



(51) International Patent Classification:

A01B 1/00 (2006.01) *A01G 29/00* (2006.01)
A01M 17/00 (2006.01) *A01C 15/02* (2006.01)
A01M 25/00 (2006.01) *A01C 23/02* (2006.01)
A01C 5/02 (2006.01)

(21) International Application Number:

PCT/US2013/049940

(22) International Filing Date:

10 July 2013 (10.07.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

13/549,048 13 July 2012 (13.07.2012) US

(71) Applicants: **BASF AGRO B.V., ARNHEM (NL), ZURICH BRANCH** [CH/CH]; Im Tiergarten 7, CH-8055 Zurich (CH). **DRYJECT, INC.** [US/US]; 307 Lincoln Avenue, Hatboro, Pennsylvania 19040 (US).

(72) Inventors: **CINK, James, H.**; 1003 Saint Paul Run, Ballwin, Missouri 63021 (US). **WARRINER, Richard, A.**; 908 Heritage Greens Drive, Wake Forest, North Carolina 27587 (US). **BROWN, Kenneth, S.**; 3568 Tree Court Industrial Blvd., St. Louis, Missouri 63122 (US). **PADDOCK, John**; 3 Heather Lane, Hainesport, New Jersey 08036 (US). **DES GARENNE, Michael, Chris**; 251 Thomas Jefferson Terrace, Elkton, Maryland 21921 (US).

(74) Agents: **BRIDGE, Richard, L.** et al.; Armstrong Teasdale LLP, 7700 Forsyth Blvd., Suite 1800, St. Louis, Missouri 63105-1847 (US).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: APPARATUS FOR INJECTING SOIL TREATMENTS

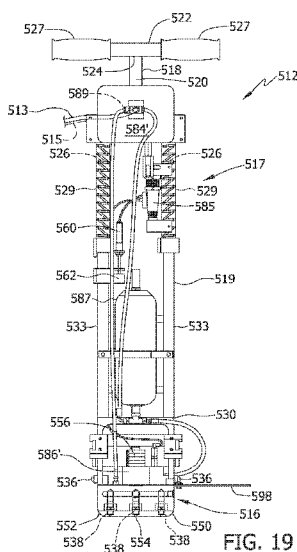


FIG. 19

(57) Abstract: Apparatus for injecting soil treatment into soil includes a manifold head (16) having at least one high pressure nozzle (38) for injecting the soil treatment into the soil and a handle (17) having a longitudinal axis and a lateral axis. The handle comprises an upper portion (18) having two spaced-apart tubular shafts and a lower portion (19) having two spaced-apart tubular shafts. The tubular shafts of the lower portion are connected to the tubular shafts of the upper portion.

APPARATUS FOR INJECTING SOIL TREATMENTS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Patent Application Serial Number 13/549048, filed July 13, 2012, which is a continuation-in-part of U.S. Patent Application Serial No. 13/033,469 filed February 23, 2011, which claims priority to U.S. Provisional Patent Application Serial No. 61/307,183, filed on February 23, 2010, and U.S. Provisional Patent Application Serial No. 61/307,178 filed on February 23, 2010. Each of these applications is incorporated herein by reference in its entirety.

BACKGROUND OF THE DISCLOSURE

[0002] The field of the disclosure relates generally to soil treatments, and more particularly to methods and apparatus for applying soil treatments (e.g., pesticides) below the ground surface using a handheld application tool in a manner which does not disturb the soil surface before the soil treatment is injected.

[0003] The insertion of soil treatments into the soil near buildings has been used to prevent or reduce the infestation of insects or other pests. Without treatment, these pests can become a significant nuisance or hazard to a building owner or its occupants. Such pests are known to attack the structure of buildings and may infiltrate the building causing other problems for its occupants.

[0004] At least one known method of soil treatment includes an application of pesticides, fertilizers, or other soil treatments by direct placement into the soil under and around structures, around or near ornamental plantings, poles, fences, decks, or other wooden elements. This direct placement method includes digging, trenching and/or rodding (i.e., forcing an application device into the soil), and then directly placing the soil treatment into the dug out area of the trench. This known method can cause damage to vegetation, disrupt landscaping, and greatly impact or diminish the aesthetic beauty and value of the treated area until either the plants recover or new plantings are installed.

[0005] For example, in some common termite treatments direct placement of a termiticide into the soil around structures involves the digging of a trench approximately 4 to 6 inches wide by 6 inches deep into which a termiticide composition is applied at a rate of 4 gallons per 10 linear feet of trench per foot of depth. In addition to the application of the soil treatment to the trench, soil treatment may also be dispensed into the ground through the use of a rod injection tool, which is plunged down into the ground or to the top of a footer (i.e., a part of the building's foundation). For a typical structure having a perimeter of 200 linear feet, the time to prepare, dig, inject, and finish the application of soil treatment requires at least 4 to 6 hours depending on the type of soil and whether the application is conducted by a pair of or a single technician(s).

[0006] Another known method of soil treatment includes the direct insertion of a tool down into the ground and delivering the pesticides, fertilizers, or other soil treatments into the ground. Applying the soil treatments below the surface of the soil has been used as a way of limiting the wash off of the treatments. Typical devices for implementing such soil treatments have utilized needles or other mechanical devices to create a passageway into the soil to allow the soil treatment to be inserted into the ground. These devices have the obvious limitation that they create holes in the soil, which may be unsightly, or create other adverse concerns, such as unwanted soil compaction adjacent the insertion sights, as well as require the creation of the hole using mechanical forces. Moreover, devices that are pushed into the ground can become contaminated with soil borne pathogens or other contaminants that can potentially be transferred to the next injection site.

[0007] The use of high pressure flows as a method of effectively injecting materials below the soil surface has been described before, such as in U.S. Pat. No. 5,370,069 to Monroe, titled Apparatus and Method for Aerating and/or Introducing Particulate Matter into a Ground Surface. These methods use high pressure jets of a fluid, such as air or water that entrain the soil treatment agent, whether the soil treatment agent is in solution with the fluid, or a granular material carried with the fluid. The high pressure jet can form a small hole in the surface into which the material is being placed, or cause the material to be absorbed by the surface in a rapid fashion, such that soil disturbance is minimal. One benefit of the use of a pressure jet is that no mechanical effort is required to

create a passageway as a predicate for the soil treatment material to be placed below the surface of the soil. Nor is any other disturbance of the soil required, such as placing a tool directly down below the ground surface.

[0008] While devices such as that disclosed in Monroe are effective at placing soil treatment materials below the surface, they are designed to distribute such materials both a short distance below the soil surface and over a large open space area, where the size of the equipment is not a limitation. These known devices are not suitable for strategically injecting soil treatments to greater depths within the soil under and around structures, ornamental plantings, poles, fences, decks and other wood elements where treatments relating particularly to treatments against insects infestation are common.

[0009] Accordingly, a handheld high pressure application tool for applying soil treatments (e.g., termiticide or other pesticide) beneath the surface of the ground adjacent a structure is needed. Such a handheld tool would permit an operator to strategically position the tool around a structure such as a house, a deck, any landscaping that may be near the house and/or deck, around utility poles, and around plants. The tool could include multiple nozzles for applying a predetermined amount of soil treatment at a controlled pressure for injecting the soil treatment down to a desired predetermined depth. This would allow for precision applications where the area of application is carefully controlled.

BRIEF DESCRIPTION OF THE DISCLOSURE

[0010] In one aspect, apparatus for injecting soil treatment into soil generally comprises a manifold head having at least one high pressure nozzle for injecting the soil treatment into the soil. A handle has a longitudinal axis, a lateral axis, an upper portion having two spaced-apart tubular shafts and a lower portion having two spaced-apart tubular shafts. The tubular shafts of the lower portion are connected to the tubular shafts of the upper portion.

[0011] In another aspect, apparatus for injecting soil treatment into soil generally comprises a handle having a pair of hand grips for facilitating manual manipulation of the apparatus by an operator. The hand grips are selectively moveable

from a first position on the handle to a second position on the handle. At least one high pressure nozzle is provided for injecting the soil treatment into the soil and a supply of soil treatment is in fluid communication with the at least one high pressure nozzle.

[0012] In yet another aspect, apparatus for injecting soil treatment into soil generally comprises a handle having an upper portion and a lower portion. The lower portion is angled relative to the upper portion. At least one high pressure nozzle is carried by the lower portion of the handle and is adapted to inject the soil treatment into the soil. A supply of soil treatment is in fluid communication with the at least one high pressure nozzle.

[0013] In still another aspect, apparatus for injecting soil treatment into soil generally comprises a handle and a manifold head carried by the handle. The manifold head has a plurality of a pressure nozzle for injecting the soil treatment into the soil and thereby define an injection site. A kick guard extends outward from at least one side of the manifold head to block debris that may be kicked-up during the injection of soil treatment.

[0014] In still yet another aspect, a high pressure injection system for injecting soil treatment into soil generally comprises a supply cart and a handheld portable application tool connected to the cart via a conduit defining a fluid passageway and at least one electrical connection. A hose reel is mounted on the supply cart. The hose reel comprises a spool, a mounting bracket for mounting the spool to the supply cart, and a handle for manually rotating the spool relative to the mounting bracket. The spool is rotatable relative to the mounting bracket using the handle to wind and unwind the conduit about the spool. The handle includes a rotary electrical connector for feeding the electrical connection to the conduit wound about the spool.

[0015] In yet a further aspect, a valve and conduit defining a fluid passageway that can be opened and closed to allow the flow of fluid, gases or the combination of the two to bypass an electronic actuator thereby purging the line of any gases traveling in the conduit that may interrupt or cause intermittent flow of fluids through the conduit and manifold head or releasing fluid pressure from the conduit prior to disconnecting the conduit leading from the supply cart and connecting to the handheld portable application tool.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Figure 1 is a schematic illustration of a high pressure injection system for injecting a termiticide into the ground in accordance with an exemplary embodiment in which the system includes a base unit and a handheld application tool.

[0017] Figure 2 is a front view schematic illustration of the handheld portable application tool of Figure 1 with parts cut away.

[0018] Figure 3 is a side view schematic illustration of the handheld portable application tool of Figure 2.

[0019] Figure 4 is a perspective schematic illustration of an elongated shaped manifold head for use with the application tool.

[0020] Figure 5 is a perspective schematic illustration of an arcuate shaped manifold head for use with the application tool.

[0021] Figure 6 is a perspective schematic illustration of the manifold head shown in Figure 2 having low pressure nozzles positioned adjacent to high pressure nozzles.

[0022] Figure 7 is a perspective schematic illustration of the manifold head shown in Figure 2 having low pressure nozzles concentric with high pressure nozzles.

[0023] Figure 8 is a bottom schematic illustration of the manifold head shown in Figure 2 having nozzles on the perimeter for applying marking materials.

[0024] Figure 9 is a side view schematic illustration of the base unit shown in Figure 1.

[0025] Figure 10 is a top plan schematic illustrating the high pressure injection system of Figure 1 being used to inject termiticide into the soil adjacent a structure.

[0026] Figure 11 is a perspective schematic illustration of a manifold head that includes multiport center nozzles.

[0027] Figure 12 is a perspective schematic illustration of a manifold head that includes four center nozzles.

[0028] Figure 13 is a perspective schematic illustration of another embodiment of a handheld application tool.

[0029] Figure 14 is a perspective schematic illustration of the handheld application tool of Figure 13 but with a trigger switch of the tool being actuated.

[0030] Figure 15 is a schematic illustration of a high pressure injection system for injecting a termiticide into the ground in accordance with another exemplary embodiment in which the system includes a base unit and a handheld application tool.

[0031] Figure 16 is a front view schematic illustration of the handheld portable application tool of Figure 15 with parts cut away.

[0032] Figure 17 is a side view schematic illustration of the handheld portable application tool of Figure 16.

[0033] Figure 18 is a schematic illustration of a high pressure injection system for injecting a termiticide into the ground in accordance with another exemplary embodiment in which the system includes a base unit and a handheld application tool.

[0034] Figure 19 is a front view schematic illustration of the handheld portable application tool of Figure 18.

[0035] Figure 20 is a side view schematic illustration of the handheld portable application tool of Figure 18.

[0036] Figure 21 is a back view schematic illustration of the handheld portable application tool of Figure 18.

[0037] Figure 22 is an enlarged perspective schematic illustration of a hose reel removed from the base unit of Figure 18.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0038] A high pressure injection system for applying a soil treatment (e.g., pesticide, insecticide or termiticide) beneath the surface of the ground is described below in detail. It is understood that the system disclosed herein can be used to apply any suitable soil treatment including pesticide, insecticide, or termiticide and can be used to inhibit or control various types of pests. For example, it may be desirable to inhibit and/or control termites, ants, cockroaches, beetles, earwigs, silverfish, crickets, spiders, centipedes, millipedes, scorpions, pillbugs, sowbugs, flies, mosquitoes, gnats, moths, wasps, hornets, bees, and the like. As used herein, the term “pesticide” refers to any substance or mixture for preventing, destroying, repelling, or mitigating any pest including insects, animals (e.g., mice, rats), plants (e.g., weeds), fungi, microorganisms (e.g., bacteria and viruses), pseudocoelomates (e.g., nematodes) and prions. The term “insecticide”, which is a type of pesticide, is used herein to mean any substance or mixture for preventing, destroying, repelling, or mitigating insects. The term “termiticide”, which is a type of insecticide, is used herein to mean any substance or mixture for preventing, destroying, repelling, or mitigating termites.

[0039] Although the methods and systems described herein relate to the application of termiticides beneath the surface of the ground, the methods and systems could also be used to apply pesticides, insecticides, or other soil treatments. The use of termiticides as described herein is not intended to be limiting in any way. Rather, it is for exemplary purposes. The methods and systems described herein may be used, therefore, to apply any type of soil treatment beneath the ground (e.g., pesticides, fertilizers, other soil conditioning materials and insect treatments including insecticides placed around the perimeter of a structure), and is in no way limited to only termiticides.

[0040] The methods and systems described herein include a termiticide fluid supply cart (a base unit), and a portable handheld application tool that facilitates the application or injection of termiticides into the soil under and around structures, ornamental plantings, poles, fences, decks and other wood elements. The example embodiment eliminates the need to apply termiticides using certain known techniques such as digging, trenching, and/or rodding, which all require mechanically disturbing at least the surface of the ground or soil. These known techniques can cause damage to vegetation, disrupt

landscaping, and impact or diminish the aesthetic beauty and value of the treated area until the plants recover or new plantings are installed.

