An advancement mechanism for horizontal earth boring machinery which can automatically advance or retract the boring unit without independent manipulation of the locking unit associated with the advancement mechanism. The device comprises a set of dogs pivotally mounted on the advancement mechanism so as to engage rails provided to support the earth boring equipment. A variable volume pump is employed with a hydraulic cylinder to alternately advance the earth boring machine and the advancement mechanism. Further, a lever is employed which has the capability of automatically switching the direction of flow of the hydraulic pump to enable the progression of the total unit to be completely automatic.

6 Claims, 9 Drawing Figures
This invention relates to advancement mechanisms for horizontal earth boring machines. More specifically, this invention is directed to an improved means for locking and unlocking the advancement mechanisms during the walking process and for controlling the walking process using the improved locking means. Heavy-duty, horizontal earth boring equipment generally requires mechanical means for driving the boring unit and auger into and out of the intended horizontal shaft. To accomplish this, a rail or rails have been employed. These rails provide the means for aligning the unit as well as provide the base from which force is applied to both advance and retract the boring unit from the shaft. Advancement mechanisms have been among the methods employed to advance and retract these boring units along the rails. A advancement mechanism is operated by first anchoring it to the track to provide a base for forcing the boring unit either toward or away from the shaft along the rails. When the boring unit has been moved the predetermined distance, the advancement mechanism is disengaged from the track and drawn along to the next position. This sequence is then repeated for as many times as required to cross the desired distance.

Advancement mechanisms heretofore employed to both advance and retract the boring units have required specific separate operations to either engage or disengage the advancement mechanism during each cycle. This separate independent step requires the operator to stop the walking process of each cycle to either engage or disengage the advancement mechanism. This procedure necessarily slows the overall process of drilling a shaft. Further, the walking process cannot be totally automated using this separate engagement step without excessive mechanical complication.

An object of the present invention is to provide an advancement mechanism for a horizontal earth boring machine which will automatically engage and disengage itself from the supporting rails during the walking process. This walking process can be accomplished in either direction. Rail engaging dogs are provided which, when unconstrained, are free to move from engagement with the rails. Selective constraint means are provided which prevent the dogs from disengaging when the advancement mechanism is moved in either one or both directions along the rails. Because the dogs can be selectively constrained from disengagement in a given direction, the advancement mechanism will automatically disengage, advance, and lock in each succeeding position as required.

A second object of the present invention is to provide an automatic advancement mechanism which will selectively allow the walking process to be performed in either direction along the rails. Because of the selective constraint means, the advancement mechanism can be made to automatically perform the cycle of disengagement, advancement, and lock for both advancement and retraction along the rails. Thus, a direction of walking is first selected. The advancement mechanism is then driven by a hydraulic cylinder to perform its function without further independent manipulation of the locking means.

A further object of the present invention is to provide a practical means for automatically actuating a cylinder or other device which is used to alternately force the advancement mechanism toward and then away from the boring unit to accomplish the walking process. Because the operation of the advancement mechanism has been automated through the present invention, a further advantage is obtained. The walking operation may be totally automated with little or no further mechanical complication using a variable volume pump to drive a hydraulic cylinder and a simple control lever.

Thus, a advancement mechanism is herein disclosed which automatically locks and unlocks to accomplish the walking process and provides for easy adaptation to a wholly automatic advancement system for a horizontal earth boring machine. Further objects and advantages will become apparent from the description herein.

FIG. 1 is a side view of the horizontal earth boring unit and the advancement mechanism.

FIG. 2 is a top view of the advancement mechanism and the attached hydraulic cylinder.

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2.

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 3.

FIG. 5 is a top view of the advancement mechanism shown in the advancing mode.

FIG. 6 is a top view of the advancement mechanism shown in the retracting mode.

FIG. 7 is a top view of the control arm and lock taken along the line 7—7 of FIG. 1.

FIG. 8 is an enlarged view of the part of the apparatus shown in FIG. 1.

FIG. 9 is a view of the part of the device shown in FIG. 8.

