SYSTEM FOR CONSTRUCTING DRAIN LINES

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ABSTRACT

A system for constructing a drain line including laying a uniformly thick and contoured bed of particulate material, such as gravel, within the confines of a trench.

9 Claims, 5 Drawing Figures
SYSTEM FOR CONSTRUCTING DRAIN LINES

This invention relates to the construction of drain fields. The invention also relates to systems for laying beds of particular material. It has been the practice heretofore in the construction of drain fields to dig a narrow trench, several feet deep, spread gravel in the bottom of the trench, make a furrow along the approximate center line of the gravel layer and lay tubular tile members end to end in the furrowed bed. The aligned tile members are gradually sloped from one end of the trench to the opposite end so that liquid matter may flow by gravity through the tile members into the gravel bed to become disbursted and eventually absorbed by the adjacent earth. The aligned tile members in the furrowed gravel are then covered with additional gravel so as to fully encompass the tile member with a selected thickness of gravel.

Heretofore, in drain line construction the gravel has been manually spread in the bottom of the trench with shovels or rakes and subsequently furrowed using hand implements. Obviously this procedure was time consuming, expensive and in general comprised very arduous labor. It has been particularly difficult to furrow the gravel because the gravel first had to be leveled and then, with great force, moved laterally to develop the furrow. The tendency of the gravel to roll and tumble back into the furrow as it was pulled out increased the difficulty of the task. Due to the nature of the work involved, manual labor for constructing such drain fields is not readily obtainable.

Further, in laying a gravel bed in the bottom of a trench by manual labor it has been extremely difficult to obtain a uniformly thick layer of the gravel with the result that in many instances excessive gravel has been consumed thereby increasing the cost of the drain fields. On the other hand, it has not been uncommon in such manually laid gravel beds that the drain tile has been disposed in a bed of gravel insufficient to convey away the liquid matter fed into the drain field from the tile, or that the tile was improperly graded to produce the desired gravity flow of liquid thereallong.

It is therefore an object of the present invention to provide an economical system for constructing a drain line including laying a uniformly thick and contoured bed of particulate material in the bottom of a trench for receipt of drain tile or the like. It is a further object of this invention to provide an apparatus for laying a bed of particulate material and having pull bar means accommodating the usual tool bucket of a backhoe for propulsion of the apparatus along the length of the trench. Other objects and advantages of the invention will become apparent from the detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a schematic representation of the present invention and depicting various novel features thereof;

FIG. 2 is a fragmentary view of several drain tile disposed in a gravel bed within a trench;

FIG. 3 is a side elevational view of the hopper apparatus of FIG. 1;

FIG. 4 is a top view of the hopper apparatus of FIG. 2, and

FIG. 5 is a front elevational view of the apparatus of FIG. 2.

Briefly stated, the present invention comprehends a system for constructing a drain line including laying a uniform bed of particulate material, i.e., gravel, in the bottom of a trench in position to receive a drain tile or the like. In accordance with the present invention, apparatus such as a backhoe, for excavating a trench and apparatus adapted to be moved along the length of the trench and lay the desired bed and have a hopper disposed beneath each longitudinal edge of the hopper. Alternatively, wheel means may be substituted for the runners and earth for holding the tile in place. It will be appreciated that liquid effluent passing into the drain line flows by gravity (preferably very slowly) along the individual drain lines and through the butt joints between tiles into the gravel bed where it is dissipated for absorption by the surrounding earth. Other types of tile include spaced openings in the tile wall through which the effluent is passed to the gravel bed. In any event, it is the function of the gravel, in addition to supporting the tile in position, to provide a type of reservoir effective to receive the effluent and disperse it to the earth for absorption.

In the absence of the gravel, dirt clogs the openings in or between the tiles so as to prevent the discharge of effluent and thus destroy the effectiveness of the drain field.

The trenches for the drain fields and similar constructions contemplated in the present invention may be advantageously dug by the use of a backhoe 40 (FIG. 1), i.e., a mechanical digger having a tool bucket 41 which is pivoted on a hydraulically operated arm 42 designed to be swung outwardly to a position of digging. As the arm is pulled back toward the backhoe, the bucket traverses an arcuate path and digs into the earth. The bucket is pivoted during its return swing so as to collect and hold the freshly dug earth within the bucket. This arm and bucket are then raised and moved away from the trench for dumping of the load.

