May 7, 1968 L. F. WELLS 3,381,478

CONTROL SYSTEM FOR PIPE-LAYING APPARATUS

Filed Aug. 18, 1966 4 Sheets-Sheet 1

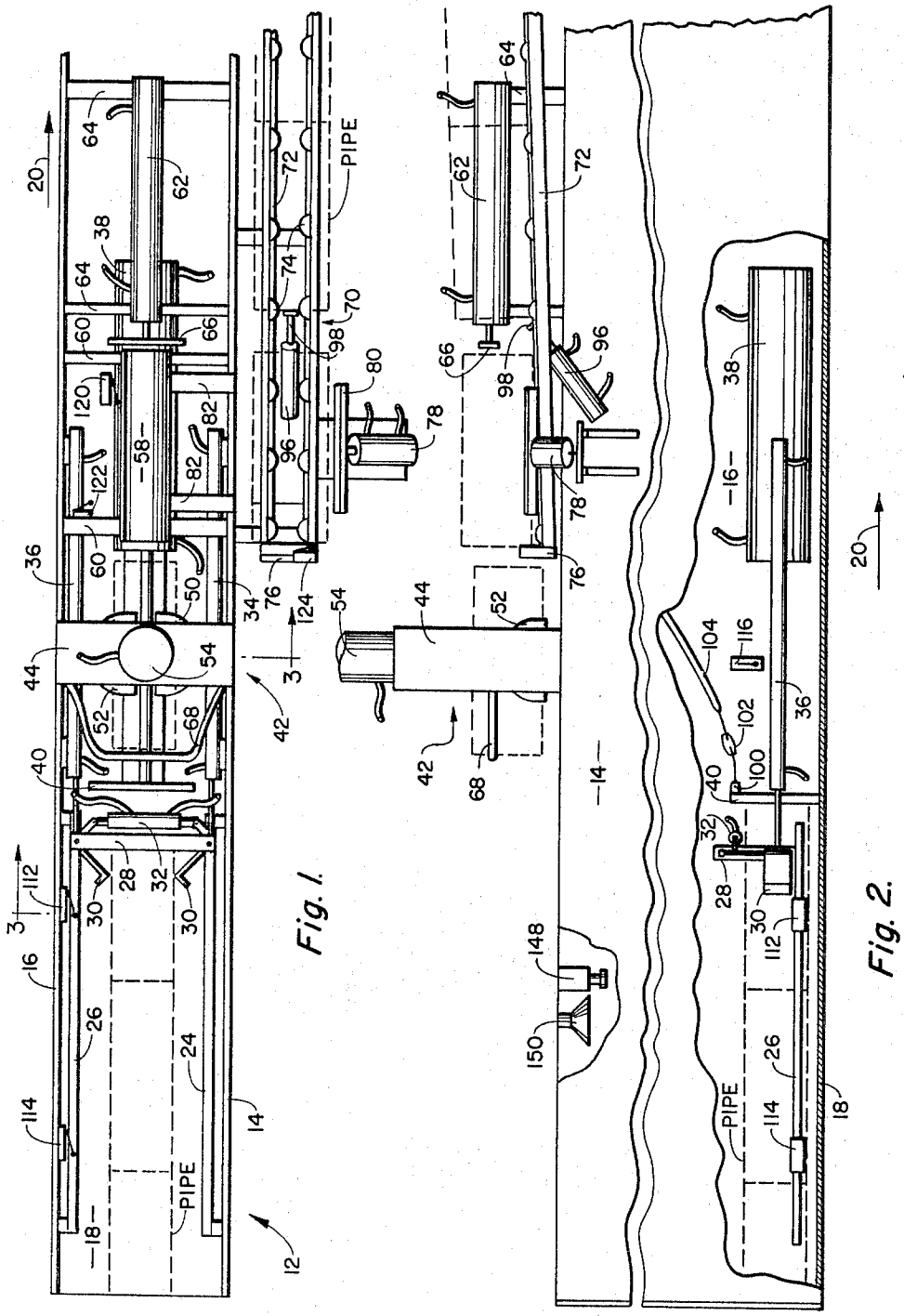


Fig. 1.

Fig. 2.

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CONTROL SYSTEM FOR PIPE-LAYING APPARATUS