[0041] The application system described herein includes an application tool that has a tee-handle at the top of the tool and a manifold assembly at the bottom of the tool. The tee-handle includes a hand grip portion on each side of a vertical shaft that extends between the handle and the manifold assembly. The hand grip portions may include rubber grips to aid in holding the tool during application and to reduce hand strain. The vertical shaft of the tool consists of several parts that allow the shaft to compress, when the handle is pushed down, much like a pogo stick. The compression of the shaft activates an electronic triggering switch (broadly, “an actuator”) that temporarily opens a discharge valve, for example a poppet. When the operator has the manifold assembly (i.e., device plate) in position on the ground, the operator uses the handle to apply a downward pressure (approximately 15-20 pounds) onto the shaft to actuate the trigger switch, which in turn causes a single injection of termiticide into the ground. The operator must release the pressure applied to the shaft to disengage the switch, which results in the system being reset.

[0042] In the example embodiment, the switch actuates the discharge valve a single time for each compression of the shaft. Thus, for each compression of the shaft, the discharge valve is opened a single time and a predetermined quantity of termiticide is discharged from the tool. The switch of tool is reset when the shaft is released. The next application can then be made by again compressing the shaft.

[0043] The application tool also includes a mounting bracket that mounts the manifold assembly to the shaft. This bracket allows the application head or manifold assembly to pivot about at least one axis. This allows the operator to adjust the tool such that the manifold assembly is properly positioned before activating the application switch.

[0044] The manifold assembly includes an inlet port, a discharge valve, a plurality of high pressure nozzles, a manifold head, and a contact plate for protecting the plurality of high pressure nozzles. The system also includes at least one high pressure liquid line and electrical connections that extend between the supply cart and the handheld application tool. The system also includes a pressure manifold and an electronic controller

(broadly, “a valve closer”) that sets the length of time the discharge valve remains open during each activation of the electronic switch.

[0045] In operation, a measured dose of a liquid termiticide concentrate from a container housed on the supply cart is mixed with measured supply of water and fed to the application tool by an inline injection system. In another embodiment, the termiticide solution is supplied to the application tool from a tank or container without the need of an inline injection pump or device. In yet another embodiment, the termiticide concentrate can be carried by the operator and housed in a transportable container formed into and/or held within a backpack, a shoulder holster, a sling, a belt holster, a leg holster, or other suitable device capable of holding the pesticide container.

[0046] The methods and systems described herein utilize high pressure to inject the termiticide into soil beneath the surface of the ground. The high pressure injection system described herein differs from at least some known liquid injection systems that apply termiticides for soil application in that the current industry standard liquid termiticide injection systems inject liquids into the ground using pressures of 25 to 35 psi and through a single injection port or tip. The example system described herein injects the termiticide solution into the ground at pressures ranging from about 50 psi to about 10,000 psi, and in another embodiment, from about 1,000 psi to about 7,000 psi, and in yet another embodiment, at about 4,000 psi.

[0047] In operation, the application tool is set at a desired pressure for applying the termiticide. The operator then places the manifold assembly, and more specifically, the contact plate, which protects the injection nozzles, in a desired application area. The desired area may be, for example, adjacent to a wall or foundation of a structure. The operator then press down on the application handles to compress the shaft of the tool. This downward pressure causes the upper and lower portions of the device shaft to come together thereby activating an electronic switch. The switch would temporarily open the discharge valve and allow a predetermined amount of termiticide solution to pass through the high pressure injection nozzles and into the ground. The switch would only allow a single charge (i.e., a predefined amount of termiticide solution) to pass through the nozzles. The switch is reset by releasing the pressure on the handle and allowing the two parts of the electronic switch to separate. The operator applicator would then lift or slide the handheld

application tool along the wall to the next application point and press down on the handle again, thus repeating the injection of the termiticide solution into the soil. The operator continues to move the handheld application tool and inject termiticide until the desired application area is injection. In one example, the desired application area is the perimeter of the structure so that a barrier of termiticide completely surrounds the structure and thereby inhibits termites from passing through the barrier to the structure.

[0048] In an alternative embodiment, the electronic switch could be positioned on or near the tee-handle portion of the tool where it could be activated by the operator pressing down on a button or switch with a finger or thumb. In another embodiment, the tool could include a position marker, such as a foam, dust, powder, paint, or a dye material that would be applied when the termiticide is applied. The position marker would apply a marking material to the ground to mark the position of the contact plate during each application. This would allow the operator to visually determine where an application has been made and where the device plate should be re-positioned to ensure that a continuous application of the termiticide is made around the perimeter of the structure. The marker would also aid in preventing over or under application of the termiticide solution in the application area.

[0049] The high-pressure application tool and methods of using the same as described herein have many advantages over the known systems. For example, the tool described herein may include an inline injection assembly which eliminates the need to mix large volumes of the termiticide solution, and reduces the hazards associated with transporting or handling large volumes of termiticide solutions on public roadways or on private property. The use of the high-pressure injection tool also eliminates the need for digging (i.e., trenching) before applying the termiticide solution into the ground. This reduces the destruction of the landscaping and/or natural vegetation around the perimeter of a structure being treated. The high-pressure injection tool also reduces or eliminates the need for rodding into the soil with an application device in order to apply the termiticide solution. The high-pressure tool can also be programmed to deliver a specific volume of termiticide solution per nozzle, and control the depth to which the solution penetrates into the soil by controlling the application pressure. By controlling the volume and the pressure, the application volume of the termiticide can be reduced by 25% to 80% of a

normal liquid termiticide application, thus saving cost and reducing demands on water. This is especially important in drier climates or during times of drought. The high-pressure tool also greatly reduces the time required to complete a termiticide treatment around a structure. This reduction in time can range between 40% and 80%. As a result, less time is spent at the site and thereby labor costs associated with the site preparation and application are reduced. Also, the application tool, which is designed to place the injection nozzles in close proximity to the ground when injecting the termiticide into the ground, reduces the risk of exposure to the operator or anyone in the immediate area of the application.

[0050] Referring to the drawings, Figure 1 is a schematic illustration of a high pressure injection system 10 for injecting termiticide into the ground in accordance with an exemplary embodiment of the present invention. The injection system 10 includes a handheld portable application tool 12 (broadly, an “injection apparatus”) and a termiticide fluid supply cart 14 (broadly, a “base unit”). The application tool 12 is connected to the cart 14 via a conduit 13 defining a fluid passageway (e.g., a hose) and at least one electrical connection 15. The conduit 13 permits fluid (e.g., water and/or a termiticide solution) to flow from the cart 14 to the application tool 12. The electrical connection 15 is used for transmitting various control signals between the application tool 12 and the cart 14.

[0051] Figure 2 is a front view schematic illustration of the handheld portable application tool 12, and Figure 3 is a side view schematic illustration of the application tool 12. The handheld portable application tool 12 includes a handle 17 and a manifold head 16 mounted to the handle. The handle 17 includes an upper portion 18 and a lower portion 19. The upper portion 18 includes a tubular section 20 and a hand grip section 22 attached to an upper end 24 of the tubular section 20. As a result, the upper portion 18 of the handle 17 has a generally T-shape. The lower portion 19 of the handle 17, which is tubular, is sized for insertion into the tubular section 20 of the upper portion 18 of the handle. With the lower portion 19 of the handle 17 inserted into the tubular section 20 of the upper portion 18 of the handle, the upper portion can move with respect to the lower portion from a first, extended position to a second, compressed position. A biasing element, such as a spring 26, is provided to bias the upper portion 18 of the handle 17 toward its first, extended position. It is understood, however, that any known biasing

element 26 may be used. A flange (not shown) or other suitable retainer(s) may be provided to inhibit the lower portion 19 of the handle 17 from being pulled or otherwise withdrawn from the upper portion 18 to thereby ensure that the lower portion remains telescopically attached to the upper portion. A lower end 28 of lower portion 19 of the handle 17 is attached to an inverted U-shaped attachment bracket 30. The manifold head 16 is pivotally attached at each of its ends 32, 34 to the attachment bracket 30 via a pair of pivot pins 36.

[0052] The manifold head 16 includes at least one internal passage to distribute the termiticide to a plurality of high pressure nozzles 38 in fluid communication with the internal passage. As seen in Figure 3, the illustrated manifold head 16 includes two main internal passages 40, 42, and a cross passage 44 connecting main internal passages. It is contemplated that the manifold head 16 may include any number of high pressure nozzles 38 including a single nozzle. For example, the manifold head 16 of the exemplary embodiment has a matrix of six high pressure nozzles 38 with each nozzle generally equidistant from each other. Each of the high pressure nozzles 38, in one embodiment, has an orifice diameter ranging from about 0.002 inch to about 0.01 inch.

[0053] With reference again to Figure 2, a contact plate 50 is attached to a bottom surface 52 of the manifold head 16 to protect the high pressure nozzles 38. In the illustrated embodiment, the contact plate 50 includes a plurality of openings 54 with each of the openings being generally aligned with a respective one of the plurality of high pressure nozzles 38. As a result, the high pressure nozzles 38 are spaced from the soil by the contact plate 50 and therefore do not directly contact the soil. Moreover, the contact plate 50 shields or otherwise blocks soil, rocks, and/or other debris that may be “kicked-up” during the injection of the termiticide. The contact plate 50 includes rounded edges to facilitate sliding of the tool 12. The contact plate 50 can be made from any suitable material, for example, metal and/or plastic.

[0054] The size and shape of the manifold head 16 may be selected based on the particular application for which the tool 12 is intended to be used. In one embodiment, the manifold head 16 has a shape with a high length to width ratio such as the high pressure nozzles 38 being arranged linearly in a row as shown in Figure 4. In another embodiment, the manifold head 16 has an arcuate shape as shown in Figure 5. The arcuate

shaped manifold head 16 may be used to conform around circular edges, such as around trees. It is contemplated that the manifold heads 16 can be interchangeable. That is, the operator of the tool 12 can selectively change out the manifold head 16. It is also contemplated that the manifold head 16 can be replaced with other delivery means (e.g., a rod injection tool) for delivering a supply of termiticide at low pressures. These low pressure delivery means can be used in areas less suitable for high pressure injection.

[0055] The weight of the manifold head 16 may be selected so that the mass of the manifold head 16 assists in retaining tool 12 in position during a discharge from the plurality of high pressure nozzles 38, without being unduly burdensome for manual positioning and moving the tool by an operator. In general, the lighter the mass of the manifold head 16, the greater the force that the operator must apply to the handle 17 to retain the tool 12 in position during a discharge of termiticide from the high pressure nozzles 38.

[0056] As illustrated in Figure 2, a discharge valve 56 is attached to the manifold head 16 and is in fluid communication with the internal passages 40, 42, 44 in the manifold head and the supply of termiticide. More specifically, one end of the discharge valve 56 is coupled to a high pressure inlet port 58 and the other end of the discharge valve is coupled to the hose 13. The discharge valve 56 is moveable between an opened position and a closed position. When the discharge valve is in its closed position, termiticide is inhibited from flowing from the supply of termiticide via the hose 13 to the internal passages 40, 42, 44 in the manifold head via the high pressure inlet port 58. When the discharge valve 56 is opened, the termiticide solution flows from the supply of termiticide through the hose 13 and into inlet port 58 under high pressure. From the inlet port 58, the pressurized termiticide flows into internal passages 40, 42, 44 of the manifold head 16 and through the high pressure nozzles 38 from which the termiticide is injected into the ground. In one embodiment, the termiticide is pressurized to a pressure of about 25 psi to about 10,000 psi, and in another embodiment, from about 1,000 psi to about 7,000 psi, and in yet another embodiment, at about 4,000 psi.

[0057] In one suitable embodiment, the discharge valve 56 is a solenoid operated poppet valve capable of sufficiently rapid operation to allow opening and closing of the discharge valve 56 within the desired time parameters to allow correct depth

penetration of the soil based on the pressure in use and correct volume of termiticide solution for the specific application. While it is possible to use a hydraulically actuated valve, the size and weight constraints of such a valve may otherwise limit the utility of the handheld application tool 12.

[0058] In another suitable embodiment, the manifold head 16 may have a discharge valve 56 associated with each of the high pressure nozzles 38, such that even distribution of termiticide fluid across the plurality of high pressure nozzles 38 may be ensured. While discharge balancing can be obtained within reasonable parameters simply through proper sizing of the internal passages 40, 42, 44, should it be required, and should it justify the expense, multiple discharge valves 56 may be used, such that pressurized termiticide solution contained in a feed hose supplying each of the discharge valves 56 may provide that an adequate amount of termiticide solution is available for each of the high pressure nozzle 38. Such a configuration, however, adds complexity to the system 10 in that the controller must be able to actuate the multiple discharge valves 56 in response to a single actuation, i.e., increasing the amount of wiring and power required to control the valves, although the power requirement may be offset by the use of smaller discharge valves 56.

[0059] As illustrated in Figure 2, a trigger switch 60 (broadly, an “actuator”) is mounted on the lower portion 19 of the handle 17 and a trigger switch actuator 62 is mounted on the upper portion 18. The trigger switch 60, which is electrically coupled to the discharge valve 56, activates the discharge valve 56 when the trigger switch actuator 62 engages the trigger switch 60. In the illustrated embodiment and as seen in Figure 3, the trigger switch actuator 62 is engaged with trigger switch when the upper portion 18 of the handle 17 is moved to its second, compressed position. Thus, the trigger switch 60 can be actuated by moving the upper portion 18 of the handle 17 from its first, expanded position to its second compressed position by applying a force on the upper portion so that it slides downward relative to the lower portion 19 of the handle until the trigger switch actuator engages the trigger switch 60.

[0060] In another embodiment (not shown), the trigger switch 60 can be located on the hand grip section 22 of the upper portion 18 of the handle 17 where it can be actuated by the operator using a finger or thumb. The trigger switch may be a mechanical

device, which interrupts the flow of termiticide from the discharge valve 56 to the high pressure nozzles 38, or may be an electrical switch which interrupts the electrical signal to the discharge valve 56, thus preventing actuation of the discharge valve 56.

