EXCAVATING SYSTEMS AND METHODS

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ABSTRACT

An excavating system may include a nozzle attached to an extendable arm of an excavating vehicle and a fluid supply. The fluid supply may supply fluid to the nozzle and create a fluid stream flowing from the nozzle, where the fluid stream may excavate earth away from an underground line. A method of excavating earth away from an underground line that may include the steps of generating a fluid stream flowing from a nozzle at a flow rate greater than approximately 11 gallons per minute, and excavating earth away from the underground line by directing the fluid stream toward the earth surrounding the underground line. A method of excavating earth away from an underground line that may include the steps of generating a fluid stream flowing from a nozzle, trenching alongside the underground line with the fluid stream, and excavating earth away from the underground line with the fluid stream.
GENERATE FLUID STREAM

LOCATE TRENCH BESIDE EXCAVATE UNDERGROUND UNDERGROUND UNDERGROUND LINE LINE LINE

STOP FLUID STREAM

PERFORM ANOTHER TASK?

FIG. 10
EXCAVATING SYSTEMS AND METHODS

BACKGROUND

[0001] This disclosure relates generally to excavating around existing pipelines and, in an example described below, more particularly provides an excavating system.

[0002] A significant number of lines connecting facilities with energy sources and/or telecommunications resources, such as oil and gas pipelines, telephone lines, fiber optic lines, utility lines, etc., are buried underground. When it is necessary to install additional lines or repair existing lines, the earth around the existing lines is removed to provide access for workers to implement the additions and/or repairs.

[0003] However, there are many safety risks involved in locating underground lines and excavating earth from around them. Recent regulations require no mechanical equipment to be used within a certain distance of an existing underground line. Manual laborers using hand tools such as shovels, hoes, etc. usually perform excavating earth away from an existing underground line within this certain distance. Therefore, it can be seen that improvements in the art are needed.

SUMMARY

[0004] In the disclosure below, an excavating system and related methods are provided which solve at least one problem in the art. One example is described below in which a nozzle is attached to an arm of an excavating vehicle. A fluid stream flowing from the nozzle is used to excavate earth from around an underground line.

[0005] In one aspect, an excavating system can include a fluid supply line that supplies fluid to a nozzle attached to an extendable arm of an excavating vehicle. A fluid stream flowing from the nozzle may be used to excavate earth away from an underground line.

[0006] In another aspect, a method of excavating earth away from an underground line is provided that may include the steps of generating a fluid stream flowing from a nozzle at a flow rate greater than 11 gallons per minute, and excavating earth away from the underground line by directing the fluid stream toward the earth surrounding the underground line.

[0007] In another aspect, a method of excavating earth away from an underground line is provided that may include the steps of generating a fluid stream flowing from a nozzle, trenching alongside the underground line with the fluid stream, and excavating earth away from the underground line with the fluid stream.

[0008] These and other features, advantages and benefits will become apparent to one of ordinary skill in the art upon careful consideration of the detailed description of representative examples below and the accompanying drawings, in which similar elements are indicated in the various figures using the same reference numbers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a representative side view of an excavating system which can embody principles of this disclosure.

[0010] FIG. 2 is a representative side view of another configuration of the excavating system which can embody principles of this disclosure.

[0011] FIG. 3 is a representative perspective view of an excavator which can embody principles of this disclosure.

[0012] FIG. 4 is a representative perspective view of another configuration of the excavator.

[0013] FIG. 5 is a representative perspective view of an actuator.

[0014] FIG. 6 is a representative perspective view of a nozzle which can be used in the excavating system.

[0015] FIG. 7 is another representative perspective view of the nozzle of FIG. 6.

[0016] FIG. 8 is another representative perspective view of yet another configuration of the excavator.

[0017] FIG. 9 is a representative perspective view of yet another configuration of the excavator.

[0018] FIG. 10 is a representative flow chart for a method of excavating earth away from an underground line.