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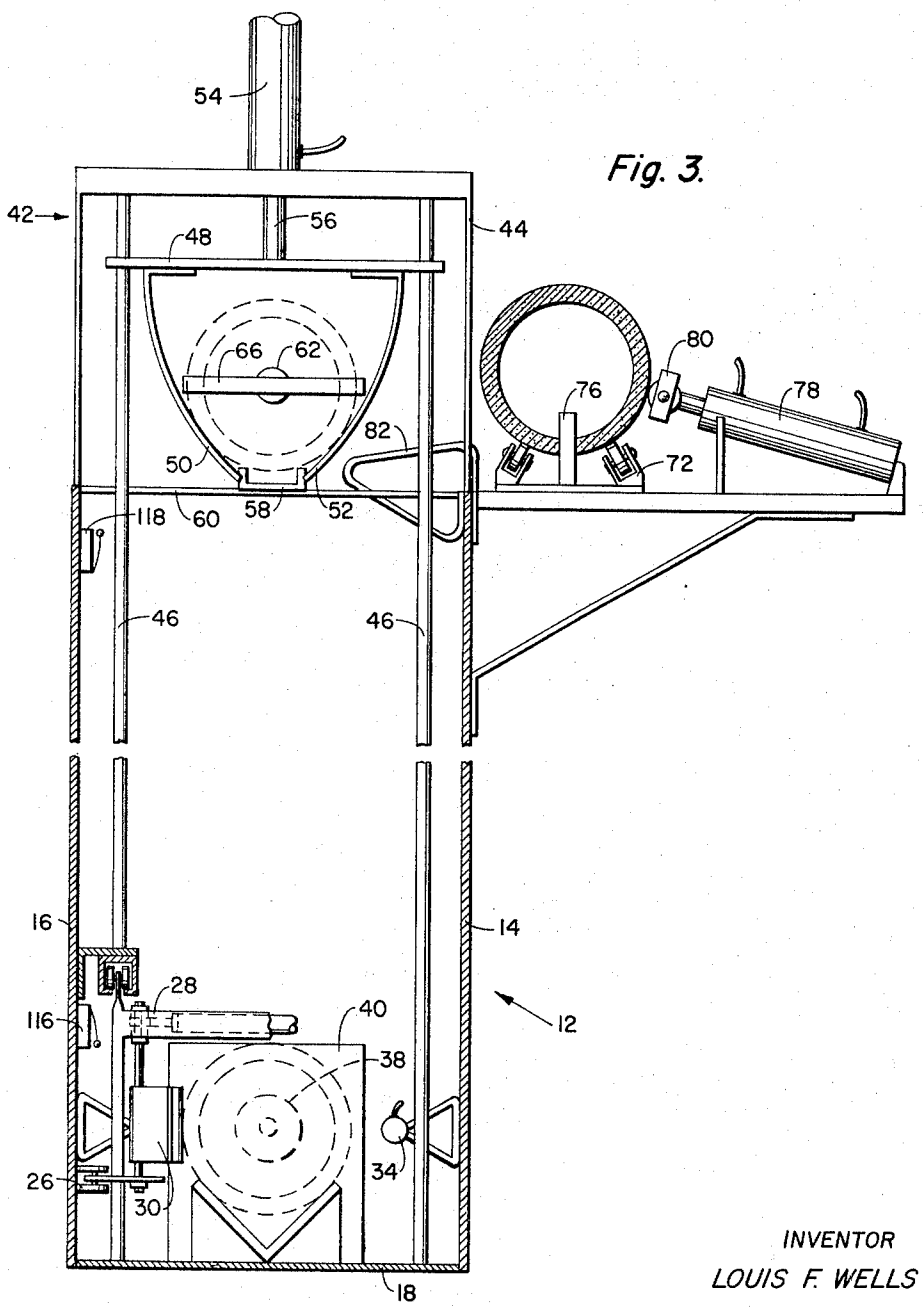


Fig. 3.

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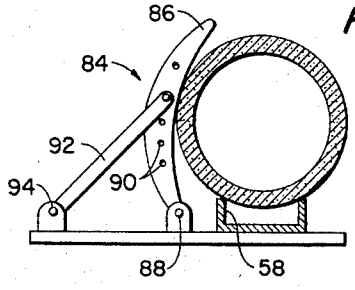
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CONTROL SYSTEM FOR PIPE-LAYING APPARATUS

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Fig. 5.



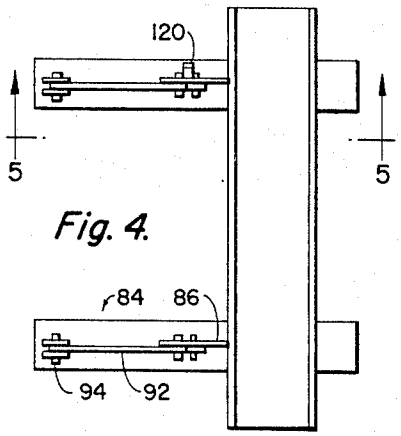


Fig. 4.

Fig. 6.

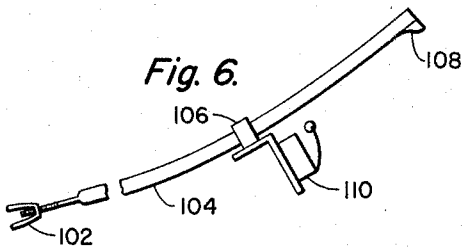
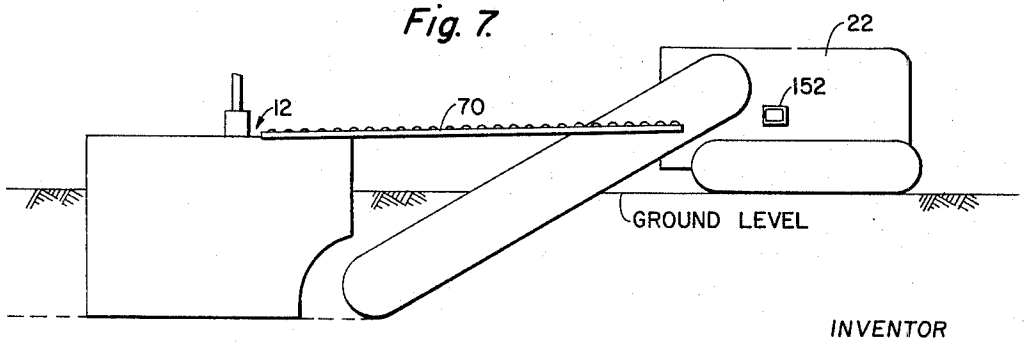


Fig. 7.