Turning now to the drawings, FIG. 1 schematically illustrates the employment of the automatic advancement mechanism 10 with the horizontal earth boring unit 12. The unit 12 is shown with an auger 14 in position. Rails 16 are provided to support and guide the total assembly. The automatic advancement mechanism 10 includes a base plate 22 which supports the advancement mechanism 10 on the rails 16. The advancement mechanism 10 also is capable of selectively engaging the rails 16 at engaging means here provided by slots 20. A double acting hydraulic cylinder 18 extends between the horizontal earth boring unit 12 and the advancement mechanism 10 which is capable of acting in combination with the engagement mechanism of the advancement mechanism 10 to force the horizontal earth boring unit 12 in a plurality of steps along the rails 16.

The automatic advancement mechanism 10 is best illustrated in FIGS. 2 through 6. The advancement mechanism 10 has a base plate 22 which is supported on rails 16. Support members 24 are welded to the base plate 22 and add structural rigidity to the unit. Structural members 24 are extended to form brackets 26 and 28 for coupling the hydraulic cylinder 18 to the advancement mechanism 10. A circular hole 30 is provided in each bracket 26 and 28 for the location of pin 32. The cylinder 18 has an eye member 34 which fits between brackets 26 and 28 to cooperate with pin 32. Locking pins 36 and 38 keep pin 32 in position. The base plate 22 is provided with two notches 40 and 42 to accommodate brackets 26 and 28. The base plate 22 is further supported by plates 44 and 46 which are welded to the base plate 22 and the structural members.
Locking members 50 and 52 are provided to keep the advancement mechanism 10 from lifting off the track 16. Pins 54 and 56 tightly fit into brackets 58 and 60 which are in turn welded to the base plate 22. Pivoted arms 62 are allowed to rotate about pins 54 and 56. Plates 64 extend between arms 62 and are welded thereto. Locking members 66 extend under the rails 16 to prevent the advancement mechanism 10 from lifting off the rails 16. Studs 68 are rigidly fixed to the base member 22. Plates 64 fit over studs 68. Locking pins 70 prevent the locking assemblies 50 and 52 from rotating into a disengaged position because of the interference between plates 64 and pins 70.

Means are provided for engagement of the advancement mechanism 10 with rails 16. Such means must allow for disengagement as the advancement mechanism 10 is moved along the rails and further provide for a means of constraint to selectively prevent disengagement. One device for accomplishing this function is provided by dogs 72. Dogs 72 are pivotally mounted rigid members attached to the advancement mechanism 10 through pins 74 and 76 respectively. The pins 74 and 76 are rigidly fixed to the dogs 72 and rotate therewith. The pins 74 and 76 rotate in guide members 78 and 80 and in the base plate 22. The guide members 78 and 80 and in the base plate 22. The guide members 78 and 80 extend the length of the advancement mechanism 10 to keep the advancement mechanism 10 aligned on the rails 16. Washers 82 and 84 space the dogs 72 from the advancement mechanism structure 10 and provide bearing surfaces for the relative rotation between the advancement mechanism 10 and the dogs 72. The indicators 86 and 88 are provided above the base plate 22 to indicate the angular position of the dogs 72. The indicators 86 and 88 further provide a thrust surface for the washers 82. Nuts 90 are provided to lock the pins 74 and 76 in place. The dogs 72 are positioned to engage slots 20 provided in rails 16 and are pivoted to allow disengagement from the rails 16 in the manner shown in FIGS. 5 and 6. To provide positive engagement action by the dogs 72, springs 92 and 94 are provided. Eye bolts 96 anchor the springs 92 and 94 to the dogs 72, and brackets 98 and 100 provide attachment to the structure of the advancement mechanism 10.