DETAILED DESCRIPTION

[0019] Representative illustrated in FIG. 1 is an excavating system 10 and related methods for excavating earth 50 away from an underground line 36. The excavating system 10 includes an excavating vehicle 12 and an excavator 14 attached to an arm 16 of the vehicle.

[0020] A fluid supply line 18 supplies a fluid 34 from a fluid reservoir 60 to the excavator 14. The fluid 34 is pressurized before being delivered to the excavator 14. A pressure differential created across the excavator 14 generates a fluid stream 32 flowing from a nozzle 22. The fluid stream 32 may be used to excavate earth 50 away from an underground line 36. As the fluid stream 32 contacts the earth 50, the earth is displaced away from the underground line 36. The excavating system 10 manipulates the nozzle 22 in three axes of rotation to direct the fluid stream 32 towards the earth 50 surrounding the underground line 36. However, it is not required that the system 10 manipulate the nozzle 22 in three axes of rotation.

[0021] When an existing underground line 36 needs repair or replacement, then the earth 50 is excavated away from the line to allow workers access. Also, if a new line is being installed and the existing underground line 36 is encountered, earth 50 is excavated away from the line 36 to allow workers access to protect the existing line 36 from damage during installation of the new line. These are only a few examples of why earth 50 may need to be excavated away from underground lines 36.

[0022] Generally, when excavating around an underground line 36 the line is first located at the surface by various location detecting equipment well known in the art. After the approximate location of the line is established, an initial hole is dug in the earth 50 to expose a portion of the line 36. Those skilled in the art refer to this as potholing. After a portion of the line 36 is exposed and its physical location established, a trench may be dug along one or both sides of the underground line 36 a predetermined distance away from the line.

[0023] Recent regulations require no mechanical equipment to be used within a certain distance of an existing underground line. Therefore, workers are normally dispatched to manually remove the remaining earth 50 from around the line 36 using hand tools such as shovels, hoes, etc.

[0024] Referring now to FIG. 2, the excavating system 10 of this disclosure may be beneficially used to perform these operations (e.g. locating the line, trenching alongside the line, excavating from around the line, etc.), without requiring the use of mechanical equipment close to the line 36. The excavating system 10 uses the fluid stream 32 to displace earth 50 by forcibly dislodging the earth and washing it away.

[0025] To locate the underground line 36, the fluid stream 32 may be directed toward the surface of the earth 50 to begin excavating. The fluid stream 32 provides sufficient flow to
dislodge the earth 50. As the earth 50 is dislodged, the velocity and flow rate of the fluid stream 32 may cause earth to be forced out of a hole being excavated. Therefore, a vacuum may not be needed to remove fluid and earth 50 from the hole during excavation.

[0026] To trench beside the underground line 36, the fluid stream 32 may be directed at the earth 50 alongside the line to excavate trenches in the earth 50. Again, the fluid stream 32 is used to dislodge and remove the earth 50 from the trench being excavated.

[0027] To excavate the remaining earth 50 from around the underground line 36, the fluid stream is directed toward the earth surrounding the line. The fluid stream 32 dislodges the earth 50 and washes it away from the line during the excavation. The dislodged earth 50 may be forced out of the excavated area or it may be forced deeper into a trench to complete the excavation of earth from around the underground line 36. The dislodged earth 50 may also be removed manually from the trench, but a preferred method is to use the excavating system 10 to complete the excavation.

[0028] After the excavation, workers may enter the excavated area to work on the line 36, install a new line or perform any other necessary operation.

[0029] Locating, trenching, and/or excavating from around the line are just some application examples for the excavating system 10 of this disclosure. However, it should be understood that these are merely examples of how the excavating system 10 may be utilized. The system 10 is not limited to these applications.

[0030] For example, the system 10 may be used to clean off earth 50 and debris from lines being stored above ground. The system 10 may also be used to transport test fluid proof enclosures. Therefore, it can readily be seen that the excavating system 10 may be used in a wide range of applications, both underground and/or above ground.