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CONTROL SYSTEM FOR PIPE-LAYING APPARATUS

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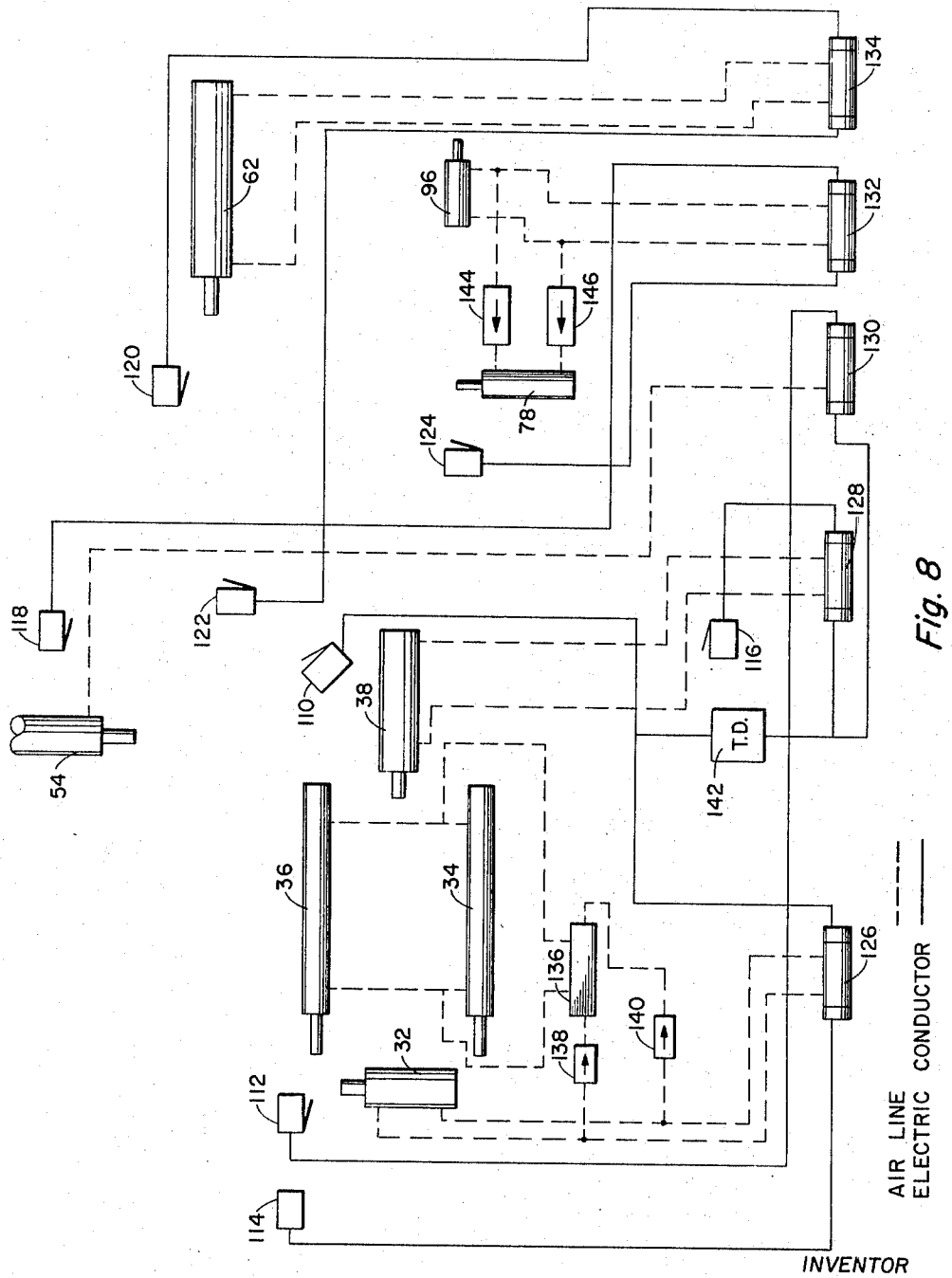


Fig. 8

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3,381,478

CONTROL SYSTEM FOR PIPE-LAYING APPARATUS

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Filed Aug. 18, 1966, Ser. No. 573,382
5 Claims. (Cl. 61—41)

ABSTRACT OF THE DISCLOSURE

An apparatus for handling and placing drain pipe in the bottom of a trench is provided with a housing which will fit into and move forwardly along the bottom of the trench. An elevator within the housing moves one pipe at a time down to the bottom of the trench after the pipe is supplied to the elevator at ground surface level from a conveyor. The conveyor extends from the elevator forwardly along a side of the trench for receiving a supply of pipe and feeding single pipe to the elevator. Each pipe at the lower level when reached by elevator is moved from the elevator by rams to add another length of pipe to drain line at the bottom of the trench. The sequence of a pipe being moved from the conveyor, to the elevator, and from the elevator into the installed line of pipes is a continuing operation by the apparatus and its automatic control system.