The general concept of the present invention is depicted schematically in FIG. 1 and includes a hopper 5 containing a quantity of gravel 35 and disposed within a rectangular trench 37. The hopper is conveniently supported above the bottom 37 of the trench on runners 15, 16 and is pulled along the length of the trench by a backhoe 40 or the like. As will appear more fully hereinafter, the bucket teeth 43 of the backhoe may be made to engage a retractable drawbar 44 disposed on the leading end of the hopper so as to establish a straight line pull force upon the hopper and move it along the length of the trench. In the preferred system a backhoe is employed to excavate the trench. After about 16 feet of trench has been dug, the hopper is lowered into the trench with the front end of the hopper facing in the direction of excavation and using the backhoe to do the lifting. The hopper in the trench is loaded with gravel directly from a dump truck. Using the backhoe, another 10 feet of trench is excavated. The tool bucket on the hydraulic arm of the backhoe is then swung toward the hopper and caused to engage the drawbar on the hopper. The arm of the backhoe is next swung toward the backhoe to pull the hopper forward to the point where the excavation ends. The bucket is disengaged and a further 10 feet of trench is excavated to recommence the cycle. As the hopper is moved forward in the trench, it lays a bed of gravel which is properly contoured to receive the drain tile.

With specific reference to the figures, the apparatus employed in the present system includes a hopper 5 of generally rectangular configuration having opposite sides 6, 7 and ends 8, 9. Preferably sides 6, 7 are of greater dimension than ends 8 and 9. The hopper 5 is open at its top and is provided with a partial bottom 10 (shown in dotted lines in FIG. 1) extending longitudinally between ends 8 and 9. The bottom is sealably joined at its points of contact with hopper ends 8, 9 and is of a lateral dimension such that its edges 11 and 12 terminate inwardly of hopper sides 6, 7, respectively, so as to define longitudinal slots 13, 14 on opposite sides of bottom 10 between its longitudinal edges and the sides of the hopper. Preferably, these slots are coextensive with the length of the hopper. Moreover, bottom 10 is gabled along its longitudinal length thereby providing sloping sides extending from the longitudi- nal apex of the gable toward the sides of the hopper. This gable and sloping sides prevent bridging of particulate material within the hopper and promote uniform distribution of the particulate material. Preferably, the bottom sides of the slots 13, 14 for dispensing as will be discussed hereinafter.

Hopper 5 is raised above its supporting surface, i.e., the bottom of a trench, preferably by a means of elongated runners 15, 16 disposed beneath each longitudinal edge of the hopper. Alternatively, wheel means may be substituted for the runners
but are more costly and less desirable. Each runner comprises a gusset 17 defining a leading edge of the runner and serving also to assist in joining the runner to the forward end of the hopper. The runners 15, 16 preferably extend rearwardly from their leading edges along substantially the entire length of the hopper. Further gussets 19, 20 are provided at the rear end of the hopper for connecting the bottom rear end of the hopper to the most rearward end of each runner. Vertical braces (typified by brace 21) extending between each runner and the lowermost edge of each side of the hopper are provided intermediate the forward and rearward ends of the hopper as deemed necessary to support the anticipated load to be contained within the hopper.

In the preferred embodiment, side panel members 22, 23 are provided between each runner and the bottom edge of each hopper side to close the space therebetween. For purposes which will appear hereinafter, these panel members preferably extend from the forward ends of runners 15, 16 approximately one-half of the length of the hopper to define the sides of a gravel dispensing chute 38, 39 beneath the hopper. In the region beneath the hopper and between the side panels 22, 23, there are provided fender panel members 45, 46 depending from the opposite edges of bottom 10. Each fender panel is preferably right triangular, having its base attached to the bottom 10 and its side depending vertically at the forward end of the hopper. Each fender panel is joined by end panels 47, 48 to gussets 17, 18, respectively. Thus, side panel 22, fender panel 45, and end panel 47 define a gravel dispensing chute 38 having an effective volume which decreases from a maximum at its forward end to a minimum at its rear end. A like chute 39 is formed on the opposite side of the hopper by side panel 23, fender 46, and end panel 47.