[0031] Another beneficial feature of the excavating system 10 is that the fluid stream 32 may force dislodged earth 50 from an excavation area (e.g. a hole, a trench, etc.) without the use of a vacuum. This greatly simplifies the excavation process, therefore, providing a more economical way to excavate earth 50 away from an underground line 36.

[0032] The excavator 14 may include an actuator 44, brackets 20 and 28, and a nozzle assembly 40. The items may be combined into subassemblies and/or included individually without departing from the principles of this disclosure.

[0033] The excavator 14 is attached to an excavating vehicle 12 by a bracket 20, which is also attached to another bracket 28. The actuator 44 and nozzle assembly 40 are assembled to the bracket 28, which provides structural support as well as impact protection for these items.

[0034] However, it is not required that the actuator 44 and nozzle assembly 40 be assembled to bracket 28. For example, these items may be assembled to the bracket 20 and not attached to bracket 28. In this example, bracket 28 may only provide impact protection for these items, not support. Additionally, bracket 28 may be omitted altogether, however, a preferred configuration is that bracket 28 be included in the excavator 14. It should be understood that many configurations of brackets are possible and the use of brackets is not necessary in keeping with the principles of this disclosure.

[0035] The excavating vehicle 12 in FIGS. 1 and 2 is shown as a backhoe, but a backhoe is merely an example of an excavating vehicle 12 that may be used in the excavating system 10. It should be understood that the excavating vehicle 12 may also be a trackhoe, a boom truck, or other similar vehicles in keeping with the principles of this disclosure.

[0036] Representatively illustrated in FIG. 3 is an example of the excavator 14 which includes a bracket 20 used to attach the excavator to the excavating vehicle 12. Holes 38 of bracket 20 mate with features on the arm 16 of the vehicle 12 and an attachment means, such as bolts, welding, etc., secures the excavator 14 to the vehicle.

[0037] The actuator 44 includes a motor 30 which drives a gearbox 24. The motor 30 operates the gearbox 24 and causes a rotary shaft 42 to rotate back and forth. The rotary shaft 42 is connected to the nozzle assembly 40, therefore, rotating the shaft 42 causes the nozzle 22 to rotate back and forth about an axis of rotation 72 (see FIG. 1). The hole 46 constrains movement of the fluid supply line 18 when the nozzle assembly 40 is manipulated during excavation.

[0038] A controller 70 may control (e.g. actuate) the actuator 44 in various ways, such as electrically, hydraulically, mechanically, etc. in keeping with the principles of this disclosure. In one configuration the controller 70 controls the actuator 44 by using an electrically operated motor 30 to operate the gearbox 24. However, the motor 30 may not be used at all. For example, in another configuration the actuator 44 is pneumatically controlled through air pressure lines connected to the actuator (not shown).

[0039] In another configuration the actuator 44 is hydraulically controlled with hydraulic control lines connected to the actuator (not shown). In yet another configuration the actuator 44 is mechanically controlled with mechanical levers and levers (not shown). Therefore, it can easily be seen that different types of controls may be used to control the actuator 44 in keeping with the principles of this disclosure.

[0040] Additionally, a second actuator 44 (not shown) may be included in the excavator 14 to rotate the nozzle assembly 40 about another axis of rotation 74. However, a preferred method is to use one actuator 44 in the excavator 14.

[0041] A connector 26 is used to connect the fluid supply line 18 to the nozzle assembly 40. A preferred configuration of the connector 26 includes a swivel connector and a 90 degree fitting. The swivel connector allows the connector 26 to be pivotally attached to the fluid supply line 18. This configuration of connector 26 allows the nozzle assembly 40 to rotate back and forth without requiring the fluid supply line 18 to also rotate back and forth. This is beneficial in that wear and tear of the fluid supply line 18 is significantly reduced.

[0042] Another configuration of the connector 26 includes a swivel connector and multiple pipe fittings. Yet another configuration of the connector 26 includes pipe fittings(s) without using a swivel connector. This configuration does not support pivoting of the fluid supply line 18 with respect to the connector 26. Therefore, it can readily be seen that many different configurations of the connector 26 are possible in keeping with the principles of this disclosure.