This invention relates to a control system for pipe-laying apparatus of the type employed in placing drainage tiles in agricultural acreage. More particularly this invention relates to an automatic system which controls the delivery and placement of individual tiles so as to improve the speed and accuracy of machine operation and to effect a substantial saving in manpower.

Apparatus with which the present invention is particularly suitable is described in U.S. Patent No. 2,830,548, entitled "Pipe-Laying Method" and in U.S. Patent No. 2,921,543 entitled "Pipe Laying Apparatus." As described in more detail in such patents, drainage lines formed of individual pipe sections or tiles having a length of about 2–2½ feet can be expeditiously laid even in extremely wet soil. Such is the case because the machine and method described in the above-cited patents includes a pair of ram mechanisms which alternately, sequentially, and continuously apply force longitudinally of the pipeline as individual pipe sections are laid in place. The apparatus, in accordance with the cited patents, is drawn through a trench immediately behind a digging machine that forms the trench, and although the patented apparatus is quite satisfactory, a large crew is necessary to utilize efficiently the apparatus and practice the invention described in the cited patents.

More specifically, at least four men are required for operation of the apparatus, such men performing the following tasks; a first man manipulates the conventional controls on the trenching apparatus to control the speed of forward movement and the depth of cut; a second man rides within the apparatus described in the cited patent in order manually to place pipe sections in alignment with the previously laid pipeline and after such manual placement, manipulate the control provided by the patented apparatus for practicing the patented method; a third man works on the ground surface adjacent the apparatus to feed tile sections into the apparatus for placement by the second man; and a fourth man also on the ground surface maintains in a full condition a gravel hopper that constitutes an element of the apparatus described in the cited patent. The principal object of the present invention is to totally eliminate the so-called second man referred to hereinabove.

Another object is to so mechanize the pipe feeding components of the apparatus that functions of the above-mentioned third and fourth men can be performed by one individual.

Apparatus achieving the foregoing objects is provided by the present invention, and as more fully described hereinafter, includes automatic pipe section feeding apparatus and a control system for assuring that the feeding apparatus supplies the pipe sections in properly timed relationships with the remainder of the apparatus. Also contributing to achievement of the objects of the invention are strategically located sensing elements which sense the position of the various components of the system to assure their proper co-ordination.

A feature and advantage of the apparatus of the present invention is that the station at which the pipe is loaded onto the apparatus is located substantially forwardly of the deepest part of the trench so that the man placing pipe sections into the apparatus need walk only on relatively solid ground. The full import of this feature and advantage can be appreciated by considering that the earth adjacent the vertical trench wall has only slight resistance to caving in and that the occurrence of cave-ins makes access to the apparatus difficult. By eliminating the necessity for workmen to approach the trench walls the likelihood of cave-ins is materially reduced, thereby lessening the effort required by the workman loading pipe tile sections onto the apparatus.

Another feature and advantage of the present invention is that the pipe feeding and placing apparatus is controlled in response to the positional relationship of the various parts of the apparatus and of the pipe sections rather than being controlled in relation to time. Accordingly, the apparatus functions with equal efficiency when the apparatus is moving forward at a relatively rapid rate as is possible in relatively dry and soft soil, or at a relatively slow rate as is necessary in muddy or swampy regions. Such accuracy of operation is attained without necessity for any manual adjustments.

Still another object of the present invention is to provide an automatic control system of the type referred to hereinabove that can be quickly and conveniently disabled should extraordinary operating conditions and/or component malfunction occur.

Other objects, features and advantages will be more apparent after referring to the following specification and accompanying drawings in which:

FIG. 1 is a plan view of a pipe laying apparatus incorporating the present invention;

FIG. 2 is a side elevation view of the apparatus of FIG. 1;

FIG. 3 is a cross-sectional view taken along line III—III of FIG. 1;

FIG. 4 is a detail plan view at enlarged scale of a portion of the apparatus of FIG. 1;

FIG. 5 is a cross-sectional view taken along line 5—5 of FIG. 4;

FIG. 6 is a fragmentary view of a detail of the apparatus of the present invention;

FIG. 7 is a simplified side view of the apparatus in operation with a conventional trench digging machine; and

FIG. 8 is a schematic view of the electric and pneumatic systems employed in practicing the invention.

