way valve 65 and the air cylinder 109, or the same effect may be achieved by restricting the rate of air flow between the three-way valve and the two air cylinders 61.

While the two three-way valves 55 and 65 may be separately manipulated by hand, preferably they are connected to a single central control on a control panel 115. In the particular arrangement illustrated by Figs. 9 and 10, for example, the two three-way valves 55 and 65 are controlled by a master control handle 116 which is carried by a cam disc 117. The cam disc 117 is rotatably mounted on a pivot 118 and is operatively connected with the two three-way valves. The operating member 57 of the three-way valve 55 is connected to a slide member 119 that is guided by four rollers 120 and, in like manner, the operating member 71 of the three-way valve 65 is connected to a second slide member 121 guided by four rollers 122. The first slide member 119 carries a cam follower 123 that engages a cam slot 124 in the cam disc 117 and the second slide member 121 in like manner carries a cam follower 125 that engages a second cam slot 126 in the cam disc.

Cam slot 124 has a first outer dwell 130, an intermediate dwell 131, an inner dwell 132 and a second outer dwell 133. At each of the two outer dwells 130 and 133 the follower 123 actuates the three-way valve

55 to extend the piston rod 52 of the central ram 49 and at the inner dwell 132 the cam follower 123 actuates the three-way valve to retract the piston rod forward. The intermediate dwell 131 corresponds to the neutral intermediate position of the three-way valve.

The other cam slot 126 has an outer dwell 134, an intermediate dwell 135 and an inner dwell 136. When the cam follower 125 is in the outer dwell 134 the operating member 71 of the three-way valve 65 is actuated to extend the two yoke-actuating pistons 63 of the side rams 60 for rearward movement of the yoke 64 and when the cam follower is in the inner dwell 136 the three-way valve is actuated to retract the two yoke-actuating piston rods 63 to move the yoke 64 rearward. The intermediate dwell 135 corresponds to the intermediate neutral position of the three-way valve. As heretofore explained, the air cylinder 109 that controls the two clamp means 75 responds to operation of the three-way valve 65 by opening the two clamp means slightly in advance of the forward retraction of the two pistons 63 and by closing the two clamp means slightly in advance of the rearward extension of the two piston rods.

The manner in which oscillation of the cam disc 117 by the master control handle 116 correlates the operation of the various air cylinders 50, 61 and 109 may be understood by considering six control stations on the cam disc 117. These stations are represented respectively by six diametrical lines designated station 1, station 2, station 3, station 4, station 5 and station 6. When the two cam followers 123 and 125 are at station 1 the parts for the mechanism for applying longitudinal force to the pipeline are positioned as shown in Fig. 2. The two clamp means 75 are actuated by the air cylinder 109 to grip the latest added pipe section P of the pipeline and the two piston rods 63 actuated by the two side cylinders 61 exert continuous rearward thrust on the yoke 64 to cause the two clamp means 75 to maintain the pipeline under longitudinal compression. At this time the central ram 50 is retracted to position the pusher plate 53 forward from the last added pipe section P of the pipeline. Thus at station 1 of the cam disc 117 space is provided for the positioning of a new pipe section in front of the pusher plate 53 as shown in Fig. 2.

When the operator swings the master control arm 116 to shift the two followers 123 and 125 through station 2 to station 3 the parts of the force-applying mechanism respond in the manner indicated by Fig. 3. The two clamp means 75 continue to grip the same pipe section as in Fig. 2 and the two air cylinders 61 continue to apply longitudinal force to the pipeline through the two piston rods 63. The piston rod 52 of the central ram, however, is now extended to force the pusher plate 53 against the new pipe section thereby causing the pipe section to slide along the V-shaped pipe guide 44 into interlocking engagement with the pipe section P that is gripped by the clamp means 75. Thus at station 3 the central ram as well as the two side rams apply force to maintain the pipeline under longitudinal compression.