[0061] To inject the termiticide into the ground, the operator positions handheld portable application tool 12 such that the contact plate 50 is in contact with the surface of the ground. A downward force between about 15 to 20 pounds is applied by the operator to the upper portion 18 of the handle 17 to move the upper portion 18 from its first position to its second position and thereby cause the trigger switch actuator 62, which is mounted to the upper portion, to engage the trigger switch 60, which is mounted to the lower portion 19. Engagement of the trigger switch actuator 62 and the trigger switch 60 actuates the trigger switch 60. As a result, an electronic signal is sent from the trigger switch 60 to the discharge valve 56 causing the discharge valve to move from its closed position to its opened position for a predetermined amount of time thereby permitting termiticide to flow to and out the high pressure nozzles 38 for injecting the termiticide into the ground. The operator then releases the pressure from the handle 17, which resets the trigger switch. More specifically, the spring 26 causes the upper portion 18 of the handle 17 to move back to its first, extended position. The illustrated trigger switch 60 is configured to work only once during each compression of handle 17 to prevent repeated opening of the discharge valve 56 until the handle 17 has been reset.

[0062] The depth of penetration of the termiticide solution into the ground is a function of the pressure at which the termiticide solution is discharged from the tool 12 and the type of soil into which the termiticide is discharged. For example, hard packed or compacted soil, such as clay, is harder to penetrate and may require higher pressures than a soft sandy soil. Thus, at a given pressure the penetration of termiticide into a sandy soil may be about 12 to 14 inches, while the penetration of termiticide into a sandy loam at the same pressure may be about 6 to 9 inches, and the penetration of termiticide into a clay soil at the same pressure may be about 2 to 5 inches. It is understood, however, that the penetration of termiticide can be greater at higher pressures. For example, the penetration of termiticide into a clay soil may be about 10 to 12 inches at a sufficiently high pressure.

[0063] Referring to Figure 5, the manifold head can be formed into an arch, a semicircle, or other form of angled deflection. A manifold formed in such a manner would be well suited for facilitating the injection of a pesticide solution around a tree, a bush, a post, a pole, a potted plant, root ball, or other plant or structural element where the curved or angled manifold enables the applicator to position the pesticide into an area proximate to the targeted point of application.

[0064] Referring also to Figures 6 and 7, the manifold head 16 may also include a plurality of the low pressure nozzles 66. In the illustrated embodiment of Figure 6, each of the lower pressures nozzles 66 positioned adjacent to one of the plurality of high pressure nozzles 38. In another embodiment, which is illustrated in Figure 7, each of the low pressure nozzles 66 is concentric with one of the high pressure nozzles 38. The low pressure nozzles 66 apply the termiticide solution onto the surface of the ground when a low pressure discharge valve 68 is opened. The lower pressure discharge valve operates in the same manner as the previously described discharge valve 65. The low pressure nozzles 66 are configured to apply the termiticide solution to the ground at a pressure of less than about 35 psi.

[0065] Referring now to Figure 8, the handheld portable application tool 12 may also include a plurality of nozzles 70 (broadly, a “dispenser”) for depositing position marker material onto the surface of the soil to indicate an area in which the termiticide has been injected, and marking the position of the manifold head 16 during each application. Marking the position of the manifold head 16 permits the operator to visually observe where termiticide has been applied and to where the manifold head should be positioned next so that a uniform application of the termiticide can be applied around the perimeter of a structure. In addition, the applied marking material may also aid in preventing over and/or under application of the termiticide. Any suitable marking material may be used, for example, a foam, a powder, a paint, and a dye. In the illustrated embodiment, the marking material is applied by the plurality of nozzles 70 about the circumference of the manifold head 16. A container 72 containing the marking material may be carried by the application tool 12 or a remotely located device such as the cart 14 shown in Figure 1. It is understood that the marking material may be applied by any suitable delivery device and remain within the scope of this invention.

[0066] The supply of termiticide solution may be provided by the supply cart 14. In one embodiment, the cart 14 includes a water reservoir 80, a high pressure pump 82 for pressurizing the termiticide solution, a termiticide concentrate reservoir 84, and a mixing device 86 that supplies the appropriate amount of termiticide concentrate to be mixed with the appropriate amount of water to form the termiticide solution. A water inlet 81 for receiving water from an external water source (e.g., a standard residential water spigot) is also provided. It is contemplated that either the water reservoir 80 or the water inlet 81 can be omitted. The supply cart 14 also includes a gasoline engine 88 with a generator 90 for generating power for operating the pressure pump 82 and generating electrical current for operating a controller 92 associated with the tool 12. In another embodiment, electrical power can be supplied by connecting into an electrical outlet located at the application site.

[0067] It is contemplated that the supply cart 14 may be vehicle mounted (e.g., a truck, a van, a ATV), trailer mounted, self propelled, or even a combination thereof, such that the cart 14 can be towed to a job site, then moved around a location under its own power. It is also contemplated that some the various components of the system 10 described herein as being mounted on the supply cart 14 may be mounted on the application tool 12. For example, it is contemplated that the termiticide concentration reservoir 84 and the mixing device 86 can be mounted on the application tool 12 instead of the supply cart 14. It is further contemplated that the supply cart 14 can be omitted. In such an embodiment, at least the termiticide concentration reservoir 84, the mixing device 86, and the water inlet 81 are carried on-board the application tool 12.

[0068] The controller 92, which is mounted on the cart 14, permits the operator of the system 10 to selectively set a pulse duration and pressure level for termiticide injections. The controller 92 may be programmable to permit the operator to enter parameters associated with a particular manifold head 16 in use, such as by defining the number of orifices and their sizes, parameters with a termiticide solution in use, such that dosing through the mixing device 86 can be properly controlled, or the number of injections can be tracked, and the like. It is understood that the pulse duration and/or pressure level for termiticide injections can be manually adjustable (e.g., via a manually adjustable valve) in addition to or instead of being set using the controller 92.

[0069] As illustrated in Figure 10, the system 10 can be used according to one embodiment of a method for treating soil adjacent to a structure, such as a house 94. For example, the system 10 can be used to inject and/or apply termiticide to the soil around the perimeter of the house 94 and thereby establish a barrier to inhibit termites from accessing the house and to control termites in close proximity to the house. According to one method, the base unit 14 is placed at a stationary location relative to the house 94 and the tool 12 is positioned over, and more suitably in contact with, an injection site 96 generally adjacent the house. The tool 12 is operated as described above to inject termiticide down into the soil at the injection site 96 without prior disturbance of the soil. The tool 12 is then moved relative to the supply cart 14 to another injection site 96 that at least in part different from the previous injection site and generally adjacent the house 94. In the illustrated embodiment, the injections sites 96 are generally in side-by-side relationship with each other. The tool 12 is again operated to inject termiticide down into the soil at this next injection site 96 without prior disturbance of the soil.

[0070] As seen in Figure 10, the tool 12 is moved to and operated at a plurality of injection sites 96 adjacent the structure so that the injection sites cooperatively surround substantially the entire perimeter of the house 94. Figure 10 illustrates a plurality of injection sites 96 at which termiticide has been injected (illustrated in the Figure with solid lines) and a plurality of injection sites at which termiticide will be injected (illustrated in the Figure with dashed lines). It is understood that termiticide can also be applied to surface of the soil at each or some of the injection sites 96. It is further understood that marking material can be deposited onto the soil to indicate where the pesticide solution had been injected into the soil. It is also contemplated that, if necessary, the supply cart 14 may be moved to another location as the handheld tool 12 is used about the perimeter of the house 94.

[0071] Referring now to Figure 11, in another embodiment the manifold head 16 includes four high pressure nozzles 38 arranged in a rectangular and more suitably a square matrix configuration 100 wherein adjacent nozzles 38 are generally equidistant from each other. In the illustrated embodiment, each of the high pressure nozzles is generally positioned at each corner of the square matrix configuration 100. It is contemplated that more than one square matrix of high pressure nozzles 38 may be formed

in the manifold head 16. For example, Figure 12 illustrates an embodiment wherein six high pressure nozzles 38 form two side-by-side square matrices 100 (or a single rectangular matrix). It is contemplated that the manifold head 16 may include $4+x$ equidistant high pressure nozzles 38 forming $1+(x/2)$ side-by-side square matrices 100, wherein x is an even integer greater than 0. It is also contemplated that the high pressure nozzles 38 can be arranged in an orthogonal matrix configuration, for example, a rectangular matrix, an hexagonal matrix, an octagonal matrix, and the like.

[0072] As seen in Figures 11 and 12, a multiport high pressure nozzle 102 can be positioned in the center of each of the square matrices 100. Each of the illustrated multiport nozzles 102 includes four ports 104 that are angled toward the corners of matrix 100. Each of the high pressure nozzles 38 is orientated so that a discharge stream 106 of termiticide from the nozzle 38 is substantially perpendicular to the bottom surface 52 of the manifold head 16. When the manifold head 16 is positioned on the ground, the discharge stream 106 is substantially normal to the ground surface, e.g., vertical, when the surface of the ground is substantially level. Each of the ports 104 of the multiport nozzle 102 is configured to direct a discharge stream 108 of termiticide from the port to intersect the discharge stream 106 from one of the high pressure nozzles 38. The intersection of the discharge stream 106 from one of the high pressure nozzles 38 by the discharge stream 108 from one of the ports 104 of the multiport high pressure nozzle 102 may be about 1 inch to about 12 inches below the surface of the ground. An angle off vertical 110 of the discharge stream 108 of one of the ports 104 of the multiport nozzle 102 is based on the depth of intersection desired and the distance between the nozzles 38. The intersection of the discharge streams potentially results in the pooling of some of the injected termiticide. For example, when the high pressure nozzles 38 are 2 inches apart from each other, the angle off vertical 110 of the discharge stream 108 of the port 104 is about 54 degrees for an intersection at one inch below the surface, and about 9 degrees for an intersection at 6 inches below the surface, and about 5 degrees for an intersection at 12 inches below the surface.

[0073] It is contemplated that the ports 104 of the multiport nozzle 102 can be configured such that the discharge streams of termiticide emitted therefrom are generally vertically and that some or all of the plurality of high pressure nozzles 38 can be

configured such that the discharge streams of termiticide emitted therefrom are other than vertical. In one suitable embodiment, the termiticide is emitted from the nozzles 38 in a generally conical discharge stream. It is further contemplated that the ports 104 of the multiport nozzle 102 and the plurality of high pressure nozzles 38 can be configured to emit discharge streams of termiticide that are other than vertical. In either of these arrangements, some or all of the plurality of high pressure nozzles 38 can be configured to emit discharge streams that are angled toward the periphery of the control plate (i.e., away from the multiport nozzle 102) to thereby increase the coverage area of the termiticide and that some or all of the plurality of high pressure nozzles 38 can be configured to emit discharge streams that are angled inward and toward the multiport nozzle 102 for intersecting the discharge streams emitted from the ports 104 of the multiport nozzle.

[0074] In operation, the manifold head 16 is positioned on the ground and the operator activates the trigger switch 60 causing the discharge valve 56 to open thereby permitting the predetermined quantity of termiticide to flow to and out each of the high pressure nozzles 38 and each of the ports 104 of the multiport high pressure nozzle 102 to thereby injecting termiticide into the ground. The discharge streams 106 of termiticide from each of the high pressure nozzles 38 is injected substantially vertically into the ground. The discharge streams 108 of termiticide from the ports 104 are injected into the ground at an angle off vertical 110 which causes the discharge streams 108 from each of the ports 104 to intersect respective discharge streams 106 from the high pressure nozzles 38 below the surface of the ground.

[0075] The angled discharge streams 108 of ports 104 provide for supplying the termiticide to a greater volume of the injection area than just using the high pressure nozzles 38. The angled discharge streams 108 of the ports 104 inject termiticide into the soil within a central injection zone of the injection area, which is located within an outer injection zone defined by the termiticide injected by the high pressure nozzles 38. Injection of termiticide at high pressures causes the soil to fracture as the discharge streams 106, 108 of termiticide pass through the soil. In another embodiment, each of the ports 104 are slightly offset so that their discharge streams 108 of termiticide do not precisely intersect respective discharge streams 106 from the high pressure nozzles 38.

[0076] Referring again to Figure 12, in another embodiment four center high pressure nozzles 112 may be used instead of the multiport nozzle 102. The four center nozzles 112 are collectively positioned in the center of the matrix 100 and are each angled toward a different corner of the square matrix. Similar to the multiport nozzles 102 described above, the center nozzles 112 are configured to direct their discharge streams 108 to intersect a respective discharge stream 106 from one of the high pressure nozzles 38. The intersection of the discharge stream 106 from one of the high pressure nozzle 38 by the discharge stream 108 from one of the center high pressure nozzles 112 may be about 1 inch to about 12 inches below the surface of the soil. The angle off vertical 110 of the discharge stream 108 of the center nozzle 112 is based on the depth of intersection desired and the distance between the high pressure nozzles 38. For example, when high pressure nozzles 38 are 2 inches apart from each other, the angle off vertical 110 of the discharge stream 108 from the center nozzle 112 is about 54 degrees for an intersection at one inch below the surface, and about 9 degrees for an intersection at 6 inches below the surface, and about 5 degrees for an intersection at 12 inches below the surface.

[0077] Figure 13 is a schematic illustration of another embodiment of a handheld portable application tool 212 (broadly, an “injection apparatus”) suitable for use with the high pressure injection system for injecting termiticide into the ground, which was described above. The relative size of the tool 212 makes it suitable for use in tight spaces (e.g., crawl spaces) as well as open spaces (e.g., a lawn). As seen in Figure 13, the application tool 212 includes a handle 217 and a manifold head 216 mounted to the handle. The manifold head 216, which is pivotally mounted to the handle 217 via a pair of pivot pins 236 (one of the pivot pins being seen in Figures 13 and 14), is substantially the same as the manifold head 16 illustrated in Figures 1-3. As a result, the manifold head 216 illustrated in Figures 13 and 14 will not be described in detail.