Referring more particularly to the drawings, reference numeral 12 indicates a housing described in somewhat more detail in the above-cited patents, which housing includes spaced-apart vertical walls 14 and 16, and a bottom wall 18, which form a rigid structure adapted to be drawn along a trench in a direction indicated by arrow 20. A conventional trenching machine 22 is provided and performs the dual functions of digging the

trench and propelling housing 12 along the trench. As is described with more specificity in the above-cited patents, a pipeline is formed by sequentially laying a series of individual pipe sections P; for assuring that the joints between adjacent tiles P are properly formed the cited patents disclose apparatus by which constant longitudinal force is applied to the entire line and to the individual tiles as they are laid.

For applying such continuous longitudinal force to the pipeline, the apparatus described in the patents cited above includes side rails 24 and 26 secured to opposite side walls 14 and 16 adjacent to bottom wall 18. Rollably supported on the rails is a yoke 28, on opposite sides of which are pivotally mounted clamp jaws 30 which are operatively linked to a pneumatic cylinder or the like 32. It will be seen most clearly in FIG. 1 that on application of air pressure to cylinder 32 the jaws 30 will move inwardly to engage a pipe section P. For moving the yoke rearwardly a pair of cylinders 34 and 36 is provided which cylinders have their respective rods connected to the yoke and their cylinder bodies attached to respective side walls 14 and 16. Cooperating with yoke 28 and its accouterments is a centrally located main ram cylinder 38 having a ram head 40 which bears against the forward end of pipe tile P to apply longitudinal force to the pipeline intermediate the period that the pipeline is engaged by jaws 30. As will be appreciated from a perusal of the above-cited patents, one or the other of head 40 and jaws 30 are at all times in engagement with the pipe to apply continuous longitudinal force to the pipeline and thereby assure the integrity of the joints between adjacent sections.

The elements described up to this point are fully disclosed in the cited patents and do not in themselves form a part of the present invention.

For placing the pipe sections into position for operation thereon by ram head 40 and jaws 30, an elevator structure 42 is provided. As can be seen most clearly in FIG. 1, the elevator is disposed in front of the forwardmost position of yoke 28 and rearwardly of ram 40 when it is in the retracted position in cylinder 38. The elevator includes a frame structure 44 projecting above the top edge of the housing 12 which frame structure supports the upper ends of rods 46, the lower ends of which are secured to bottom wall 18. The rods form vertical guides for a crossbar 48 which is slidably mounted on the rods to move between an upper position and a lower position. Depending from the crossbar are curved members 50 and 52 which form a basket for supporting a pipe section. For raising and lowering the elevator a pneumatic cylinder 54 is provided and has a piston rod 56 secured to crossbar 48.

Pipe sections are loaded into the elevator from a cradle 58 which is rigidly supported on housing 12 forwardly of and in alignment with the elevator. Cross braces 60 so support the cradle. Forwardly of cradle 58 and in longitudinal alignment therewith and with the elevator is a pneumatic cylinder 62 mounted rigidly of housing 12 by means of braces 64. The cylinder has a pusher bar 66 mounted on its piston rod as a consequence of which tiles residing in cradle 58 are pushed onto the elevator when air is supplied to cylinder 62 to extend the rod. In order to prevent excessive rearward travel of the tile section a bail 68, formed for example of ¾ inch diameter steel rod, is secured to frame 44 and configured so as to limit rearward movement of the tile so that the tile is centered in the elevator basket.

Laterally spaced from cradle 58 and on the outboard side of side wall 14 is a roller conveyor 70 that is formed by two mutually parallel structural members 72 which carry a plurality of anti-friction rollers 74 oriented to define a generally V-shaped path along which pipe tiles P travel. Structural members 72 are sloped downwardly to the rear so that pipe tiles loaded adjacent the forward end of the conveyor will move rearwardly in response to the force of gravity acting on the tiles. A transverse stop 76 defines the rear extremity of conveyor 70 and is located so as to position a pipe tile resting thereagainst transversely opposite cradle 58.

As can best can be seen in FIG. 7, conveyor 70 extends forwardly by an amount sufficient that its front or input end is adjacent substantially solid ground. Thus a workman loading pipe tile sections onto conveyor 70 need not stand on ground adjacent the deepest part of the trench. The likelihood of cave-ins is thereby reduced since the ground adjacent the front of conveyor 70 is solid.

It will further be noted that conveyor 70 is sufficiently long that a plurality of pipe sections can be loaded at one time, thereby at least partially freeing a man for other duties.

A pneumatic cylinder 78 is mounted outboard of the rearward extremity of conveyor 70 and has a pusher frame 80 secured to the rod thereof so that on energization of the air cylinder 78 a pipe tile section residing against stop 76 is transferred laterally to cradle 58. A pair of rigid bands 82 is mounted between conveyor 70 and cradle 58 to support the pipe tile as it is rolled laterally in response to energization of cylinder 78. For arresting lateral rolling movement of the tile section (see FIG. 4) a pair of stops 84 is mounted on the side of cradle 58 opposite from conveyor 70. Each stop includes a crescent-shaped member 86 pivotally mounted to the cradle at 88 and provided with a series of holes 90 therein. Engaged in a selected one of holes 90 by means of a pin or bolt is one end of a lever 92, the opposite end of which is pivotally mounted to the frame of the apparatus at 94. The stops 86 can be adjusted to position any size tile properly in cradle 58; in one structure designed according to the present invention the holes were so arranged that pipes having a diameter of from four inches to twelve inches could be accommodated simply by appropriately positioning the stops.