When the operator swings the master control handle 116 further clockwise to shift the two cam followers 123 and 125 through station 4 to station 5 the parts of the force-applying mechanism respond in the manner indicated in Fig. 4. The central ram continues to press the pusher plate 53 against the end of the last added pipe section P to maintain the pipeline under longitudinal compression but the two clamp means 75 open for disengagement from the pipeline and the two air cylinders 61 retract the two piston rods 63 to move the yoke 64 forward alongside the last added pipe section.

The operator now reverses the master control handle 116 counter-clockwise to rotate the cam disc back through station 4 to station 3 with the result that the two clamp means 75 positioned as shown in Fig. 4 close to grip the last added pipe section P. Here again force is applied to the pipe line simultaneously by both the central ram and the two side rams, both forces in this instance being applied simultaneously to the last added pipe section. Thus the periods of force application by the central ram overlap the periods of force application by the two side rams.

The operator completes the operating cycle by moving the master control handle 116 further counter-clockwise to rotate the cam disc 117 back through station 2 to station 1 thereby causing the central ram to retract to provide room for a new pipe section as shown in Fig. 1. Thus each cycle of operation for adding a new pipe section P to the pipeline without interrupting the application of longitudinal pressure to the pipeline is carried out simply by swinging the master control handle 116 first clockwise and then counter-clockwise to cause the cam disc 117 to rotate from station 1 to station 3, from station 3 to station 5, from station 5 back to station 3, and from station 3 back to station 1.

If the operator finds it necessary to retract both the central piston rod 52 and the two side piston rods 63 at the same time, for example, at the start of laying a pipeline, he shifts the master control handle 116 to rotate the cam disc 117 to station 6, this station being shown in operative position in Fig. 10. At this station the follower 123 is in the second outer dwell 133 and the follower 125 is in the inner dwell 136. As a result, the two three-way valves 55 and 56 are actuated to retract the central piston rod 52 and to open the two clamp means 75 and retract the two side pistons 63.

Preferably suitable means is provided for normally preventing rotation of the cam disc 117 beyond station 5 to station 6. For example, a stop lever 137 having a handle 138 may be mounted on a pivot 139 and may be normally held by the suitable spring 140 against a stop lug 141 on the face of the cam disc. Normally the lever 137 is in abutment with the stop lug 141 to serve as a stop in cooperation with the cam follower 123 to block rotation of the cam disc beyond station 5. Whenever it is desired to rotate the cam disc 117 to station 6, the lever 137 may be swung out of the way.

As the housing H moves in tandem behind the ditch digger D it provides a moving pipe laying zone in the trench in the region of operation of the central ram 49 and the two side rams 60 and also provides an adjacent trailing gravel-packing zone into which gravel is dropped by the duct 40 from the gravel hopper 41. As the housing H moves along the newly dug trench the hopper 41 is continually replenished and new pipe sections P are lowered into the housing H on the inclined chute 42 as often as required. The operator inside the housing H simply reciprocates the master control handle 116 to oscillate the cam disc 117 between the two limit positions represented by stations 1 and 5 to carry out the previously described operating cycle repeatedly.

At the beginning of each operating cycle the operator transfers a new pipe section P from the delivery chute 42 to a position on the pipe guide in front of the installed pipeline as indicated in Fig. 2. When central ram 49 and the two side rams 60 are in operation, i.e. when they are both forcing the same or two adjacent pipe sections against the established pipeline at the same time, they gradually extend automatically at the rate of longitudinal forward movement of the housing H. As the gravel-packing compartment 36 shifts forward with movement of the housing H, gravel from the duct 40 gravitates around and under the installed pipe to extend the gravel bed 21 progressively. A bulldozer 142 operating behind the traveling housing forces the piled dirt 143 back into the trench to completely refill the trench above the level of the bed of gravel.