[0043] As illustrated in FIG. 3, the bracket 28 is C-shaped with gussets attached in the corners for additional support. This C-shaped bracket 28 provides impact protection to the nozzle assembly 40 as the excavator 14 is maneuvered around the underground pipe 36 during excavation. However, it is not required that the bracket 28 be C-shaped, nor is it required that the bracket 28 provide impact protection for the nozzle assembly 40.

[0044] The bracket 28 includes a hole 46 through which the connector 26 extends. The fluid supply line 18 is connected to the connector 26 outside of the C-shaped bracket 28. The hole 46 constrains movement of the fluid supply line 18 when the nozzle assembly 40 is manipulated during excavation.
[0045] Referring to FIG. 4, another configuration of the excavator 14 is illustrated with the bracket 28 configured as a flat plate. This bracket 28 supports the actuator 44, but provides limited impact protection for the nozzle assembly 40. Therefore, it can easily be seen that several configurations of the bracket 28 are possible in keeping with the principles of this disclosure.

[0046] FIGS. 3 and 4 show that the actuator 44 includes a motor 30 and a gearbox 24 as individual units. However, a preferred configuration of the actuator 44 is shown in FIG. 5, wherein the motor 30 and gearbox 24 of the actuator are combined into a single assembly. This configuration of the actuator 44 simplifies the assembly of the excavator 14 and may reduce the overall size of the excavator.

[0047] Additionally, FIGS. 3 and 4 show the nozzle 22 as a fitting attached to a pipe tee fitting. The connector 26 is connected to one end of the pipe tee fitting and the rotary shaft 42 is connected to another end. However, a preferred configuration of the nozzle 22 is shown in FIGS. 6 and 7. FIG. 6 shows a nozzle 22 with a threaded inlet 52 and a threaded outlet 54. In this configuration, the connector 26 is attached to the inlet 52 and a pipe extension 62 (see FIG. 9) may be attached to the threaded outlet 54.

[0048] The pipe extension 62 projects from the nozzle 22 to provide an operator a visual aid to indicate the direction of flow of the fluid stream 32. However, it is not required that the extension 62 be used. The fluid stream 32 may exit the threaded outlet 54 without a pipe extension 62 being attached in keeping with the principles of this disclosure. Referring to FIG. 7, an opposite side of the nozzle 22 is shown. This side includes a rotary shaft interface 56 for mating with the rotary shaft 42.

[0049] Referring to FIG. 8, another configuration of the excavator 14 is representatively illustrated. This configuration is very similar to the excavator 14 in FIG. 3 except for two notable differences. In FIG. 8 the actuator 44 shown in FIG. 5 is used instead of the individual motor 30 and gearbox 24 units, and the nozzle 22 shown in FIGS. 6 and 7 is used instead of the nozzle assembly 40. This configuration of the excavator 14 with a pipe extension 62 connected to the outlet 54 is a preferred configuration of the excavator.

[0050] Referring to FIG. 9, yet another configuration of the excavator 14 is representatively illustrated. This configuration is very similar to the excavator 14 in FIG. 8 except for two notable differences. In FIG. 9 a turntable 64 is used instead of the actuator 44 and a different nozzle 22 is used. The turntable 64 includes another actuator (not shown) that controls the rotation of the turntable. The inlet 52 of nozzle 22 has been moved from a bottom side of the nozzle to a top side. In this configuration, both the inlet 52 and the rotary shaft interface 56 are formed on the top side of the nozzle 22.

[0051] The turntable 64 allows the fluid supply line 18 to deliver pressurized fluid 34 through the connector 26 and through the center of the turntable to the top side of the nozzle 22. This eliminates connections on the bottom side of the nozzle 22, which may be beneficial in some applications. The fluid supply line 18 is also conveniently located for attachment to the arm 16 of the excavating vehicle 12.