In order that one and only one tile is moved transversely onto cradle 58 in response to actuation of cylinder 78 a hold-back cylinder 96 is mounted intermediate and below rails 72 and is so oriented that its rod 98 when extended inhibits further feeding of pipe tiles P to the rear extremity of the conveyor. As will appear hereinafter provisions are made for automatically energizing cylinder 96 at the appropriate stage of operation of the apparatus.

The positions of the various elements in the present apparatus are sensed in order to derive control signals for controlling the sequence of operation of the elements. With reference to the forward movement of ram head 40 by cylinder 38, a rod 100 is pivotally mounted on the back surface of the ram head and has a threaded portion for engagement by a turnbuckle 102. On the opposite end of the turnbuckle is a similarly threaded rod 104 the opposite end of which is carried in a guide member 106 mounted rigidly with respect to housing 12. On the extreme end of rod 104 a cam 108 is formed, a limit switch 110 being supported adjacent guide 106 and positioned to be actuated by cam 108 when ram 40 has reached a particular rearward position as will be explained subsequently. For sensing the rearward movement of yoke 28 is a forward limit switch 112 mounted adjacent track 26 and in the path of travel of the yoke. A rear limit switch 114 is similarly mounted adjacent track 26. Limit switch 112 is so positioned as to be energized subsequent to energization of limit switch 110 and limit switch 114 is arranged to be actuated subsequent to actuation of limit switch 112. Associated with elevator 42 is a lower limit switch 116 which senses the arrival of the elevator at the lowermost position thereof and an upper limit switch 118 which senses arrival of the elevator at the uppermost position thereof. For sensing the arrival of a tile onto cradle 58 a limit switch 120 is provided and for sensing the forwardmost position of pusher bar 66, an event that occurs

when a tile has been fully loaded onto elevator 42, is a limit switch 122.

For sensing the arrival of a pipe tile at the rear extremity of conveyor 70, a limit switch 124 is mounted on stop 76, the limit switch having an actuator arm that is contacted by a pipe tile P when the latter moves down conveyor 70 into a position opposite cradle 58.

The interconnection of the previously described limit switches and cylinders can be appreciated by reference to FIG. 8. In the figure, the various pneumatic cylinders and limit switches are shown in simple schematic form and are interconnected with air hoses indicated by broken lines on the drawing and electric conductors indicated by solid lines on the drawing. In the drawing only a portion of one side of the total electrical circuit is shown; it is to be understood that each limit switch has a connection to one terminal of a power source (not shown) which is connected to the conductor shown in the drawing when the limit switch is closed, and that the other terminal of the power source is commonly connected to each solenoid valve. The air and electrical elements of the system are functionally interconnected through a plurality of solenoid valves indicated at 126, 128, 130, 132 and 134. The valves are conventional elements, each of which has two air connections and two electrical connections. When one of the electrical connections is energized from a power source, the valve acts to supply pressurized air to one of the air connections and to exhaust air from the other air connection, and when the second electrical connection receives an electrical impulse the valve shifts so that the condition at the respective air connections is reversed. Valve 126 is pneumatically associated with cylinder 32 so that application of electrical signals to the valve causes cylinder 32 to be extended to a position wherein clamp jaws 30 engage a pipe section and retract it to a position at which clamp jaws 30 are disengaged from the pipe section. Valve 126 is electrically energized to the first-named condition through limit switch 110 which is closed in response to forward movement of the piston of main ram cylinder 38. Cylinder 32 is retracted in response to contact of limit switch 114 by yoke 28 when the yoke has reached the rearwardmost position on tracks 24 and 26.

Cylinders 34 and 36, which move yoke 28 back and forth, are actuated in response to actuation of clamping cylinder 32. For this purpose a conventional pilot valve 136 has two output connections connected to the respective ends of cylinders 34 and 36 and two input connections connected through flow control valves 138 and 140 to the air lines feeding the respective ends of cylinder 32. Thus, when cylinder 32 is supplied with air in the cylinder end thereof, which moves clamps 30 into engagement with the pipe tile, air is also supplied through a flow control valve 140 to pilot valve 136. The consequence of such application is that air is supplied to the cylinder end of cylinders 34 and 36 to cause the rods on cylinders 34 and 36 to be extended. Such actuation occurs at a time delayed from the time of actuation of cylinder 32 because pressure control valve 140 inhibits flow of air into pilot valve 136. When cylinder 32 is retracted to disengage clamp 30 from the pipe tile, cylinders 34 and 36 are actuated to retract yoke 28. For this purpose a flow control valve 138 is interposed between the air line connected to the rod end of cylinder 32 and pilot valve 136. The consequence of the presence of flow control valve 138 is that the retraction of cylinders 34 and 36 will be delayed sufficiently that cylinder 32 can disengage clamps 30 from the pipe section.