[0078] The handle 217 of the tool 212 includes an upper portion 218 and a lower portion 219. In the illustrated embodiment, both the upper and lower portions 218, 219 of the tool comprise generally U-shaped brackets. The upper portion 218 of the handle 217 can move relative to the lower portion 219 from a first, extended position (Figure 13) to a second, compressed position (Figure 14). A biasing element, such as a pair of springs 226, biases the upper portion 218 of the handle 217 toward its first, extended position and

away from the lower portion 219. In the illustrated embodiment, each of the springs 226 is mounted on the handle 217 via a bolt 223. In addition, a pair of upper stops 225 and a pair of lower stops 227 are mounted on the lower portion 219 and extend through a slot 229 formed in the upper portion 218 to limit the range of movement of the upper portion relative to the lower portion. One of the upper stops 225 and one of the lower stops 227 are shown in Figures 13 and 14. It is understood, however, that any known biasing element 226 may be used and the biasing element can be mounted on the handle 217 in other suitable manners. It is also understood that other types of stops can be used to limit the relative movement between the upper and lower portions 218, 219 of the handle 217.

[0079] As illustrated in Figures 13 and 14, a trigger switch 260 (broadly, an “actuator”) is mounted on the lower portion 219 of the handle 217. The trigger switch 260 is electrically coupled to a discharge valve 256 and activates the discharge valve when the trigger switch is actuated. As seen in Figure 14, the trigger switch 260 is actuated by the upper portion 218 of the handle 217 being manually pressed into contact with the trigger switch. That is, the trigger switch 260 can be actuated by manually moving the upper portion 218 of the handle 217 from its first, expanded position to its second compressed position by applying a force on the upper portion so that it slides downward relative to the lower portion 219 of the handle until the trigger switch 260 is actuated. Actuation of the trigger switch 260 causes termiticide to be injected into the ground through the manifold 216.

[0080] Referring now to Figures 15-17, these Figures schematically illustrate a high pressure injection system 310 for injecting termiticide (or other suitable treatment) into the ground in accordance with another exemplary embodiment. As seen in Figure 15, the injection system 310 includes a handheld portable application tool 312 (broadly, an “injection apparatus”) and a supply cart 314 (broadly, a “base unit”). The application tool 312 is connected to the cart 314 via a conduit 313 (e.g., a hose) defining a fluid passageway and at least one electrical connection 315. The conduit 313 permits fluid (e.g., water and/or a termiticide solution) to flow from the cart 314 to the application tool 312. The electrical connection 315 is used for transmitting various control signals between the application tool 312 and the cart 314.

[0081] Figure 16 is a front view schematic illustration of the handheld portable application tool 312, and Figure 17 is a side view schematic illustration of the application tool 312. The handheld portable application tool 312 includes a handle 317 and a manifold head 316 mounted to the handle. The handle 317 includes an upper portion 318 and a lower portion 319. The upper portion 318 includes a tubular section 320 and a hand grip section 322 attached to an upper end 324 of the tubular section 320. As a result, the upper portion 318 of the handle 317 has a generally T-shape. The lower portion 319 of the handle 317, which is also tubular, is sized for insertion into the tubular section 320 of the upper portion 318 of the handle. With the lower portion 319 of the handle 317 inserted into the tubular section 320 of the upper portion 318 of the handle, the upper portion can move with respect to the lower portion from a first, extended position to a second, compressed position. A biasing element, such as a spring 326, is provided to bias the upper portion 318 of the handle 317 toward its first, extended position. It is understood, however, that any known biasing element 326 may be used. A flange (not shown) or other suitable retainer(s) may be provided to inhibit the lower portion 319 of the handle 317 from being pulled or otherwise withdrawn from the upper portion 318 to thereby ensure that the lower portion remains telescopically attached to the upper portion.

[0082] A lower end 328 of lower portion 319 of the handle 317 is attached to an inverted U-shaped attachment bracket 330. The manifold head 316 is pivotally attached at each of its ends 332, 334 to the attachment bracket 330 via a pair of pivot pins 336. It is contemplated that one or more stops (not shown) can be provided to limit the pivoting movement of the handle 317 relative to the manifold 316. Attached to the U-shaped attachment bracket 330 is a foot bracket 331. During use of the tool 312, the user can place one of his/her feet on the foot bracket 331 to inhibit movement of the tool during an injection.

[0083] The manifold head 316 includes at least one internal passage to distribute the termiticide to a plurality of high pressure nozzles 338 in fluid communication with the internal passage. As seen in Figure 17, the illustrated manifold head 316 includes two main internal passages 340, 342, and a cross passage 344 connecting main internal passages. It is contemplated that the manifold head 316 may include any number of high pressure nozzles 338. For example, the manifold head 316 of the exemplary embodiment

has a matrix of six high pressure nozzles 338 with each nozzle generally equidistant from each other. Each of the high pressure nozzles 338, in one embodiment, has an orifice diameter ranging from about 0.002 inch to about 0.01 inch.

[0084] With reference again to Figure 16, a contact plate 350 is attached to a bottom surface 352 of the manifold head 316 to protect the high pressure nozzles 338. In the illustrated embodiment, the contact plate 350 includes a plurality of openings 354 with each of the openings being generally aligned with a respective one of the plurality of high pressure nozzles 338. As a result, the high pressure nozzles 338 are spaced from the soil by the contact plate 350 and therefore do not directly contact the soil. Moreover, the contact plate 350 shields or otherwise blocks soil, rocks, and/or other debris that may be “kicked-up” during the injection of the termiticide. As seen in Figure 17, the contact plate 350 includes rounded edges to facilitate sliding (e.g., dragging) of the tool 312. The contact plate 350 can be made from any suitable material, for example, metal and/or plastic.

[0085] In this embodiment, a kick guard 398 extends outward from three sides on the contact plate 350 to further shield or otherwise block soil, rocks, and/or other debris that may be “kicked-up” during the injection of the termiticide. In the illustrated embodiment, one side of the contact plate 350 is free from the kick guard 398 to facilitate placement of the contact plate and manifold head 316 in close proximity to objects and structures. It is understood, however, that the kick guard 398 can extend around the entire periphery (i.e., all four sides) of the contact plate 350. In one suitable embodiment, the kick guard 398 is made from three pieces of suitable rubber material, which each piece of rubber material extending outward from a respective side of the contact plate 350. It is understood, however, that the kick guard 398 can have other suitable configurations (e.g., bristles, strips, flaps) and be made from any suitable material.

[0086] As illustrated in Figure 16, a discharge valve 356 is attached to the manifold head 316 and is in fluid communication with the internal passages 340, 342, 344 in the manifold head and a supply of termiticide. The discharge valve 356 is moveable between an opened position and a closed position. When the discharge valve is in its closed position, termiticide solution is inhibited from flowing to the internal passages 340, 342, 344 in the manifold head via the high pressure inlet port 358. When the discharge

valve 356 is opened, the termiticide solution flows into inlet port 358 under high pressure. From the inlet port 358, the pressurized termiticide solution flows into internal passages 340, 342, 344 of the manifold head 316 and through the high pressure nozzles 338 from which the termiticide solution is injected into the ground. In one embodiment, the termiticide solution is pressurized to a pressure of about 25 psi to about 10,000 psi, and in another embodiment, from about 1,000 psi to about 7,000 psi, and in yet another embodiment, at about 4,000 psi.

[0087] In one suitable embodiment, the discharge valve 356 is a solenoid operated poppet valve capable of sufficiently rapid operation to allow opening and closing of the discharge valve 356 within the desired time parameters to allow correct depth penetration of the soil based on the pressure in use and correct volume of termiticide solution for the specific application. While it is possible to use a hydraulically actuated valve, the size and weight constraints of such a valve may otherwise limit the utility of the handheld application tool 312.

[0088] As illustrated in Figure 16, a trigger switch 360 (broadly, an “actuator”) is mounted on the lower portion 319 of the handle 317 and a trigger switch actuator 362 is mounted on the upper portion 318. The trigger switch 360, which is electrically coupled to the discharge valve 356, activates the discharge valve 356 when the trigger switch actuator 362 engages the trigger switch 360. In the illustrated embodiment and as seen in Figure 16, the trigger switch actuator 362 is engaged with the trigger switch 360 when the upper portion 318 of the handle 317 is moved to its second, compressed position. Thus, the trigger switch 360 can be actuated by moving the upper portion 318 of the handle 317 from its first, expanded position to its second compressed position by applying a force on the upper portion so that it slides downward relative to the lower portion 319 of the handle until the trigger switch actuator engages the trigger switch 360.

[0089] In one suitable embodiment, a kill switch (not shown) can be located on the hand grip section 322 of the upper portion 318 of the handle 317 where it can be actuated by the operator to quickly and easily shut the system 310 off. It is contemplated that the kill switch can be located on other portions of the tool 312 besides the hand grip section 322 of the handle 317. It is also contemplated that a kill switch can be provided on the cart 314 in addition to or instead of the kill switch located on the tool

312. It is further contemplated that the kill switch can be programmed into the system (i.e., a controller) whereby if the discharge valve 356 does not open within a specified time interval it will cause a clutch to disengage from the pressure manifold and/or kill the engine.

[0090] In this embodiment, a first termiticide concentrate reservoir 384' and a dosing device 385 are mounted on the handle 317 of the tool 312. The dosing device 385 is in fluid communication with termiticide concentrate reservoir 384' and is adapted to deliver a predetermined amount (i.e., a dose) of concentrated termiticide to a suitable first mixing device 386' each time the trigger switch 360 is actuated. In one suitable embodiment, the dosing device 385 is adjustable so that the predetermined amount of concentrated termiticide can be adjusted. In another suitable embodiment, the dosing device 385 is non-adjustable. That is, the amount of concentrated termiticide delivered to the mixing device 386' each time the trigger switch 360 is actuated cannot be changed without replacement of the dosing device. One suitable dosing device 385 is available from SMC Corporation of America of Indianapolis, Indiana as part no. NCMB075-0125. In the illustrated embodiment, the mixing device 386' is mounted on top of the manifold head 316 but it is understood that the mixing device can be otherwise mounted. For example, the mixing device 386' can be mounted on the lower portion 319 of the handle 317.

[0091] With reference still to Figure 16, a pressure accumulator 387 is mounted to the handle 317. The pressure accumulator 387 is adapted to store pressurized water (or other suitable carrier liquids) from the cart 314 prior to it being delivered to the mixing device 386'. The pressure accumulator 387 minimizes the effect of the pressure drop between the cart 314 to the mixing device 386'. Thus, the pressure accumulator 387 provides pressurized water from the cart 314 to the mixing device 386' at a higher pressure than if the pressurized water was delivered directly to the mixing device from the cart.

[0092] In the embodiment illustrated in Figure 15, the cart 314 includes a water reservoir 380, a high pressure pump 382, a second termiticide concentrate reservoir 384, and a second mixing device 386 that is capable of supplying the appropriate amount of termiticide concentrate to be mixed with the appropriate amount of water to form the termiticide solution. A water inlet 381 for receiving water from an external water source

(e.g., a standard residential water spigot) is also provided. It is contemplated that either the water reservoir 380 or the water inlet 381 can be omitted.

[0093] The supply cart 314 also includes a gasoline engine 388 with a generator 390 for generating power for operating the pressure pump 382 and generating electrical current for operating a controller 392 associated with the system 310. In another embodiment, electrical power can be supplied by connecting into an electrical outlet located at the application site. A radiator 191 is provided to cool the pressurized water being driven by the high pressure pump 382. In the illustrated embodiment, a hose reel 193 is mounted on the cart 314 for winding the hose 313 that extends between the cart 314 and the application tool 312. A pressurized water bypass 389 is provided on the handle 317 of the tool 312 for allowing pressurized water to discharged prior to the pressure accumulator 387. The bypass 389 can be used to facilitate priming of the high pressure pump 382 and flushing termiticide solution from the hose 313.

[0094] The controller 392 permits the operator of the system 310 to selectively set a pulse duration and pressure level for termiticide injections. The controller 392 may be programmable to permit the operator to enter parameters associated with a particular manifold head 316 in use, such as by defining the number of orifices and their sizes, parameters with a termiticide solution in use, such that dosing through the mixing device 386 can be properly controlled, or the number of injections can be tracked, and the like.

[0095] To inject the termiticide into the ground, the operator positions handheld portable application tool 312 such that the contact plate 350 is in contact with the surface of the ground. A downward force between about 15 to 20 pounds is applied by the operator to the upper portion 318 of the handle 317 to move the upper portion 318 from its first position to its second position and thereby cause the trigger switch actuator 362, which is mounted to the upper portion, to engage the trigger switch 360, which is mounted to the lower portion 319. Engagement of the trigger switch actuator 362 and the trigger switch 360 actuates the discharge valve 356. More specifically, an electronic signal is sent from the trigger switch 360 to the discharge valve 356 causing the discharge valve to move from its closed position to its opened position for a predetermined amount of time.

[0096] In addition, movement of the upper portion 318 of the handle 317 relative to the lower portion 319 causes a predetermined amount of termiticide concentrate to be delivered by the dosing device 385 from the first termiticide concentrate reservoir 384' to the mixing device 386'. Opening the discharge valve 356 causes the pressure accumulator 387 to release at least a portion of the pressurized water stored therein to the mixing device 386'. The termiticide concentration and pressurized water mix within the mixing device 386' to form a termiticide solution. The termiticide solution is then driven to the manifold head 316 where it flows to and out the high pressure nozzles 338 for injection into the ground.

[0097] The operator then releases the pressure from the handle 317, which resets the trigger switch 360, the dosing device 385, and the pressure accumulator 387. More specifically, the spring 326 causes the upper portion 318 of the handle 317 to move back to its first, extended position. The illustrated trigger switch 360 is configured to work only once during each compression of handle 317 to prevent repeated opening of the discharge valve 356 until the handle 317 has been reset.

[0098] The depth of penetration of the termiticide solution into the ground is a function of the pressure at which the termiticide solution is discharged from the tool 312, the duration for which the discharge valve 356 remains open, and the type of soil into which the termiticide is discharged. In one suitable embodiment, the penetration of termiticide into the ground is between about 12 to 16 inches.

[0099] The second termiticide concentrate reservoir 384 and the second mixing device 386, which are mounted on the cart 314, allow the cart to be used for low pressure applications. Low pressure applications of termiticide can be carried out using the application tool 312 illustrated herein or using conventional rodding techniques. It is understood that the second termiticide concentrate reservoir 384 and the second mixing device 386 can be omitted.