To determine the direction of travel of the advancement mechanism 10, means must be provided to work in conjunction with the engagement means or dogs 72 to selectively constrain the dogs 72 from disengagement when the advancement mechanism 10 is forced in a given direction. One form of constraining means which is conveniently operated in conjunction with a single actuation member is provided by dog extensions 102 and a series of stops strategically placed to selectively restrict the movement of the dogs through interference therewith. In the present embodiment blocks 104 and 106 provide such stops. The blocks 104 and 106 are placed on an actuation member or shaft 108 in such a manner that the longest dimension of one block is perpendicular to the longest dimension of the other. The blocks 104 and 106 and the shaft 108 are capable of rotating 90 degrees in order to allow for the positioning of each of the blocks 104 and 106 in a horizontal position. When either of the two blocks 104 or 106 is horizontally disposed, it operates to prevent the dogs 72 from rotating in one direction. Because the blocks 104 and 106 are perpendicularly oriented, when one of the two blocks is horizontally disposed so as to prevent rotation of the dogs 72 in a first direction, the other block is vertical and thereby allows rotation of the dogs 72 in the opposite direction. The two modes provided by rotation of the blocks 104 and 106 are shown in FIGS. 5 and 6. The shaft 108 is pivotally mounted in bearing 110. Spacer collar 112 helps to properly position the shaft 108 in the walking beam. The bearing 110 is welded to structural support plate 114 which extends across the advancement mechanism 10 between rails 16. A lever 116 is mounted on the end of shaft 108. Hole 118 accepts bolt 120 which acts to hold the lever 116 and the shaft 108 in place. Circular guide 122 is fastened to the base plate 22 by bolts 124. Circular guide 122 extends beyond the structural member 114 and base plate 22 to provide interference with the lever 116. Notches 126 are provided in the extended portion of the guide 122 vertically above the center of shaft 108 and at 45 degrees in either direction therefrom. Lever 116 is positioned 45 degrees from the longest dimension of each block 104 and 106 in order that one or the other of blocks 104 and 106 will be horizontally disposed when the lever 116 is in either of the notches 126 located 45 degrees from the vertical. When the lever 116 is in the center notch 126, the blocks 104 and 106 are each rotated 45 degrees from vertical. In this position, both blocks 104 and 106 interfere with the rotational motion of the dogs 72 which in turn prevents the disengagement of the dogs 72 from the rails 16 in either direction.

A hydraulic cylinder 18 of the double action type provides means for both extension and retraction of the advancement mechanism 10 to accomplish the walking process. The cylinder 18 is driven by pump 128. It is advantageous to use a variable volume pump to provide relatively rapid displacement of the cylinder 18 under low load conditions and a relatively large pressure output with a correspondingly smaller travel of the cylinder 18 under high load conditions. The pump swash plate shaft 130 is coupled with shaft extension 132 and subsequently through the rod 134 to control lever 136. The control lever 136 is pivotally mounted to the structure of the boring unit 12. Rotation of the control lever 136 from the vertical determines the direction of flow through the pump and the magnitude of volume per cycle.

There are forces inherent in a variable volume pump which drive the pump swash plate shaft 130 to the neutral position when great resistance to hydraulic flow is experienced. Through proper alignment and bearing tolerance, the frictional resistance between the pump swash plate shaft 130 and the control lever 136 can be reduced below the level of these inherent forces. When the cylinder 18 reaches the limit of either an extension or a contraction stroke, the pump swash plate shaft 130 and necessarily the control lever 136 will be accelerated to the neutral position. Because of the inherent mass in the shaft 130, extension 132, connectors 134, and control lever 136, the control lever 136 has been found to continue to oscillate through multiple cycles of the walking process until the boring unit 12 or the advancement mechanism 10 itself encounters high resistance to travel.

When this totally automatic feature is not desired, resistance arm 138 can be swung into interference with the control lever 136. The resistance arm 138 is pivotally mounted to the structure of the boring unit 12 and
has a plate 140 which extends into the path of the control lever 136. A notch 142 is provided on the plate 140 to catch and retain the control lever 136 as it travels toward the neutral position when an excessive resistance is encountered by the pump 128. Because the plate 140 partially extends into the path of the lever 136, it provides frictional resistance to relative movement between the control lever 136 and the structure of the boring unit 12.