The rear end 9 of the hopper 5 is provided with a depending portion 24 which converges inwardly and receives a collar 25 (preferably square in cross section) at its point of convergence. As may best be seen in FIG. 3, a second collar 26 is secured by a structural member 27 to the approximate central portion of bottom 10. Collar 26 depends from the bottom 10 at a point about halfway between the ends of the hopper and is coaxial with collar 25. A plow beam 28 (also preferably square in cross section) is slidably received by the spaced-apart collars and thereby nonrotatably mounted in trailing relation to the hopper. The extent of rearward sliding movement of beam 28 within the collars is limited by a lug 29 provided on the forward end of beam 28 in position to contact the forward edge of collar 26 as beam 28 is moved in a rearward direction. A triangular plow blade 30 is fixedly secured to the end of beam 28. This plow 30 is disposed at an angle, preferably between about 5° and 15°, with respect to the vertical and tangential to the inclination of the plow causing its pointed tip 31 to be positioned more rearwardly with respect to hopper 5 than its uppermost edge 32. That is, plow 30 has a "negative" angle of attack when pulled forward for purposes to appear hereinafter. The collars 25, 26 and their supporting structures 24, 27 may be reinforced by a further strut members (not shown) as necessary. It will be appreciated that beam 28 and its supporting framework are wholly confined immediately beneath the centerline of bottom 10 and do not project laterally such as would obstruct the flow of particulate material from hopper 5 through slots 13, 14.

The hopper 5, containing its load of gravel and positioned within the trench, is pulled along the length of the trench by engaging the toothed bucket of the backhoe in a drawbar 44 (FIG. 1) secured at the forward end of the hopper at its bottom. Drawbar 44 preferably comprises a generally flat pan member 49 having its forward edge 50 turned to afford a radially leading edge so as to permit the pan to slide along the dirt bottom of the trench. This radially leading edge of the pan also serves to receive the toothed bucket 41 in pulling engagement (see dotted outline of FIG. 1). The pan 49 preferably is secured to the hopper by means of a pair of chains 51, 52 disposed on opposite sides of the pan 49 and leading rearwardly through a pair of openings 53, 54 on a transverse cross member 55 disposed between gussets 17 and 18 on the leading edges of runners 15, 16, respectively (see FIG. 3). The chains 51, 52 extending through the openings 53, 54 separately engage a pair of coil springs 55, 56, one end of each spring engaging each chain. The springs are anchored at one of their ends to a structural member 57 fixedly secured on the underside of the bottom 10 at a point approximately half-way between the opposite ends of the hopper 5.

Each of the chains is provided with a pair of stops 58, 59 and 60, 61, one stop on each side of openings 54, 53, respectively in cross member 62. It may be visualized that upon the toothed bucket of the backhoe engaging the radially leading edge of pan 49 and exerting a longitudinally directed pulling force to the pan, the mass of the loaded hopper is sufficiently great to cause springs 55, 56 to become extended to the point where stops 58 and 60 on chains 52, 51, respectively are caused to bear against the most rearward edge of openings 54, 53. Thereupon, further pulling force exerted by the backhoe bucket causes the hopper to be pulled along the trench. When the hopper has reached the forward limit of travel which is possible during a single swing of the arm of the backhoe, the bucket is disengaged from the drawbar 44 and the pulling force is thus released, springs 55, 56 cause pan 49 to be retracted toward the hopper until stops 59 and 61 engage the most forward edge of openings 54 and 53 and halt the retraction. While the hopper is in the trench, this retrieval action of the springs withdraws the pan from that area of the trench within which it is desired to recommence excavation.