Main ram cylinder 38 is controlled by a valve 128. Cylinder 38 is caused to extend rearwardly (leftwardly as viewed in the drawing) to apply longitudinal force on the pipeline by connection of limit switch 116 to the appropriate electrical terminal on valve 128. When elevator 42 reaches the lowermost position in its path of travel, a position in which the pipe tile carried by the elevatator is in alignment with the pipeline, limit switch 116 is closed to cause solenoid valve 128 to supply air to the cylinder end of main cylinder 38 and so to cause the rod of the cylinder to be extended rearwardly. Cylinder 38 is retracted when limit switch 110 is closed, an electrical time delay device 142 being provided to delay retraction of cylinder 38 until cylinders 32, 34 and 36 have been actuated.

For controlling the elevator cylinder 54 a four-way valve 130 is provided. In order to lower the elevator, air is permitted to be released from the piston end of cylinder 54, as a consequence of which the elevator drops by gravity. Such action occurs in response to actuation of limit switch 112 when yoke 28 has moved rearwardly sufficient to provide space in vertical alignment with the elevator to receive an additional pipe tile section. The elevator is raised after casing 12 has moved forwardly sufficiently that the tile carried by the elevator has been moved into contact with the pipeline and engaged by clamp jaws 30. Actuation of limit switch 110 switches solenoid valve 130 to cause the elevator to raise, the relatively larger volume of cylinder 54 as compared to cylinder 38 permitting the latter cylinder to retract before the elevator is moved upwardly.

The apparatus for transporting a pipe tile from conveyor 70 to elevator 42 is controlled by electro-pneumatic control valves 132 and 134. When elevator 42 reaches the upper extremity of its path of vertical travel switch 118 is actuated which in turn, through valve 132, causes retraction of cylinder 96 to permit an additional tile to be fed by gravity rearwardly along conveyor 70. Substantially simultaneously with such retraction, cylinder 78 is retracted through an air flow control valve 144. When a tile reaches the rearward extremity of conveyor 70, the tile actuates limit switch 124 which does two things: it energizes cylinder 96 to prevent another tile from moving down the conveyor, and after a brief delay caused by air flow control valve 146, operates cylinder 78 so that its rod is extended and the tile is consequently moved transversely into cradle 58. On arrival of the pipe section in cradle 58, limit switch 120 is actuated, which through control valve 134, causes the rod of cylinder 62 to extend and push the pipe section onto elevator 42. At the end of travel of the rod of cylinder 62, limit switch 122 is contacted and cylinder 62 is retracted readying the apparatus for receipt of another tile onto cradle 58.

Apparatus according to my invention operates as follows: Let it be assumed that the apparatus is positioned as shown in FIG. 1 and that limit switch 110 has just been closed by cam 108 on rod 104 in response to forward movement of housing 12 relative to the pipeline. The consequences of closure of limit switch 110 are as follows: (1) cylinder 32 is extended, through the action of valve 126, so that the sides of a pipe tile section are engaged by jaws 30. When such engagement is complete (2) cylinders 34 and 36 are actuated so that a rearwardly directed longitudinal force is applied to the pipeline. (3) The cylinder 38 is retracted at a short time following the above-described action, because of the delay afforded by time delay element 142, and elevator 42 is raised by air supply to cylinder 54 through the action of valve 130. When the elevator reaches the upper end of its path of travel limit switch 118 causes valve 132 to admit air to retract cylinders 96 and 78, as a consequence of which another pipe tile section is permitted to move down conveyor 70 and actuate limit switch 124. Actuation of limit switch 124 causes the rod of cylinder 96 to extend and prevent further movement of tiles on conveyor 70 and also causes the piston rod of cylinder 78 to extend moving the tile transversely into cradle 58. Arrival of the tile in the cradle 58 is sensed by limit switch 120 which, through valve 134, causes cylinder 62 to load the tile onto elevator 42. Limit switch 122 is actuated at the end of travel of the rod of cylinder 62 so as to retract cylinder 62.

During the time that the loading of elevator 42 has taken place as described next above, yoke 28 has effec-

tively moved rearwardly because housing **12** has moved forward. Because cylinders **34** and **36** are actuated through valves **126** and **136**, constant force is maintained longitudinally of the pipeline. As yoke **28** moves rearwardly on tracks **24**, **26**, the yoke contacts limit switch **112**, the spacing of which is such that sufficient space exists for receipt of another tile at the bottom of the elevator. When limit switch **112** is contacted, the elevator is lowered by the action of valve **130** which releases air from cylinder **54** and permits the elevator to drop by gravity. When the elevator reaches the lower point on its path of travel, so that the tile carried thereby is in alignment with the pipeline, limit switch **116** is actuated and the rod of cylinder **38** extends to push the newly-arrived pipe section into the pipeline. Further rearward movement of carriage yoke **28** causes actuation of limit switch **114** which, through valve **126**, releases cylinder **32** thereby releasing clamps **30** from the pipe section and retracts cylinders **34** and **36**, thereby returning yoke **28** to its forwardmost position. Limit switch **114** is so positioned that during the forward return of yoke **28**, continuous longitudinal force is applied to the pipeline by plunger **40** driven by cylinder **38**. The above-described cycle is repeated when limit switch **110** is again actuated by further rearward movement of cylinder **38**.