The two side walls 31 of the housing H keep the sides of the trench from caving in and the bottom wall 30 of

the housing keeps the bottom of the newly dug trench from upheaval. As the trailing end of the bottom wall **30** of the housing uncovers the bottom of the trench, the gravel-packing compartment **36** moves over the exposed trench bottom to deposit gravel thereon and the deposited gravel transmits any upward upheaval forces against the underside of the pipeline. Thus the deposited gravel prevents upheaval by transmitting upheaval forces to the pipeline, the longitudinal compression of the pipeline being sufficient to resist any tendency for such upheaval forces to push the newly added pipe sections upward out of alignment with the installed pipe sections. As the housing H moves along to expose the bed of gravel **21**, the bulldozer **142** fills in the trench so that the weight of the filled-in earth on top of the bed of gravel becomes effective to prevent upheaval forces from forcing sections of the installed pipe upward. It is apparent, therefore, that the force applied by the force-applying means in the pipe laying zone keeps the pipeline under longitudinal compression to resist upheaval forces until the trench is filled in to impose such weight on the installed pipe as to permanently resist the upheaval forces. The soil in which the pipe laying operation is performed may be relatively wet and even semi-fluid without interfering with the described procedure and the functioning of the described apparatus.

It is to be noted that the apparatus of the invention is by no means limited to the specific steps and structure shown and described. Obviously the invention may be practiced without the use of cam disc **117** since valves **55** and **65** or equivalents thereof may be operated manually and independently. Similarly, any convenient means other than chute **42** may be employed to introduce pipe into the housing H. Still further, pipe guide **44** may take any convenient shape and need not necessarily be used at all.

My description in specific detail of the presently preferred practice of the invention set forth herein by way of example to illustrate the principles involved, will suggest to those skilled in the art, various other changes, substitutions and other departures from my disclosure that properly lie within the spirit and scope of the appended claims.

What is claimed is:

1. Pipe-laying apparatus comprising: a housing adapted to move along in a trench; a yoke to fit over a first pipe section at the bottom of said housing; means to support said yoke from said housing in a position to extend over the top of and to move horizontally over pipe to be established; a holder suspended from each side of said yoke on each side of said first pipe section to rotate about parallel axes; a friction shoe fixed to each of said holders; a first hydraulic ram having one end fixed to one of said holders and the other end fixed to the other of said holders to selectively press said shoes against the outer circumference of said first pipe section and to release said first pipe section and press said shoes against a second pipe section; at least one second horizontally disposed hydraulic ram having one end fixed to said housing and the other end fixed to said yoke to press said first pipe section against the forward end of an established pipe while said first ram is operated to press said shoes against said first pipe section and while said housing is moved forwardly away from the forward end of the established pipe; a third hydraulic ram having means at one end to engage the forward end of said second pipe section to press it against the forward end of said first pipe section while said first pipe section is being pressed against the forward end of the established pipe, said third ram having its other end fixed to said housing; and control apparatus for actuating said rams to keep the established pipe continuously under compression.

2. Pipe-laying apparatus comprising: a housing adapted to move along in a trench; a yoke to fit over a first pipe section at the bottom of said housing; means to support said yoke from said housing in a position to extend over the top of and to move horizontally over pipe to be established; a holder suspended from each side of said yoke on each side of said first pipe section to rotate about parallel axes; a friction shoe fixed to each of said holders; first means to pull said shoes together to engage the outer circumference of a first pipe section to grip it securely; second means fixed to said housing for pressing said yoke rearwardly therein to press said first pipe section against a forward end of an established pipe; third means fixed to said housing at one end and slidable thereon at the other end for pressing a second pipe section against the forward end of said first pipe section at said other end of said third means; and control apparatus operable sequentially (1) to actuate said first means to pull said shoes together to engage the outer circumference of said first pipe section to grip it securely, (2) to actuate said second means to press said yoke rearwardly in said housing and thereby to press said first pipe section against the forward end of the established pipe while said first means is actuated with (1) preceding, and (3) to actuate said third means to hold said second pipe section against said first pipe section while said first and second means are actuated to release the first and second means preliminary to repeating said sequential operation with the next succeeding pipe section.