In addition to the resiliency provided in the drawbar mechanism, it has been found important in the present invention that this drawbar mechanism include a flexible means for joining the pan 49 to the hopper 5. In the preferred embodiment, as set out above, this flexibility is afforded by the chains 51, 52. This flexibility is preferred for accommodating the necessarily nonlinear movement of the toothed edge of bucket 41 as the bucket is drawn toward the backhoe bucket 40 by the combination of pivotal movements of arm 42 and bucket 41. In the absence of this flexible connection between the point of engagement of the bucket with the drawbar and the point on the hopper where the drawbar is anchored for pulling, the necessarily coarse and gross movements of the toothed bucket result in frequent disengagement of the bucket from the drawbar or destruction of the drawbar due to the application of uneven forces by the bucket. In either of the latter events, there will necessarily result a loss in time and consequential increase in cost of the overall operation.

As a further matter of importance in the present invention, it is to be noted that the pulling force exerted by the toothed bucket acting through the drawbar mechanism to pull the hopper along the trench constitutes a straight-line horizontal pulling force. Pulling forces applied to the hopper in other than a straight-line horizontal direction, such as a force exerted at an upward angle, cause the forward end of the hopper to be lifted off the bottom of the trench, thereby destroying control over the thickness and contour of the gravel bed. Accordingly, it is unsatisfactory to utilize such pulling means as a cable leading from the hopper upward out of the trench to a tractor or the like. Consequently, the present system comprehends a unique combination of the trench-excavating apparatus with the gravel-dispensing apparatus.

A pair of hooks 63, 64 are provided on the forward end of hopper 5 so that pan 49 can be cradled in these hooks when it is desired to transport the hopper outside the trench. When the pan is thus cradled in the hooks, it will be appreciated that a pull bar (not shown) of a suitable conventional type may be attached centrally of cross member 62 for purposes of providing a point of attachment for pulling the hopper about by means of a tractor, truck or similar road vehicle. For purposes of such open road travel, wheel members (not shown) such as a trolley or the like may be positioned beneath the hopper for rollably supporting it.

In laying a bed of gravel in a trench employing the system of the present invention, the empty hopper, with the plow 28
disposed in its most forward position, is lowered into the trench. Because the plow does not appreciably project beyond the end of the hopper, the device can be located at the end of the trench so as to commence laying the gravel bed at the end of the trench and thus utilize all the excavated area. A lifting lug secured on the top of the hopper provides a means for grasping it to raise and lower it into the trench. In the usual operation a backhoe fitted with a cable on its bucket for engaging the lifting lug is utilized for lowering the hopper into the trench. Once in position within the trench, the hopper is loaded with gravel directly from a dump truck. Not infrequently, as much as 3-4 tons of gravel are dumped into the hopper. It will be appreciated that the hopper may be lowered into the trench and filled with gravel by a single operator in a very brief period of time.

The gravel is metered from the hopper through slots 13, 14 into the space beneath the hopper. Upon the hopper being initially placed within the trench and loaded with gravel, the gravel flows from the hopper through slots 13 and 14 and substantially fills the space immediately beneath the rear half of the hopper. The gravel is restrained against lateral flow by the chutes 38, 39 at the front end of the hopper. There are no panels provided on the rear one-half of the sides of the hopper so that gravel is free to flow from beneath the hopper laterally into the space the trench proper. This initial flow of gravel into the space beneath the hopper causes gravel to be dispersed into the trench commencing at the very end of the excavated trench. After the space beneath the rear half of the hopper is filled by the gravel, the toothed bucket of the backhoe is engaged with the drawbar pan to pull the hopper along the length of the trench. As the hopper is pulled along the trench, gravel is metered through chutes 38, 39 on opposite sides of the hopper. As the hopper progresses forwardly, the gravel enters each chute at the most forward end of the chute and flows downwardly through the chute between the side panel and fender defining the chute. The two separate streams of gravel flowing through the chutes converge beneath the hopper at a point about halfway between the ends of the hopper and form a single bed of gravel having a rudimentary furrow along its centerline. This delayed convergence of the gravel creates an open space which is free of gravel adjacent the forward end of the hopper so as to provide an area within which the drawbar mechanism can operate. Specifically, within this gravel-free area there are mounted the springs and chains leading from beneath the hopper to be forward end and engaging the drawbar pan. When gravel are allow to flow into the area immediately beneath the hopper adjacent its forward end, these gravel become lodged in the springs and chains and destroy their ability to function. Further, the rudimentary furrow thus formed affords a clearance for the collars 25, 26 and their supporting structure. It has been found to also enhance subsequent furrowing by initially positioning the gravel laterally of the bed centerline and lessen the work required of the plow.