In order to assure precise alignment of each succeeding tile section a television camera **148** is mounted in housing **12** in alignment above the path of travel of yoke **28**. A light source **150** is provided for illuminating such area. A TV monitor screen **152** is mounted adjacent the operator's station on trencher **22** so that should the operator observe a malfunction or a misaligned pipe section, he can discontinue forward movement of the trencher until the misaligned or malfunctioning condition is eliminated. Because the rearward force of cylinders **34** and **36** and/or **38** is insufficient to propel housing **12** forwardly, interruption of forward movement of trencher **22** is sufficient to arrest further feeding of the pipe while at the same time maintaining continuous longitudinal rearwardly directed force on the pipeline.

Thus it will be seen that the present invention provides an automatic control system for pipe laying apparatus which eliminates at least one man operation of the structure and reduces the amount of attention to the operation of the device.

What is claimed is: :

1. In pipe-laying apparatus of the class having; a housing that includes a pair of spaced apart vertical walls adapted to be drawn along a trench formed to receive the pipe in the bottom thereof, an elevator in said housing for lowering pipe sections from the top of said housing to the bottom thereof between the vertical walls, first ram means adjacent the bottom of said housing for rearwardly moving a pipe section from said elevator longitudinally of a previously-laid pipe section and into end-to-end engagement with the previously-laid pipe section, and second ram means engageable with the lateral surfaces of the pipe section for rearwardly urging the pipe section longitudinally of a previously-laid pipe section, the improvement comprising: means for loading a pipe section onto said elevator in response to arrival of the elevator at the top of said housing, said elevator being lowerable to a position at which the pipe section in said elevator is forward of the previously-laid pipe section and in longitudinal alignment therewith, means responsive to arrival of said elevator at the bottom of said housing for energizing said first ram means so that the pipe section is moved rearwardly of said elevator and into end-to-end engagement with the previously-laid pipe section, means responsive to rearward movement of said first ram means to engage said second ram means with the pipe section, means responsive to last said means for retracting forwardly said first ram means and raising said elevator, means responsive to further rearward movement of said second ram means for lowering said elevator, and means responsive to still further forward movement of said housing for releasing said second ram when a succeeding pipe section is in place in end-to-end relationship with the pipe section and under longitudinal force from said first ram means.

2. The invention of claim **1** wherein said pipe section loading means comprises: means defining a pipe conveyor adjacent the top of said housing and laterally outwardly of the space between said vertical walls, said conveyor sloping downwardly rearwardly so that a pipe section placed on the forward extremity of said conveyor will move to the rear extremity of said conveyor by gravity, said conveyor having a rearward extremity adjacent to and forward of said elevator, a pipe supporting cradle in transverse alignment with the rear extremity of said conveyor and in longitudinal alignment with said elevator, means for laterally transporting a pipe section from the rear extremity of said conveyor to said cradle, means responsive to the upward movement of said elevator to a level adjacent said cradle for energizing said pipe transporting means, and means responsive to the arrival of a pipe section on said cradle for transferring the pipe section from said cradle to said elevator.

3. The invention of claim **2** wherein said pipe conveyor has a forward extremity sufficiently ahead of said rear extremity that access can be had to said forward conveyor extremity without applying force to the walls of said trench adjacent said elevator.

4. In pipe-laying apparatus of the class having: a housing that includes a pair of spaced apart vertical walls adapted to be drawn along a trench formed to receive the pipe in the bottom thereof, an elevator in said housing for lowering pipe sections from the top of said housing to the bottom thereof between the vertical walls, first ram means adjacent the bottom of said housing for rearwardly moving a pipe section from said elevator longitudinally of a previously-laid pipe section and into end-to-end engagement with the previously-laid pipe section, second ram means engageable with the lateral surfaces of the pipe section for rearwardly urging the pipe section longitudinally of a previously-laid pipe section, and means for controlling the first ram, second ram, and elevator to sequentially feed pipe sections and to maintain constant longitudinal force on the line in which the sections are laid the improvement comprising: pipe section loading apparatus having means defining a pipe conveyor adjacent the top of said housing and laterally outwardly of the space between said vertical walls, said conveyor sloping downwardly rearwardly so that a pipe section placed on the forward extremity of said conveyor will move to the rear extremity of said conveyor by gravity, said conveyor having a rearward extremity adjacent to and forward of said elevator, a pipe supporting cradle in transverse alignment with the rear extremity of said conveyor and in longitudinal alignment with said elevator, means for laterally transporting a pipe section from the rear extremity of said conveyor to said cradle, means responsive to the upward movement of said elevator to a level adjacent said cradle for energizing said pipe transporting means, and means responsive to the arrival of a pipe section on said cradle for transferring the pipe section from said cradle to said elevator.

5. The invention of claim **4** wherein said pipe conveyor has a forward extremity sufficiently ahead of said rear extremity that access can be had to said forward conveyor extremity without applying force to the walls of said trench adjacent said elevator.

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EARL J. WITMER, *Primary Examiner.*