[00100] Referring now to Figures 18-22, these Figures illustrate a high pressure injection system, indicated generally at 510, for injecting termiticide (or other suitable soil treatment) into the ground in accordance with yet another exemplary embodiment. As seen in Figure 18, the injection system 510 includes a handheld portable

application tool 512 (broadly, an “injection apparatus”) and a supply cart 514 (broadly, a “base unit”). The application tool 512 is connected to the cart 514 via a conduit 513 (e.g., a hose) defining a fluid passageway and at least one electrical connection 515. The conduit 513 permits fluid (e.g., water and/or a termiticide solution) to flow from the cart 514 to the application tool 512. The electrical connection 515 is used for transmitting various control signals between the application tool 512 and the cart 514.

[00101] With reference now to Figures 19-21, the handheld portable application tool 512 includes a handle 517 and a manifold head 516 mounted to the handle. The handle 517 includes an upper portion 518 and a lower portion 519. The upper portion 518 includes a tubular section 520, a first hand grip section 522 attached to an upper end 524 of the tubular section, and a second hand grip section 523 attached to a lower end 525 of the tubular section. A pair of hand grips 527 is selectively moveable between the first hand grip section 522 and the second hand grip section 523. In the illustrated embodiment, for example, both the first hand grip section 522 and the second hand grip section 523 include a pair of thread sockets for receiving one of the hand grips 527, which are also threaded. As a result, the user can selectively move the hand grips 527 between the first hand grip section 522, which is designed to accommodate taller users, and second hand grip section 523, which is designed to accommodate shorter users. The upper portion 518 also includes two spaced-apart tubular shafts 529 extending downward from the second hand grip section 523.

[00102] The lower portion 519 of the handle 517 has two spaced-apart tubular shafts 533 configured for insertion into the tubular shafts 529 of the upper portion 518 of the handle. With the two tubular shafts 533 of the lower portion 519 inserted into the two tubular shafts 529 of the upper portion 518, the upper portion can move with respect to the lower portion from a first, extended position to a second, compressed position. It is understood that in some embodiments the upper and lower portions 518, 519 of the handle 517 can have more than two tubular shafts 529, 533. A biasing element, such as a pair of springs 526, is provided to bias the upper portion 518 of the handle 517 toward its first, extended position. In the illustrated embodiment, one spring 526 is disposed in one of the tubular shafts 529 of the upper portion 518 of the handle 517 and the other spring is disposed in the other one of the tubular shafts of the upper portion. It is

understood, however, that any suitable biasing element 526 may be used. A flange (not shown) or other suitable retainer(s) may be provided to inhibit the lower portion 519 of the handle 517 from being pulled or otherwise withdrawn from the upper portion 518 to thereby ensure that the lower portion remains telescopically attached to the upper portion.

[00103] The two tubular shafts 533 of the lower portion 519 of the handle 517 are attached to an inverted U-shaped attachment bracket 530. As seen in Figure 20, the inverted U-shaped attachment bracket 530 is angled relative to the handle 517 to facilitate placement of the manifold head 516 adjacent to and beneath structures (e.g., buildings, vegetation, fences). In the illustrated embodiment, the bracket 530 is angled about 10 degrees relative to the handle 517. It is understood, however, that the bracket 530 can be arranged at any suitable angle (e.g., any angle between about 0 degrees and about 45 degrees) relative to the handle 517. It is understood that the U-shaped attachment bracket 530 can be omitted and the manifold head 516 be attached to the two tubular shafts 533 of the lower portion 519.

[00104] In one suitable embodiment, the manifold head 516 is pivotally attached at each of its ends to the attachment bracket 530 via a pair of pivot pins 536. As a result, the handle 517 can be moved relative to manifold head 516. A pair of stops 537 is provided to limit the pivoting movement of the handle 517 relative to the manifold 516. The stops 537 inhibit the handle 517 from pivoting relative to the manifold head 516 beyond a predetermined range of motion. Suitable, the stops 537 inhibit the handle 517 from pivoting into contact with the conduit 513. Attached to the U-shaped attachment bracket 530 is a foot bracket 531. During use of the tool 512, the user can place one of his/her feet on the foot bracket 531 to inhibit movement of the tool during an injection.

[00105] The manifold head 516 includes at least one internal passage to distribute the termiticide to a plurality of high pressure nozzles 538 in fluid communication with the internal passage. It is contemplated that the manifold head 516 may include any number of high pressure nozzles 538. For example, the manifold head 516 of the illustrated exemplary embodiment has a matrix of six high pressure nozzles 538 with each nozzle generally equidistant from each other.

[00106] A contact plate 550 is attached to a bottom surface 552 of the manifold head 516 to protect the high pressure nozzles 538. In the illustrated embodiment, the contact plate 550 includes a plurality of openings 554 with each of the openings being generally aligned with a respective one of the plurality of high pressure nozzles 538. As a result, the high pressure nozzles 538 are spaced from the soil by the contact plate 550 and therefore do not directly contact the soil. Moreover, the contact plate 550 shields or otherwise blocks soil, rocks, and/or other debris that may be “kicked-up” during the injection of the termiticide. The contact plate 550 includes at least one rounded edge to facilitate sliding (e.g., dragging) of the tool 512. The contact plate 550 can be made from any suitable material, for example, metal and/or plastic.

[00107] In this embodiment, a kick guard 598 extends outward from one side (e.g. the trailing side) on the contact plate 550 to further shield or otherwise block soil, rocks, and/or other debris that may be “kicked-up” during the injection of the termiticide. More specifically, the kick guard 598 inhibits debris from being “kicked-up” by injected termiticide exiting through openings in soil created by the previous injection. Thus, the illustrated kick guard 598 is sized and shaped to generally overlie the previous injection site. In one suitable embodiment, the kick guard 598 is made from a single piece of suitable rubber material. It is understood, however, that the kick guard 598 can have other suitable configurations (e.g., bristles, strips, flaps) and be made from any suitable material.

[00108] As illustrated in Figure 19, a discharge valve 556 is attached to the manifold head 516 and is in fluid communication with the internal passages in the manifold head and a supply of termiticide. The discharge valve 556 is moveable between an opened position and a closed position. When the discharge valve is in its closed position, termiticide solution is inhibited from flowing to the internal passages in the manifold head. When the discharge valve 556 is opened, the termiticide solution flows under high pressure into the internal passages in the manifold head and through the high pressure nozzles 538 from which the termiticide solution is injected into the ground. In one embodiment, the termiticide solution is pressurized to a pressure of about 25 psi to about 10,000 psi, and in another embodiment, from about 1,000 psi to about 7,000 psi, and in yet another embodiment, at about 4,000 psi.

[00109] In one suitable embodiment, the discharge valve 556 is a solenoid operated poppet valve capable of sufficiently rapid operation to allow opening and closing of the discharge valve 556 within the desired time parameters to allow correct depth penetration of the soil based on the pressure in use and correct volume of termiticide solution for the specific application. While it is possible to use a hydraulically actuated valve, the size and weight constraints of such a valve may otherwise limit the utility of the handheld application tool 512.

[00110] As illustrated in Figures 19 and 21, a trigger switch actuator 562 is mounted on the lower portion 519 of the handle 517 and a trigger switch 560 (broadly, an “actuator”) is mounted on the upper portion 518 such that it faces downward toward the trigger switch actuator and is disposed between the tubular shafts 529, 533 of the upper and lower portions of the handle. The trigger switch 560, which is electrically coupled to the discharge valve 556, activates the discharge valve 556 when the trigger switch actuator 562 engages the trigger switch 560. In the illustrated embodiment, the trigger switch actuator 562 is engaged by the trigger switch when the upper portion 518 of the handle 517 is moved to its second, compressed position. Thus, the trigger switch 560 can be actuated by moving the upper portion 518 of the handle 517 from its first, expanded position to its second compressed position by applying a force on the upper portion so that it slides downward relative to the lower portion 519 of the handle until the trigger switch engages the trigger switch actuator. Mounting the trigger switch 560 on the upper portion 518 of the handle 517, such that it faces downward and is disposed between the tubular shafts 529 of the upper portion, inhibits inadvertent actuation of the trigger switch 560.

[00111] In this embodiment, a first termiticide concentrate reservoir 584' and a dosing device 585 are mounted on the handle 517 of the tool 512. As seen in Figure 19, the first termiticide concentrate reservoir 584' is mounted to each of the tubular shafts 529 of the upper portion 518 of the handle such that the first termiticide concentrate reservoir is generally aligned along a longitudinal axis of the tool 512. As a result, the weight of the first termiticide concentrate reservoir 584' is distributed generally equally between the two tubular shafts 529 of the upper portion 518. As also seen in Figure 19, the dosing device 585 is mounted to the lower portion 519 of the handle 517 such that it is disposed between the two tubular shafts 533 of the lower portion. As a result, the tubular

shafts 533 of the lower portion 519 of the handle 517 provide some protection for or shielding of the dosing device 585.

[00112] The dosing device 585 is in fluid communication with termiticide concentrate reservoir 584' and is adapted to deliver a predetermined amount (i.e., a dose) of concentrated termiticide to a suitable first mixing device 586' each time the trigger switch 560 is actuated. In one suitable embodiment, the dosing device 585 is adjustable so that the predetermined amount of concentrated termiticide can be adjusted. In another suitable embodiment, the dosing device 585 is non-adjustable. That is, the amount of concentrated termiticide delivered to the mixing device 586' each time the trigger switch 560 is actuated cannot be changed without replacement of the dosing device. One suitable dosing device 585 is available from SMC Corporation of America of Indianapolis, Indiana as part no. NCMB075-0125. In the illustrated embodiment, the mixing device 586' is mounted on top of the manifold head 516 but it is understood that the mixing device can be otherwise mounted. For example, the mixing device 586' can be mounted on the lower portion 519 of the handle 517.

[00113] A pressure accumulator 587 is mounted to the handle 517. More specifically, the pressure accumulator 587 is mounted between the two tubular shafts 533 of the lower portion 519 of the handle 517 such that the pressure accumulator is generally aligned along a longitudinal axis of the tool 512. As a result, the weight of the pressure accumulator is distributed generally equally between the two tubular shafts 533 of the lower portion 519. The pressure accumulator 587 is adapted to store pressurized water (or other suitable carrier liquids) from the cart 514 prior to it being delivered to the mixing device 586'. The pressure accumulator 587 minimizes the effect of the pressure drop between the cart 514 to the mixing device 586'. Thus, the pressure accumulator 587 provides pressurized water from the cart 514 to the mixing device 586' at a higher pressure than if the pressurized water was delivered directly to the mixing device from the cart.

[00114] In the embodiment illustrated in Figure 18, the cart 514 includes a water reservoir 580, a high pressure pump 582, a second termiticide concentrate reservoir 584, and a second mixing device 586 that is capable of supplying an appropriate amount of termiticide concentrate to be mixed with an appropriate amount of water to form the termiticide solution. A water inlet 581 for receiving water from an external water source

(e.g., a standard residential water spigot) is also provided. It is contemplated that either the water reservoir 580 or the water inlet 581 can be omitted.

[00115] The supply cart 514 also includes a gasoline engine 588 with a generator 590 for generating power for operating the pressure pump 582 and generating electrical current for operating a controller 592 associated with the system 510. In another embodiment, electrical power can be supplied by connecting into an electrical outlet located at the application site. A clutch mechanism 591 is provided to disengage the high pressure pump 582 between injections (or after a predetermined time interval) and thereby inhibit the water being driven by the high pressure pump from being heated. In the illustrated embodiment, a hose reel 593 is mounted on the cart 514 for winding the conduit 513 that extends between the cart 514 and the application tool 512. A pressurized water bypass 589 is provided on the handle 517 of the tool 512 for allowing pressurized water to be discharged prior to the pressure accumulator 587. The bypass 589 can be used to facilitate priming of the high pressure pump 582 and flushing termiticide solution from the conduit 513. In one suitable embodiment, the bypass 589 is fluidly connected to the manifold head 516 for allowing liquid (e.g., water, termiticide solution), gases (e.g., air) or the combination of the two passing through the bypass to be discharged beneath the manifold head.

[00116] As seen in Figure 22, the hose reel 593 includes a spool 594, a mounting bracket 595 for mounting the spool to the supply cart 514, and a handle 596 for manually rotating the spool relative to the mounting bracket. Thus, the spool 594 can be selectively rotated relative to the mounting bracket 595 using the handle 596 to wind and unwind the conduit 513 about the spool. Water from the water reservoir 580 and/or the external water source is fed to the conduit 513 through a rotary coupling 597. The rotary coupling 597 allows the spool 594 and thereby the conduit 513 wrapped about the spool to rotate relative to an inlet line (not shown) connecting the rotary coupling 597 to the water reservoir 580 and/or the external water source. The rotary coupling 597 inhibits twisting of the inlet line. With reference still to Figure 22, the handle 596 includes a rotary electrical connector 599 at its free end for feeding the electrical connection 515 to the conduit 513 wound about the spool 594. The rotary electrical connector 599 inhibits the electrical

connection 515 for being twisted as the conduit 513 is wound and unwound about the spool 594.

[00117] With reference again to Figure 18, the controller 592 permits the operator of the system 510 to selectively set a pulse duration and pressure level for termiticide injections. The controller 592 may be programmable to permit the operator to enter parameters associated with a particular manifold head 516 in use, such as by defining the number of orifices and their sizes, parameters with a termiticide solution in use, such that dosing through the mixing device 586 can be properly controlled, or the number of injections can be tracked, and the like. It is understood that the controller 592 can be mounted on the tool 512 in addition to or instead of the controller mounted on the cart 514.

[00118] To inject the termiticide into the ground, the operator positions handheld portable application tool 512 such that the contact plate 550 is in contact with the surface of the ground. A downward force between about 15 to 20 pounds is applied by the operator to the upper portion 518 of the handle 517 to move the upper portion 518 from its first position to its second position and thereby cause the trigger switch 560, which is mounted to the upper portion, to engage the trigger switch actuator 562, which is mounted to the lower portion 519. Engagement of the trigger switch actuator 562 and the trigger switch 560 actuates the discharge valve 556. More specifically, an electronic signal is sent from the trigger switch 560 to the discharge valve 556 causing the discharge valve to move from its closed position to its opened position for a predetermined amount of time.