Further as the hopper is pulled along the trench, the depth of the gravel bed is established by the height at which the hopper is maintained above the bottom of the trench and by the bottom edge of the rear end of the hopper which acts as a screeed to level the bed of gravel within the trench. It has been found preferable to construct the hopper of a width less than the width of the excavated trench to permit free movement of the hopper within the trench and to permit the construction of curved trenches. This design causes the hopper to be more narrow than the width of the trench. Accordingly, it has been necessary, for example, in laying a gravel bed of 12 inch thickness to support the hopper about 17 inches above the bottom of the trench when the trench is 36 inches wide. Other relative heights of the hopper above the trench for selected trench widths may be readily ascertained from the above guidelines to achieve adequate bearing surface. The present invention is capable of laying down a measured and uniformly thick bed of gravel, the quantity of gravel required for a particular job can be calculated beforehand so as to avoid waste. This savings alone has been found to be very significant.

Upon commencement of movement of the hopper, the plow blade experiences a drag and is caused to slide within collars 25 and 26 until lug 29 on the plow beam 28 has contacted the most forward edge of collar 26. At this point in the forward progression of the hopper, the plow blade is caused to trail behind the hopper and displace gravel laterally of the center line of the gravel bed to create a longitudinal furrow along the length of the bed. The action of the plow 30 is enhanced by the fact that the rudimentary furrow created by the two streams of gravel flowing from the hopper is redefined in part by the converging depending portion 24 of rear end 9. It has been found preferable that plow 30 be mounted on a plow beam of sufficient length so that the gravel of the bed will seek their own level and come to rest prior to commencement of the furrowing action of the blade 30. In a preferred embodiment, plow blade 30 is extended a distance of at least about 18 inches to the rear of the hopper. When the plow blade is positioned closer to the hopper than this distance, it has been found that the newly laid bed is unstable and the furrowed gravel tends to roll or fall back into the furrow thereby negating the desired action of the plow. It has also been found that the desired furrow is preferably obtained when the plow blade is provided with a negative angle of attack. That is, it is preferred that the plow blade be tilted at an angle of between about 10° and 30° with respect to the vertical so that the pointed tip of the triangular blade is positioned a short distance more rearwardly than the uppermost leading edge of the blade. This angle of inclination of the blade has been found to force the gravel laterally of the center line of the bed as well as afford a degree of compaction of the gravel in the sides of the furrow by the blade wings thereby insuring that the gravel maintain their laterally displaced position and define the desired furrow.

In the preferred embodiment, the side panels 22, 23 seal against lateral flow of the bottom of the hopper. This lateral restraint against gravel from beneath the most forward one-half of the bottom of the hopper. This lateral restraint against gravel flow reduces the friction created by gravel engaging the sides of the trench and tending to bind the hopper against forward motion. The panels also prevent the gravel from flowing underneath the leading edges of the runners and impeding the desired free sliding movement of the hopper.

It will be appreciated that the system of the present invention provides the means whereby a single workman can construct a drain field in less time that heretofore has been possible for two or three workmen. The savings in gravel and time are readily recognized, as is the more uniform nature of the product system. While a preferred embodiment has been shown and described, it will be understood that there is no intent to limit the disclosure, but rather, it is intended to cover all modifications and alternate constructions falling within the spirit and scope of the invention as defined in the appended claims. For example, whereas it is preferred for reasons of economy and expediency of operation to engage the drawbar with the backhoe bucket, the backhoe and hopper may be connected by means of a retractable boom extending between these two units.