[0052] During excavation, the excavator 14 is attached to an excavating vehicle 12 (see FIGS. 1 and 2). The fluid supply line 18 is connected between the reservoir 60 and the nozzle 22. A pump 66 pumps the fluid 34 from a fluid source 68 to the reservoir 60 and pressurizes the fluid 34. The pressurized fluid 34 flows from the reservoir 60, through the fluid supply line 18, and enters the nozzle 22 at inlet 52. A pressure differential across the nozzle 22 generates a fluid stream 32 which flows from outlet 54 of the nozzle.

[0053] The excavating system 10 may manipulate the nozzle 22 in three axes of rotation to direct the fluid stream 32 towards the earth 50 surrounding the underground line 36. The rotary shaft 42 rotates the nozzle back and forth about an axis of rotation 72. The excavating vehicle 12 may rotate the excavator 14 about an axis of rotation 74 and may rotate the arm of the arm 16 of the vehicle 12 about an axis of rotation 76 (see FIG. 1).

[0054] These three axes of rotation provide ease of manipulating the fluid stream 32 to advantageously excavate earth away from the underground line 36.

[0055] However, it is not necessary that the excavating system 10 manipulate the nozzle in three axes of rotation. For example, the vehicle 12 may be moved about to position the nozzle 22 in a desired location without requiring rotation about the axis 76. Also, the arm 16 may be maneuvered to position the nozzle 22 in a desired location without requiring rotation about the axis 72.

[0056] Also, the axis of rotation 76 may be about a pivot point of a cab on a trackhoe. Therefore, it can be readily seen that while three axes of rotation may be preferred, the system can operate with fewer axes of rotation and/or different axes of rotation in keeping with the principles of this disclosure.

[0057] Also, several configurations of fluid delivery may be used in keeping with the principles of this disclosure. For example, it is not required that a reservoir 60 be used. The fluid supply line 18 may be connected directly to the pump 66 if it is not desirable to utilize a reservoir 60. The fluid supply line 18 may also be connected directly to the fluid source 68 if the source has sufficient pressure to generate an adequate fluid stream 32.

[0058] The fluid source 68 may be a lake, a pond, a river, a fire hydrant, a portable storage tank, or any other suitable fluid source that can provide an adequate supply of the fluid 34 for a desired operation. It is not necessary for the fluid 34 to be clean and/or filtered. However, filtering the fluid 34 before the fluid enters the excavating system 10 may be preferred to at least minimize the discharge of large particles that may damage the underground line 36.

[0059] The fluid 34 may be water, dirty water, a solvent, a solution of solvents and water, a solution of water and sand, etc. Therefore, it can readily be seen that the fluid 34 may be any type fluid that best accommodates a desired operation without departing from the principles of this disclosure.

[0060] As stated previously, the fluid stream 32 is generated when a pressure differential across the nozzle 22 is created. The excavating system 10 may operate with fluid pressures between 1000 psi to 4000 psi. However, a preferred operating fluid pressure is around 1800 psi to 2000 psi.

[0061] A flow rate of the fluid stream 32 may be greater than approximately 11 gallons per minute. However, a preferred flow rate of the fluid stream 32 is approximately 63 gallons per minute.

[0062] It should be understood that several combinations of nozzle sizes and fluid pressures produce a wide range of flow rates for the fluid stream 32. These parameters can easily be modified to provide a desired fluid stream 32 for a desired operation. Pressures and flow rates that are outside the ranges given above can be accommodated by the excavating system 10 as long as the system components are rated to support the pressures and flow rates.
A flow chart of process steps for a method 80 of excavating earth 50 away from an underground line 36 is representatively illustrated in FIG. 10. The method 80 may be used with the system 10 described above to excavate earth 50 from around an underground line 36, or the method may be used with other systems in keeping with the principles of this disclosure.

In step 82, a fluid stream 32 is generated by creating a pressure differential across the nozzle 22 and forcing fluid 34 from the nozzle. The pressure differential may be created by the controller 70 turning on the pump 66 (if the pump 66 is used) which receives and pressurizes the fluid 34 from the fluid source 68.