[00119] In addition, movement of the upper portion 518 of the handle 517 relative to the lower portion 519 causes a predetermined amount of termiticide concentrate to be delivered by the dosing device 585 from the first termiticide concentrate reservoir 584' to the mixing device 586'. Opening the discharge valve 556 causes the pressure accumulator 587 to release at least a portion of the pressurized water stored therein to the mixing device 586'. The termiticide concentration and pressurized water mix within the mixing device 586' to form a termiticide solution. The termiticide solution is then driven to the manifold head 516 where it flows to and out the high pressure nozzles 538 for injection into the ground.

[00120] The operator then releases the pressure from the handle 517, which resets the trigger switch 560, the dosing device 585, and the pressure accumulator 587. More specifically, the springs 526 cause the upper portion 518 of the handle 517 to move back to its first, extended position. The illustrated trigger switch 560 is configured to work only once during each compression of the handle 517 to prevent repeated opening of the discharge valve 556 until the handle 517 has been reset.

[00121] The depth of penetration of the termiticide solution into the ground is a function of the pressure at which the termiticide solution is discharged from the tool 512, the duration for which the discharge valve 556 remains open, and the type of soil into which the termiticide is discharged. In one suitable embodiment, the penetration of termiticide into the ground is between about 12 to 16 inches.

[00122] The second termiticide concentrate reservoir 584 and the second mixing device 586, which are mounted on the cart 514, allow the cart to be used for low pressure applications. Low pressure applications of termiticide can be carried out using the application tool 512 illustrated herein or using conventional rodding techniques. It is understood that in some embodiments the second termiticide concentrate reservoir 584 and the second mixing device 586 can be omitted.

[00123] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

WHAT IS CLAIMED IS:

1. Apparatus for injecting soil treatment into soil, the apparatus comprising:

a manifold head having at least one high pressure nozzle for injecting the soil treatment into the soil; and

a handle having a longitudinal axis and a lateral axis, the handle comprising
5 an upper portion having two spaced-apart tubular shafts and a lower portion having two spaced-apart tubular shafts, the tubular shafts of the lower portion being connected to the tubular shafts of the upper portion.
2. The apparatus as set forth in claim 1 wherein the tubular shafts of the lower portion of the handle are inserted into the tubular shafts of the upper portion of the handle, the tubular shafts of the upper portion being capable of moving relative to the tubular shafts of the lower portion.
3. The apparatus as set forth in claim 2 wherein the handle further comprises a biasing member adapted to resist movement of the tubular shafts of the upper portion relative to the tubular shafts of the lower portion.
4. The apparatus as set forth in claim 1 further comprising a reservoir mounted on the handle for holding soil treatment, the reservoir being generally aligned with the longitudinal axis of the handle.
5. The apparatus as set forth in claim 1 further comprising a dosing device mounted on the handle for dosing the soil treatment from the reservoir.
6. The apparatus as set forth in claim 1 further comprising a trigger switch actuator mounted between the tubular shafts of the lower portion of the handle and a trigger switch mounted between the tubular shafts of the upper portion
7. The apparatus as set forth in claim 1 further comprising a pressure accumulator mounted on the handle.

8. The apparatus as set forth in claim 1 wherein the handle can be pivoted relative to the manifold head.

9. Apparatus for injecting soil treatment into soil, the apparatus comprising:

a handle having a pair of hand grips for facilitating manual manipulation of the apparatus by an operator, the hand grips being selectively moveable from a first position on the handle to a second position on the handle;

5 at least one high pressure nozzle for injecting the soil treatment into the soil;
and

a supply of soil treatment in fluid communication with the at least one high pressure nozzle.

10. The apparatus as set forth in claim 9 wherein the handle comprises an upper portion and a lower portion, the upper portion having first and second hand grip sections adapted to receive the hand grips, the first hand grip section corresponding to the first position of the hand grips and the second hand grip section corresponding to the
5 second position of the hand grips.

11. Apparatus for injecting soil treatment into soil, the apparatus comprising:

a handle having an upper portion and a lower portion, the lower portion being angled relative to the upper portion;

5 at least one high pressure nozzle carried by the lower portion of the handle,
the at least one high pressure nozzle being adapted to inject the soil treatment into the soil;
and

a supply of soil treatment in fluid communication with the at least one high pressure nozzle.

12. The apparatus as set forth in claim 11 wherein the lower portion is angled about 10 degrees relative to the upper portion.

13. Apparatus for injecting soil treatment into soil, the apparatus comprising:

a handle;

5 a manifold head carried by the handle, the manifold head having a plurality of a pressure nozzle for injecting the soil treatment into the soil and thereby define an injection site; and

a kick guard extending outward from at least one side of the manifold head to block debris that may be kicked-up during the injection of soil treatment.

14. Apparatus as set forth in claim 13 wherein the kick guard is sized and shaped to generally correspond to the injection site.

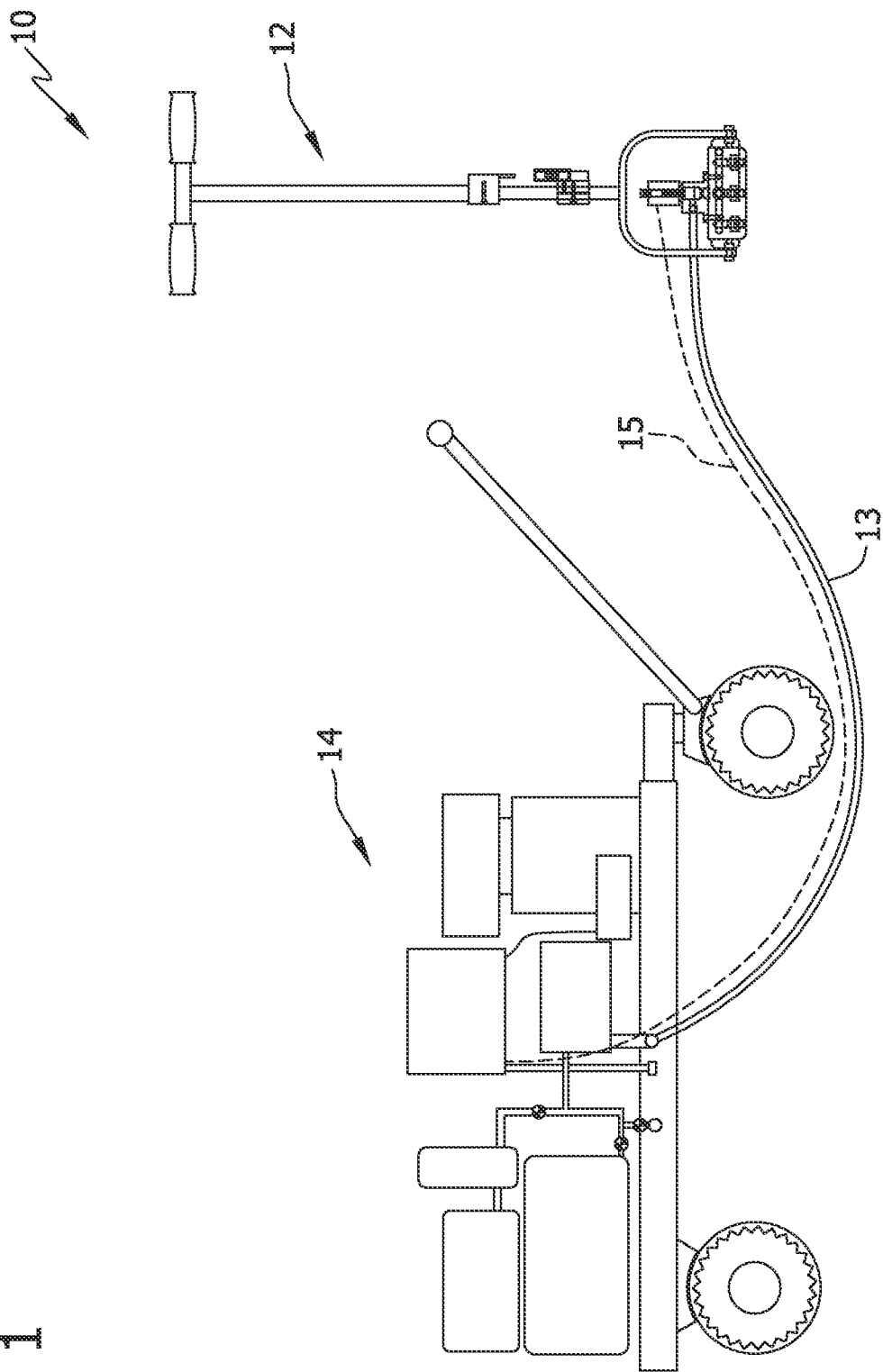
15. A high pressure injection system for injecting soil treatment into soil, the system comprising:

a supply cart;

5 a handheld portable application tool connected to the cart via a conduit defining a fluid passageway and at least one electrical connection; and

a hose reel mounted on the supply cart, the hose reel comprising a spool, a mounting bracket for mounting the spool to the supply cart, and a handle for manually rotating the spool relative to the mounting bracket, the spool being rotatable relative to the mounting bracket using the handle to wind and unwind the conduit about the spool, the
10 handle including a rotary electrical connector for feeding the electrical connection to the conduit wound about the spool.

FIG. 1



2/20

FIG. 2

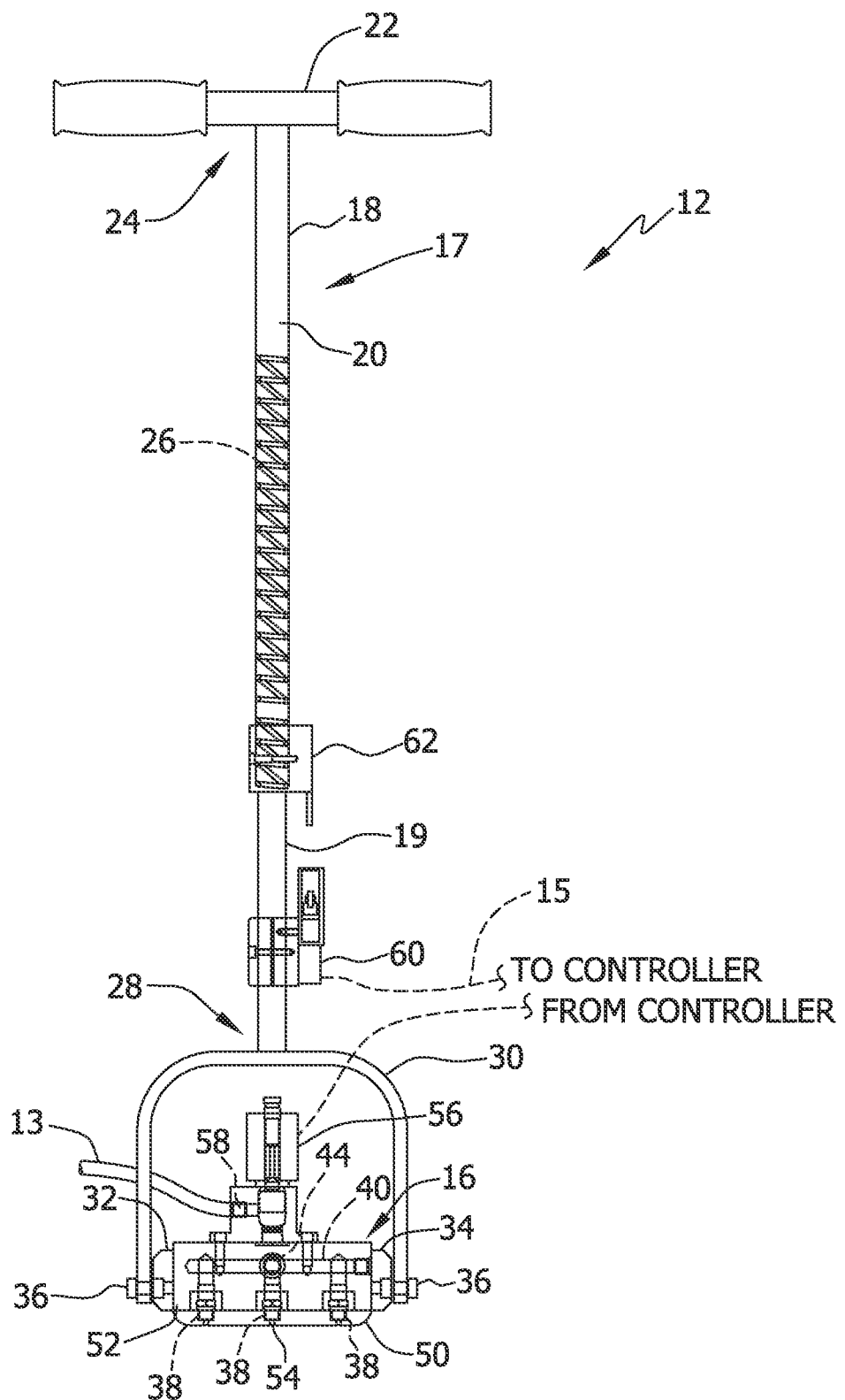
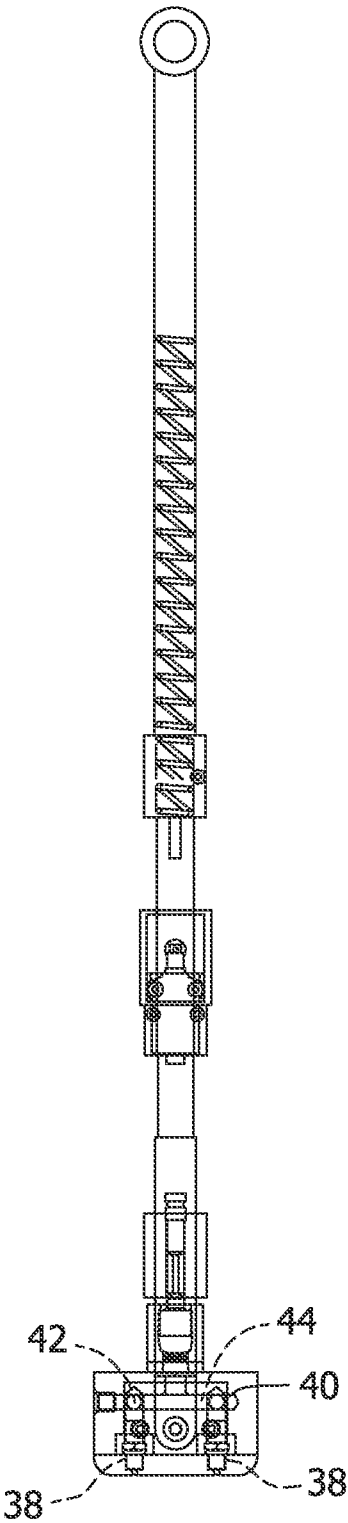