The overall operation of the unit is provided by positioning lever 116 so that block 104 is in the horizontal position. With block 104 in this position, the dogs 72 are free to rotate only as shown in FIG. 5. With the dogs 72 locked in the first set of slots 20, the cylinder 18 is expanded. The expansion of the cylinder 18 causes the earth boring unit 12 to advance along the rails 16. When the cylinder 18 has reached full extension, the hydraulic flow through the pump 128 is reversed and the cylinder 18 contracts. Because of the relative weight of the boring unit 12 as compared to the advancement mechanism 10, the advancement mechanism 10 is pulled toward the unit 12. As the advancement mechanism 10 is drawn toward the unit 12, the dogs 72 rotate from the slots 20 and slide along the rails 16. When the cylinder 18 is near the end of its contraction stroke, the next slots 20 are encountered by the dogs 72 which rotate into the engagement position. It is necessary that the cylinder stroke is slightly longer than the distance between slots 20 as the dogs 72 must pass beyond the slots 20 before they are clear to rotate into the engagement position. When engaged, the pump 128 is then reversed and the cylinder commences to expand. Because the dogs 72 are prevented from rotating by block 104, they remain in the engaged position and hold the advancement mechanism 10 fixed relative to the rails 16. Consequently, the earth boring unit 12 is again advanced in a second cycle of the walking operation. The same sequence operates for retraction of the unit 12 by rotating lever 116 90°. This places block 106 in the horizontal position as shown in FIG. 6. When the operator desires to alternately advance and retract the unit 12 through a short distance, the lever 116 is positioned vertically to bring blocks 104 and 106 into simultaneous interference with dogs 72. With the lever 116 in the vertical position, the dogs 72 are unable to rotate in either direction and the advancement mechanism 10 is consequently held fixed relative to the rails 16. To utilize the totally automatic feature of this device, interference arm 138 is rotated from the path of the control lever 136. In this location, the control lever 136 is free to oscillate and automatically reverse the travel of the cylinder 18 at each end of its stroke. Because this feature is only available when the pump is partially loaded, it can only be used for retraction of the unit 12 or advancement of the unit 12 until the auger 14 encounters the earth.

Thus, the advancement mechanism 10 is capable of operation with a single setting of the control lever 116 and does not require a separate unlocking operation for each cycle of the walking motion. Once the direction of travel is determined through the operation of lever 116, the total walking operation is controlled by control lever 136. Further, the walking operation may be totally automated under certain circumstances as noted above.

Having fully described my invention, it is to be understood that I am not to be limited to the details herein set forth but that my invention is of the full scope of the appended claims.

I claim:

1. An advancement mechanism for a horizontal earth boring machine supported on rails and comprising a base capable of being moved along the rails in first and second directions, rigid members pivotally mounted to said base and extending to the rails, and means on the rails for engaging said rigid members with the rails, said engaging means allowing pivotal movement of said rigid members in and out of engagement with the rails when said base is moved in said first direction and said engaging means allowing pivotal movement of said rigid members into and out of engagement with the rails when said base is moved in said second direction, and stops movably mounted on said base capable of being positioned to selectively interfere with pivotal movement of said rigid members to constrain said members when in engagement with said means.

2. The device of claim 1, wherein said stops include a shaft pivotally mounted to said base, and two blocks fixed to said shaft, said shaft and said blocks being positioned to pivot into the pivotal path of said rigid members.

3. The device of claim 1, wherein the advancement mechanism further comprises means for driving said base, said driving means including a hydraulic cylinder operably fixed to said advancement mechanism and to the horizontal earth boring machine, a variable volume pump hydraulically connected to said cylinder, and means for controlling the volume and the direction of flow of said pump.

4. The device of claim 3, wherein said control means comprises a lever arm of sufficient mass to carry by its momentum said variable volume pump into a reversed flow mode when said cylinder reaches each end of its stroke.

5. An advancement mechanism for a horizontal earth boring machine supported on rails and comprising a base, means mounted to said base for engaging the rails to selectively lock the base thereto, means for driving said base, including a hydraulic cylinder fixed at one end to said base and to the horizontal earth boring machine at a second end, a variable volume pump hydraulically connected to said cylinder, and means for controlling the volume and direction of flow of said pump, said control means including a lever arm of sufficient mass to carry by its momentum said variable volume pump into a reversed flow when said cylinder reaches each end of its stroke.

6. An advancement mechanism for horizontal earth boring machines supported on rails and comprising a base positioned on the rails and capable of being moved along the rails in first and second directions, rigid members pivotally mounted to said base and extending to the rails, slots provided on the rails for receiving said rigid members for engaging said rigid members with the rails, said slots allowing pivotal movement of said rigid members into and out of engagement with the
rails when said base is moved in said first direction and said slots allowing pivotal movement of said rigid members into and out of engagement with the rails when said base is moved in said second direction, a shaft pivotally mounted to said base, blocks fixed to said shaft said blocks extending to selectively interfere with the pivotal movement of said rigid members to constrain said members when in engagement with said slots, means for driving said base including a hydraulic cylinder operably fixed to said advancement mechanism to the horizontal earth boring machine, a variable volume pump hydraulically connected to said cylinder, and means for controlling the volume and direction of flow of said pump.