The pressurized fluid 34 is forced into the reservoir 60 (if the reservoir 60 is used) and then into the fluid supply line 18. The fluid supply line 18 delivers the pressurized fluid 34 to the nozzle 22, and the pressure differential across the nozzle 22 forces fluid 34 from the nozzle outlet 54, thus generating the fluid stream 32. Upon the completion of step 82, any one of steps 84, 86, and 88 may be performed next.

In step 84, the fluid stream 32 is used to locate the underground line 36 by a process called pitholing. The fluid stream is directed at the ground-level surface of the earth 50 and begins dislodging and displacing earth 50 out of a resulting hole. The fluid stream 32 may continue to displace the earth 50 until a desired portion of the underground line 36 is exposed.

In step 86, the fluid stream 32 is used to trench alongside the underground line 36 with the trench being spaced apart from the underground line. The fluid stream is directed by the excavating system 10 to displace earth 50 along a path that runs beside the underground line 36. A trench is excavated along either or both sides of the underground line 36. This allows access for further excavation by either the excavating system 10 or by workers with hand tools.

In step 88, the fluid stream 32 is used to excavate away earth 50 that is surrounding the underground line 36. The excavation preferably exposes the full circumference of a desired portion of the line 36 without the use of hand tools or a vacuum. However, hand tools and/or a vacuum can be used to excavate earth 50 away from the line 36.

In step 90, upon completion of any one of the steps 84, 86, and 88, the fluid stream 32 is stopped when the controller 70 commands the pump 66 to turn off.

In step 92, if another operation is needed, then step 82 is performed again. If no further operation is needed then the fluid stream 32 remains stopped until another operation is required.

These steps may be repeated as often as necessary to complete an excavation of an underground line 36.

It will now be fully appreciated that the above disclosure provides several advancements to the art of excavating. In examples described above, a fluid stream 32 flowing from a nozzle 22 attached to an excavating vehicle 12 may be used to excavate earth 50 from around an underground line 36.

The above disclosure provides to the art an excavator 14 that may include a nozzle 22 attached to an extendable arm 16 of an excavating vehicle 12. A fluid supply line 18 may be used to supply fluid 34 to the nozzle 22 and may create a fluid stream 32 flowing from the nozzle 22. The resulting fluid stream 32 may excavate earth 50 away from an underground line 36.

The excavating vehicle 12 may manipulate the nozzle 22 in at least one axis of rotation 74, 76. The system 10 may include an actuator 44 that manipulates the nozzle 22 in at least one axis of rotation 72. The actuator 44 may be electrically or hydraulically controlled.

The system 10 may also include a controller 70 that manipulates the nozzle 22 by controlling the actuator 44. The system 10 may manipulate the nozzle 22 in three axes of rotation 72, 74, 76.

The fluid stream 32 may excavate earth 50 away from the underground line 36 while the system 10 maintains greater than an 18 inch distance between the nozzle 22 and the underground line 36 during the excavation.

The underground line 36 may be one of a pipeline, a utility line, and a fiber optic line. The excavating vehicle 12 may be one of a backhoe, a trackhoe, and a boom truck.

A flow rate of the fluid stream 32 may be greater than 11, 12, or 14 gallons per minute.

The fluid stream 32 may also excavate earth 50 away from an underground line 36 without using hand tools and/or without a vacuum.

The above disclosure also provides a method of excavating earth 50 away from an underground line 36. The method may include the steps of generating a fluid stream 32 flowing from a nozzle 22 at a flow rate greater than approximately 11 gallons per minute, and excavating earth 50 away from the underground line 36 by directing the fluid stream 32 toward the earth 50 surrounding the underground line 36.

The flow rate may also be greater than approximately 12 gallons per minute.

Directing the fluid stream 32 may include controlling a first actuator 44 which may rotate the nozzle 22 about a first axis 72 and may include controlling a second actuator 44 which may rotate the nozzle 22 about a second axis 74.