FIG. 3



4/20

FIG. 4

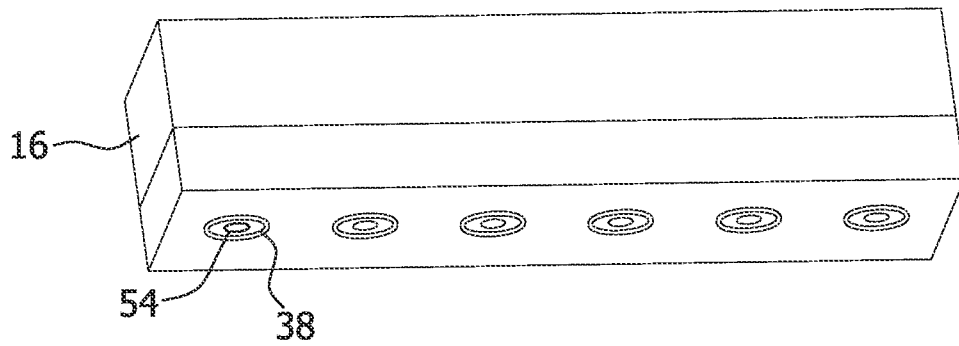
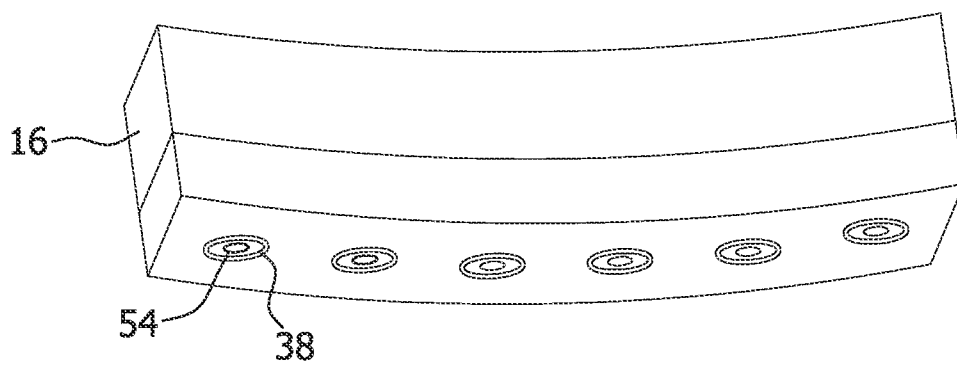


FIG. 5



5/20

FIG. 6

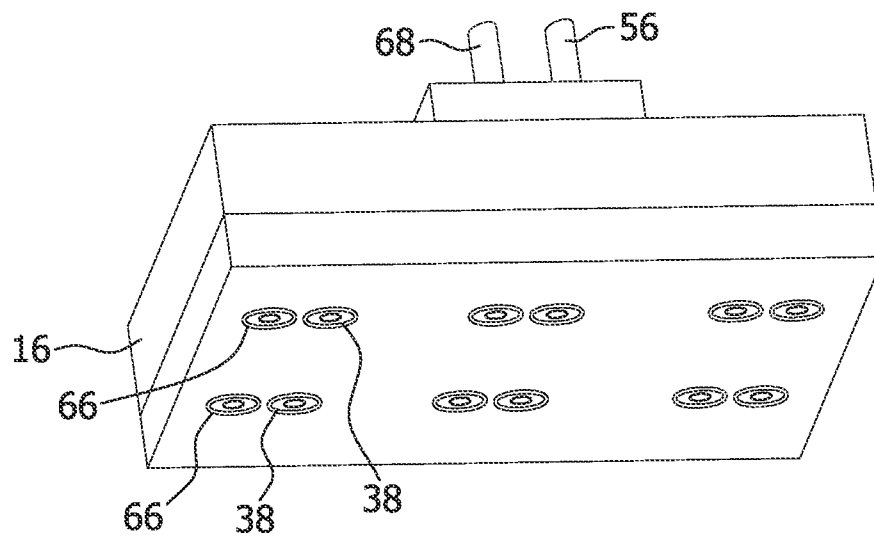
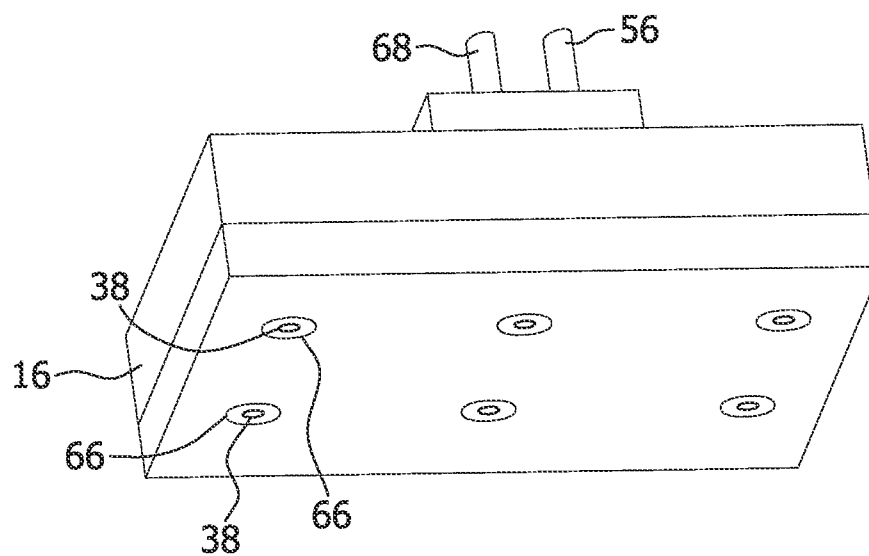
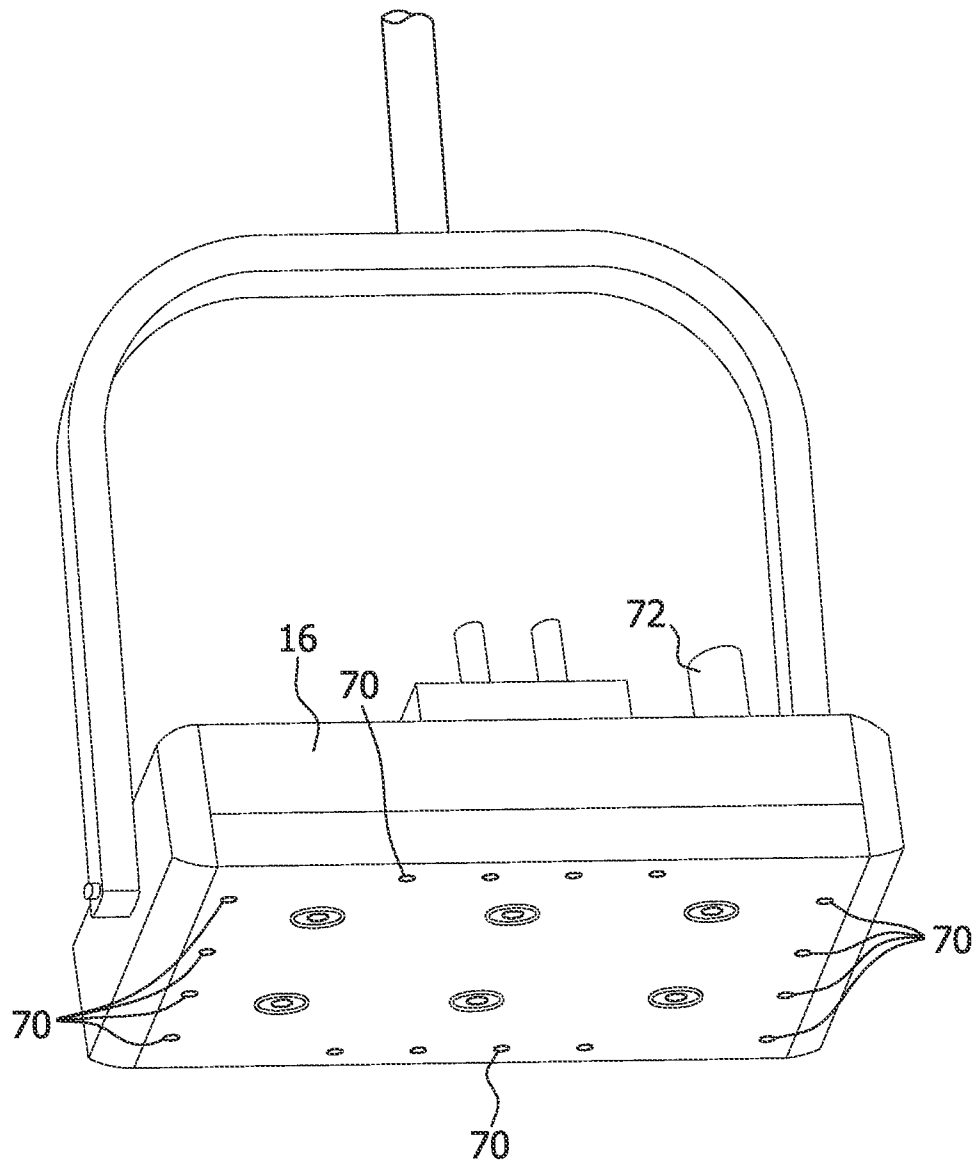