3. Pipe-laying apparatus comprising: a housing; a yoke slidable longitudinally on said housing; first longitudinal power means fixed to said yoke and to said housing to force said yoke rearwardly in said housing while said housing itself is moved forwardly; a pair of arms pivoted on said yoke; friction shoes fixed to said arms and positioned to move toward and away from opposite sides of a pipe section; transverse power means for operating said arms to cause said shoes to grip a first pipe section between them; second longitudinal power means fixed to said housing and operable independently of said first longitudinal power means and said transverse power means to press a succeeding pipe section against said first pipe section, said second longitudinal power means being reciprocable to maintain said succeeding pipe section in pressure contact with the end of said first pipe section while said shoes are in pressure contact with said first pipe section and while they are subsequently released and engaged with the outer circumference of said succeeding pipe section; and control apparatus operable sequentially (1) to actuate said transverse power means to pull said shoes together to engage the outer circumference of said first pipe section to grip it securely, (2) to actuate said first longitudinal power means to press said yoke rearwardly in said housing and thereby to press said first pipe section against the forward end of the established pipe while said transverse power means is actuated in accordance with (1) preceding, and (3) to actuate said second longitudinal power means to hold said succeeding pipe section against said first pipe section while said transverse power means and said first longitudinal power means are actuated to release the transverse and first longitudinal power means preliminary to repeating said sequential operation with the next succeeding pipe section.

4. Pipe-laying apparatus comprising: a housing; a yoke to extend around a pipe section; guide means to support said yoke in said housing in a position to move longitudinally therein; a pair of clamp means pivotally secured to said yoke, one of said clamp means being pivotally secured at one side of said pipe section and the other of said clamp means being pivotally secured to said yoke at the other side of said pipe section; first power means secured to said clamp means to pull them together about their pivotal connection against a pipe section; second means fixed to said housing and said yoke to press said yoke rearwardly in said housing; third

means fixed to said housing also for engaging a pipe section to press it rearwardly in said housing; and control apparatus operable sequentially (1) to actuate said first means to pull said clamp means together to engage the outer circumference of a first pipe section to grip it securely, (2) to actuate said second means to press said yoke rearwardly in said housing and thereby to press a first pipe section against the forward end of the established pipe while said first means is actuated in accordance with (1) preceding, and (3) to actuate said third means to hold a second pipe section against a first pipe section while said first and second means are actuated to release the first and second means preliminary to repeating said sequential operation with the next succeeding pipe section.

5. Pipe-laying apparatus comprising: a housing; a yoke to extend from one side over the top of a pipe section to the other side thereof; guide means to support said yoke in said housing in a position to move longitudinally therein; clamp means pivotally secured to said yoke on each side thereof; a transverse ram connected between said clamp means to hold them against a pipe section; a side ram fixed to each side of said yoke and fixed to said housing to press said yoke rearwardly in said housing; an auxiliary ram fixed to said housing between said yoke rams also for engaging a pipe section to press it rearwardly in said housing, all of said rams being operable by the introduction of fluid under pressure thereto; and control apparatus operable sequentially (1) to actuate said transverse ram to pull said clamp means together to engage the outer circumference of said first pipe section to grip it securely, (2) to actuate said side rams to press said yoke rearwardly in said housing and thereby to press said first pipe section against the forward end of the established pipe while said transverse ram is actuated in accordance with (1) preceding, and (3) to actuate said auxiliary ram to hold said second pipe section against said first pipe section while said transverse ram and said side rams are actuated to release the transverse and side rams preliminary to repeating said sequential operation with the next succeeding pipe section.

References Cited in the file of this patent

UNITED STATES PATENTS

1,342,231	Schaanning	June 1, 1920
1,557,762	Schaanning	Mar. 23, 1926
1,600,701	Sommer	Sept. 21, 1926
2,029,125	Russell et al.	Jan. 28, 1936
2,602,410	Vaughn	July 8, 1952
2,738,745	Harpold	Mar. 20, 1956

FOREIGN PATENTS

385,189	Germany	Nov. 20, 1923