The above disclosure also provides a method of excavating earth 50 from around an underground line 36. The method may include the steps of generating a fluid stream 32 flowing from a nozzle 22, trenching alongside the underground line 36 with the fluid stream 32, and excavating earth 50 away from the underground line 36 with the fluid stream 32.

The method may also include the step of locating the underground line 36 with the fluid stream 32, prior to the trenching step. The locating, trenching, and excavating steps may be performed without using a vacuum.

It is to be understood that the various examples described above may be utilized in various orientations, such as inclined, inverted, horizontal, vertical, etc., and in various configurations, without departing from the principles of the present disclosure. The embodiments illustrated in the drawings are depicted and described merely as examples of useful applications of the principles of the disclosure, which are not limited to any specific details of these embodiments.

In the above description of the representative examples of the disclosure, directional terms, such as “above,” “below,” “top,” “bottom,” etc., are used for convenience in referring to the accompanying drawings.

Of course, a person skilled in the art would, upon a careful consideration of the above description of representative embodiments, readily appreciate that many modifications, additions, substitutions, deletions, and other changes may be made to these specific embodiments, and such changes are within the scope of the principles of the present disclosure. Accordingly, the foregoing detailed description is
to be clearly understood as being given by way of illustration and example only, the spirit and scope of the present invention being limited solely by the appended claims and their equivalents.

What is claimed is:

1. An excavating system, the system comprising:
   a nozzle attached to an extendable arm of an excavating vehicle, and
   a fluid supply line which supplies fluid to the nozzle and creates a fluid stream flowing from the nozzle, wherein the fluid stream excavates earth away from an underground line.

2. The system of claim 1, wherein the excavating vehicle manipulates the nozzle in at least one axis of rotation.

3. The system of claim 1, wherein the system further comprises at least one actuator, wherein the actuator manipulates the nozzle in at least one axis of rotation.

4. The system of claim 3, wherein the actuator is electrically controlled.

5. The system of claim 3, wherein the actuator is hydraulically controlled.

6. The system of claim 3, wherein the system further comprises a controller that controls the actuator and thereby manipulates the nozzle.

7. The system of claim 1, wherein the system manipulates the nozzle in three axes of rotation.

8. The system of claim 1, wherein the fluid stream excavates earth away from the underground line, while the system maintains a distance between the nozzle and the underground line during the excavation.

9. The system of claim 1, wherein the underground line is one of a pipeline, a utility line, and a fiber optic line.

10. The system of claim 1, wherein the excavating vehicle is one of a backhoe, a trackhoe, and a boom truck.

11. The system of claim 1, wherein the fluid stream excavates earth away from an underground line without using hand tools.

12. The system of claim 1, wherein a flow rate of the fluid stream is greater than approximately 11 gallons per minute.

13. The system of claim 1, wherein a flow rate of the fluid stream is greater than approximately 12 gallons per minute.

14. The system of claim 1, wherein a flow rate of the fluid stream is greater than approximately 14 gallons per minute.

15. The system of claim 1, wherein the fluid stream excavates earth away from the underground line without using a vacuum.

16. A method of excavating earth away from an underground line, the method comprising the steps of:
   generating a fluid stream flowing from a nozzle at a flow rate greater than approximately 11 gallons per minute, and
   excavating earth away from the underground line by directing the fluid stream toward the earth surrounding the underground line.

17. The method of claim 16, wherein the flow rate is greater than approximately 12 gallons per minute.

18. The method of claim 16, wherein the step of directing includes the step of controlling a first actuator which rotates the nozzle about a first axis.

19. The method of claim 18, wherein the step of directing includes the step of controlling a second actuator which rotates the nozzle about a second axis.

20. A method of excavating earth from around an underground line, the method comprising the steps of:
   generating a fluid stream flowing from a nozzle, trenching alongside the underground line with the fluid stream, and
   excavating earth away from the underground line with the fluid stream.

21. The method of claim 20, wherein the method further comprises the step of locating the underground line with the fluid stream, prior to the trenching step.

22. The method of claim 21, wherein each of the locating, trenching, and excavating steps is performed without using a vacuum.

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