What is claimed is:

1. A system for constructing a drain line including a drain tile disposed in a gravel bed laid in the bottom of a narrow trench comprising mobile power means adapted to excavate said trench in increments of length from a position outside said trench and having digging means for lowering into said trench, dispensing means disposed in said excavated trench and movably supported on the bottom of said trench and a preselected desired depth of gravel. Bequests the present invention is capable of laying down a measured and uniformly thick bed of gravel, quantity of gravel required for a particular job can be calculated beforehand so
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bile power means and said dispensing means for pulling said dispensing means along said trench in increments of movement approximately equal to the increments of excavation of said trench.

plow means trailing said dispensing means as it is pulled along said trench and displacing particulate matter laterally of the approximate centerline of said bed to define a longitudinal furrow for receiving said drain tile.

2. The system of claim 1 wherein said drawbar means retracts to a position of noninterference with subsequent excavation when said power means and dispensing means are disconnected.

3. The system of claim 1 wherein said connector means is anchored by flexible strands secured at one of their respective ends to said dispensing means and at their other respective ends to said connector means.

4. The system of claim 1 wherein said connector means is spring-biased in a retracted position adjacent said dispensing means.

5. The system of claim 1 wherein said mobile power means comprises a backhoe having a toothed bucket digging means and said drawbar means comprises a connector releasably engageable by the teeth of said toothed bucket of said backhoe.

6. The system of claim 1 wherein said dispenser means comprises a hopper adapted to receive said particulate matter and having a partial bottom defining at least two laterally disposed elongated openings on opposite sides of said bottom and extending rearwardly from the forward end of said hopper at least a major part of the length of said hopper, a dispensing chute depending from at least the most forward portion of each of said lateral openings providing laterally disposed guide paths for the flow of particulate matter from said hopper through said openings into the trench beneath said dispenser means in the form of rows defining at least a rudimentary furrow therebetween.

7. Apparatus for depositing particulate matter in position for receiving drain tile within a trench defined by side walls and a bottom comprising

a hopper having side and front and rear end walls and adapted to be received within the confines of said trench, a longitudinally gabled partial bottom in said hopper and in combination with the side walls of said hopper defining at least two substantially parallel longitudinal openings laterally separated in the lower portion of said hopper for metering said particulate matter from said hopper, chute means disposed beneath about the forward one-half of each of said longitudinal openings to guide particulate matter into said trench in the form of at least two streams converging toward the approximate centerline of said trench, friction means disposed beneath said hopper and supporting said hopper above the bottom of said trench for movement of said hopper along the length of said trench, mobile power means for propelling said hopper along the length of said trench, whereby said particulate matter is deposited from said hopper into said trench in a relatively uniformly thick layer as said hopper is moved along the length of said trench, and furrowing means trailing said hopper and furrowing said layer of particulate matter along its approximate centerline.

8. The apparatus of claim 7 and including retractable drawbar means anchored to said hopper for releasably joining said mobile power means to said hopper in substantially horizontal pulling alignment for pulling said hopper along said trench in increments of movements.

9. The apparatus of claim 7 wherein said furrowing means comprises a plow having a pair of generally right triangular wing portions disposed uprightly in side-by-side relation and defining an obtuse angle, said contacting sides further defining a centerline and a downwardly projecting digging tip on said plow, said centerline being inclined at an angle between about 10° and 30° with respect to the vertical to position said digging tip of said blade more rearwardly than the top edge of said blade with respect to the direction of forward travel of said plow.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,664,137 Dated May 23, 1972

Inventor(s) James E. Lett

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, lines 2-3, change "particular" to -- particulate --

Column 3, line 51, insert comma after "vertical"

Column 5, line 8, insert comma after "operation"

Column 5, lines 11-12, change "infrequency" to -- infrequently --

Column 5, line 26, delete "the space"

Column 5, line 47, change "he" to -- the --

Column 6, line 38, after the word "the" and before the word "bottom", add: -- gravel from beneath the most forward one-half of the --

Column 6, lines 38-40, delete "This lateral restraint against gravel from beneath the most forward one-half of the bottom of the hopper."

Column 6, line 73, beginning at "drawbar," begin new paragraph which ends at the end of line 4 of Column 7.

Column 6, line 38, following "flow", insert -- of the gravel from beneath the most forward one-half --

Signed and sealed this 26th day of December 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. ROBERT GOTTSCALK
Attesting Officer Commissioner of Patents