FIG. 7



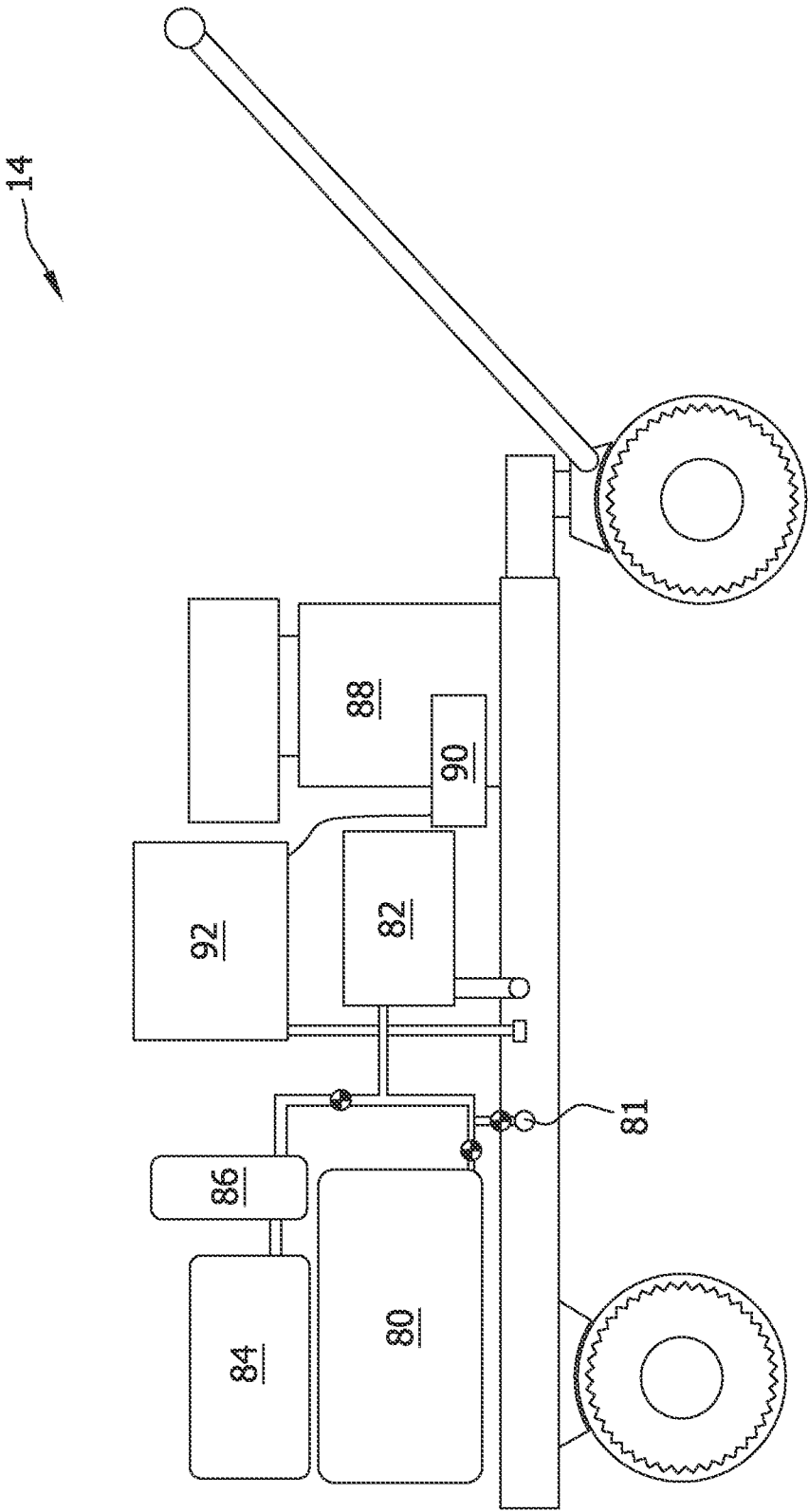
6/20

FIG. 8



7/20

FIG. 9



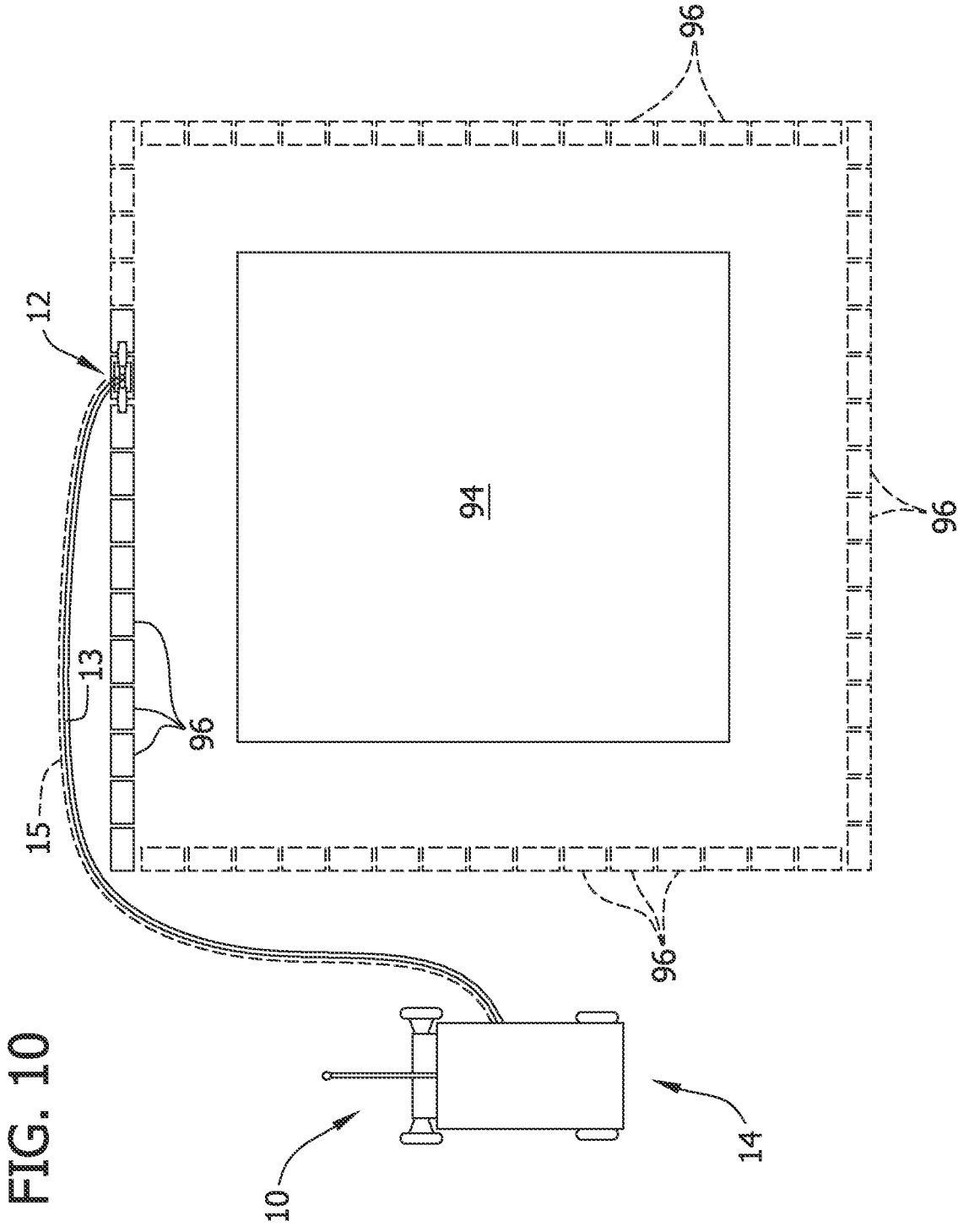


FIG. 11

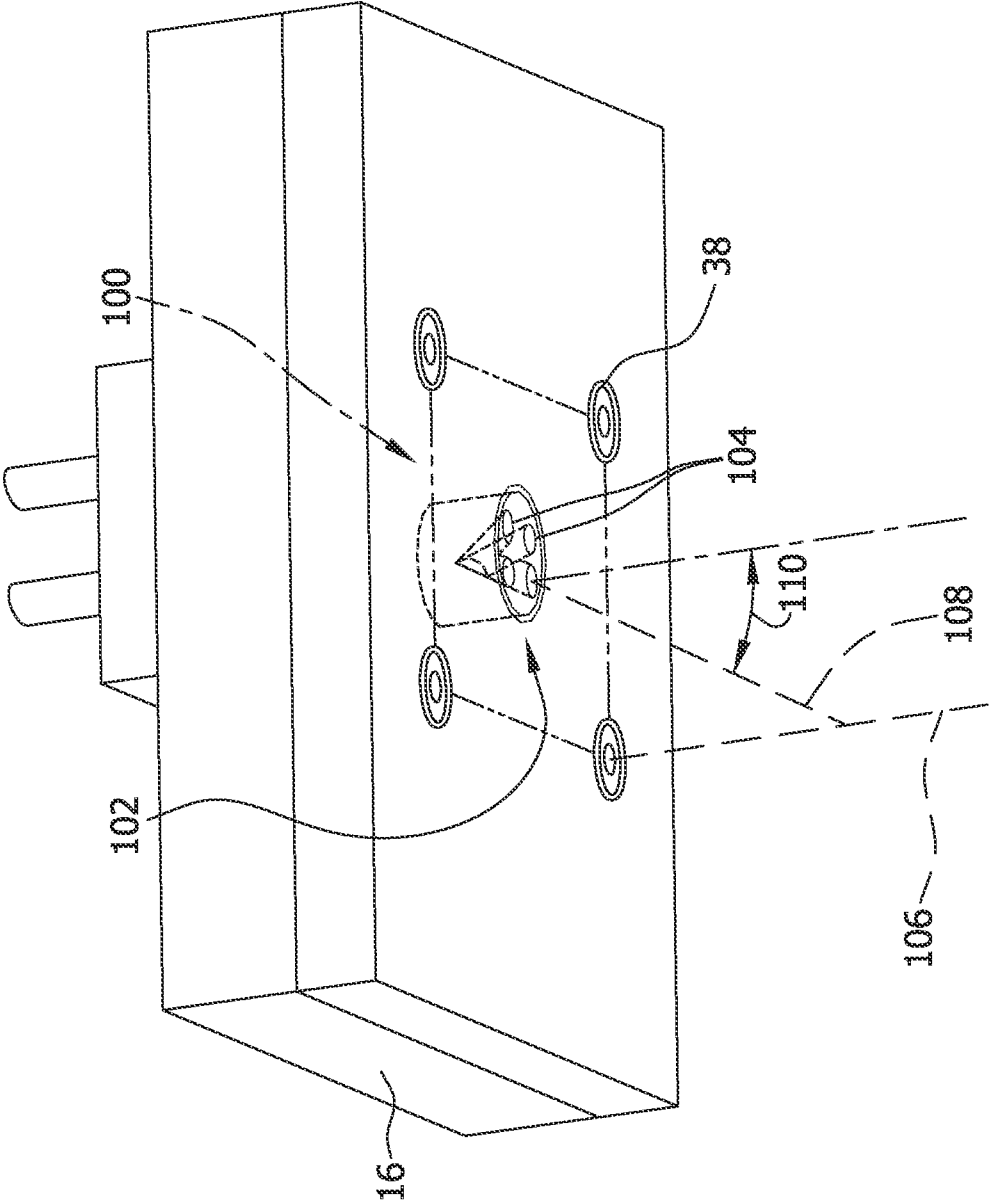
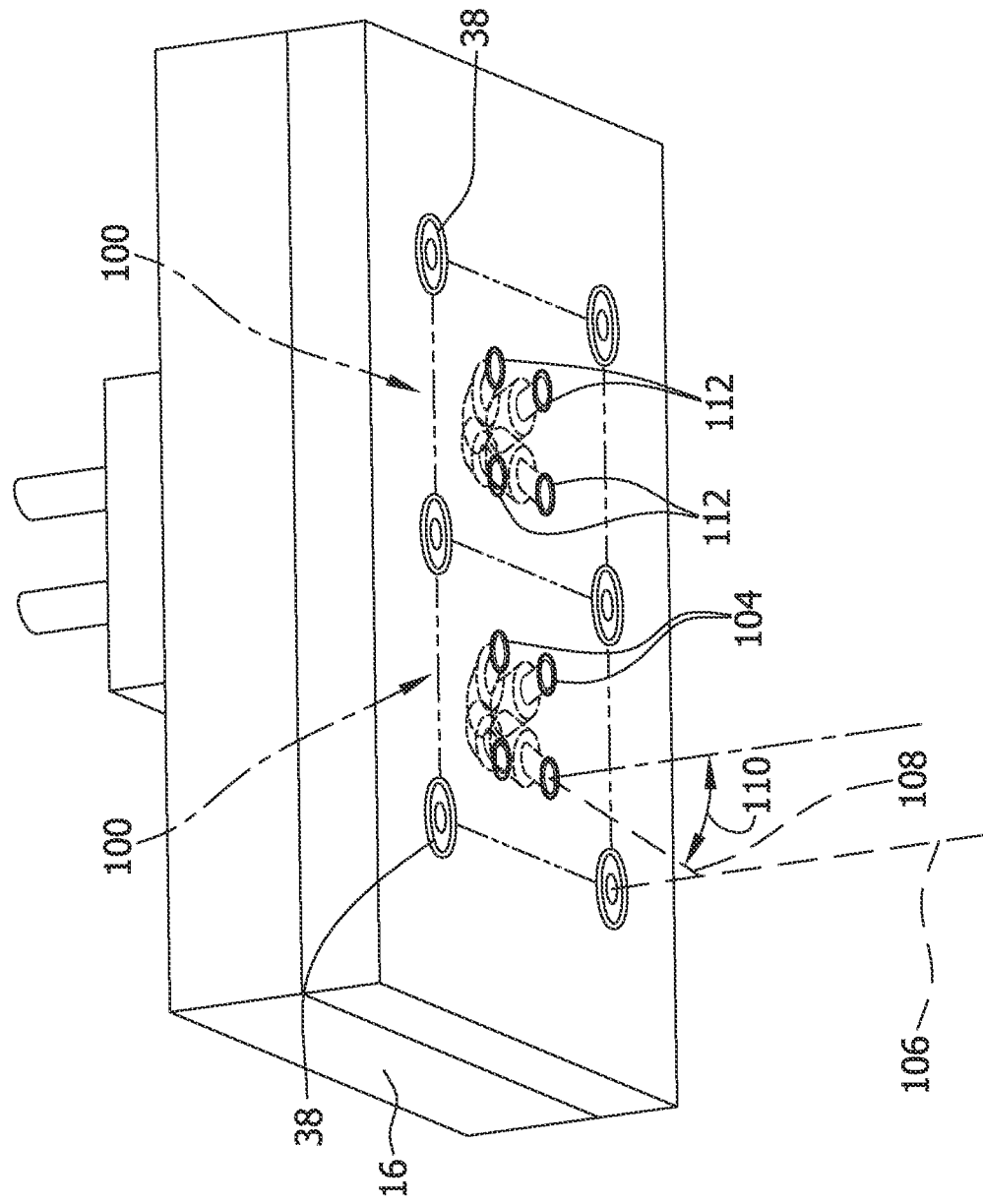
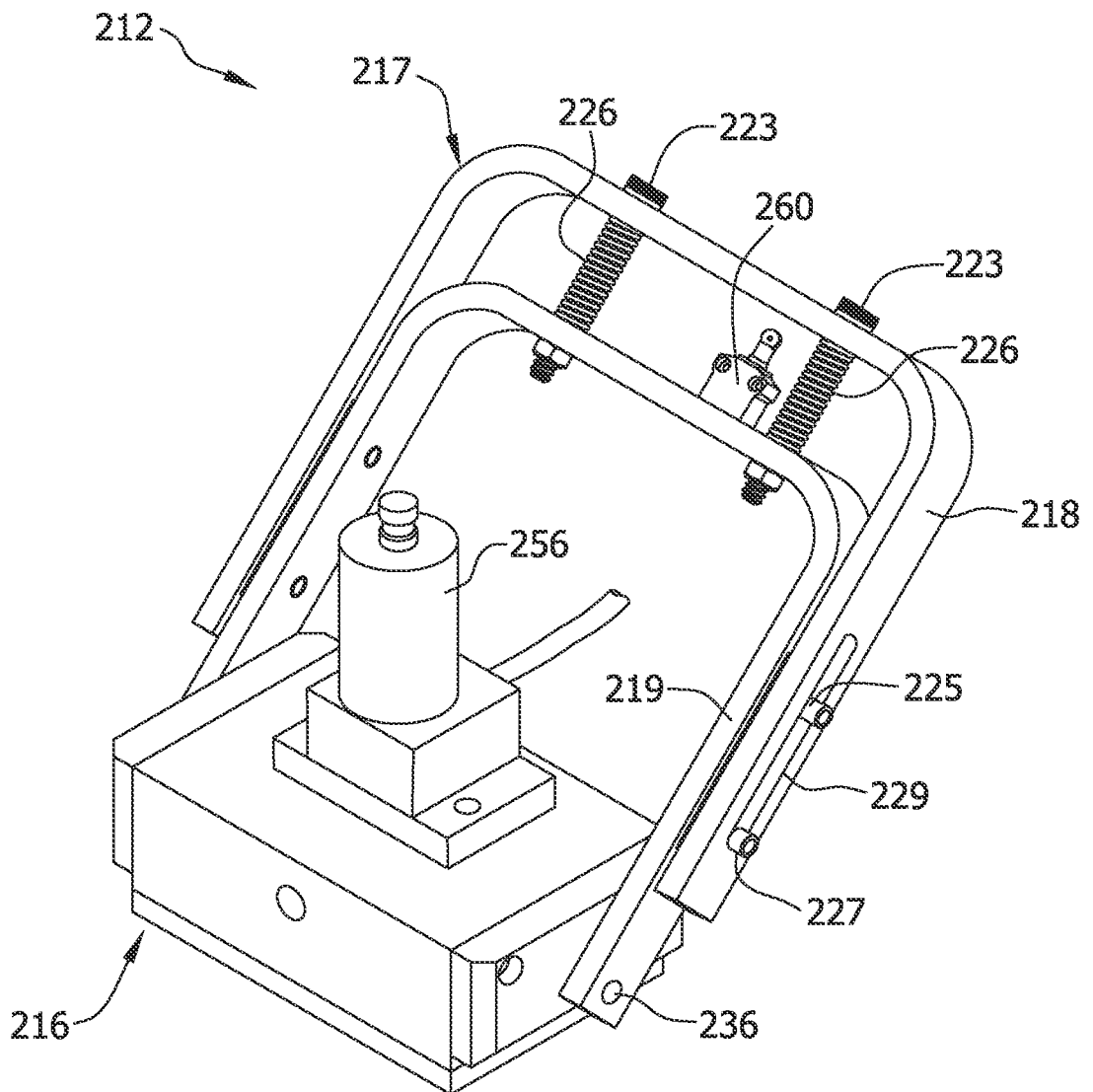


Fig. 12



11/20

FIG. 13



12/20

FIG. 14

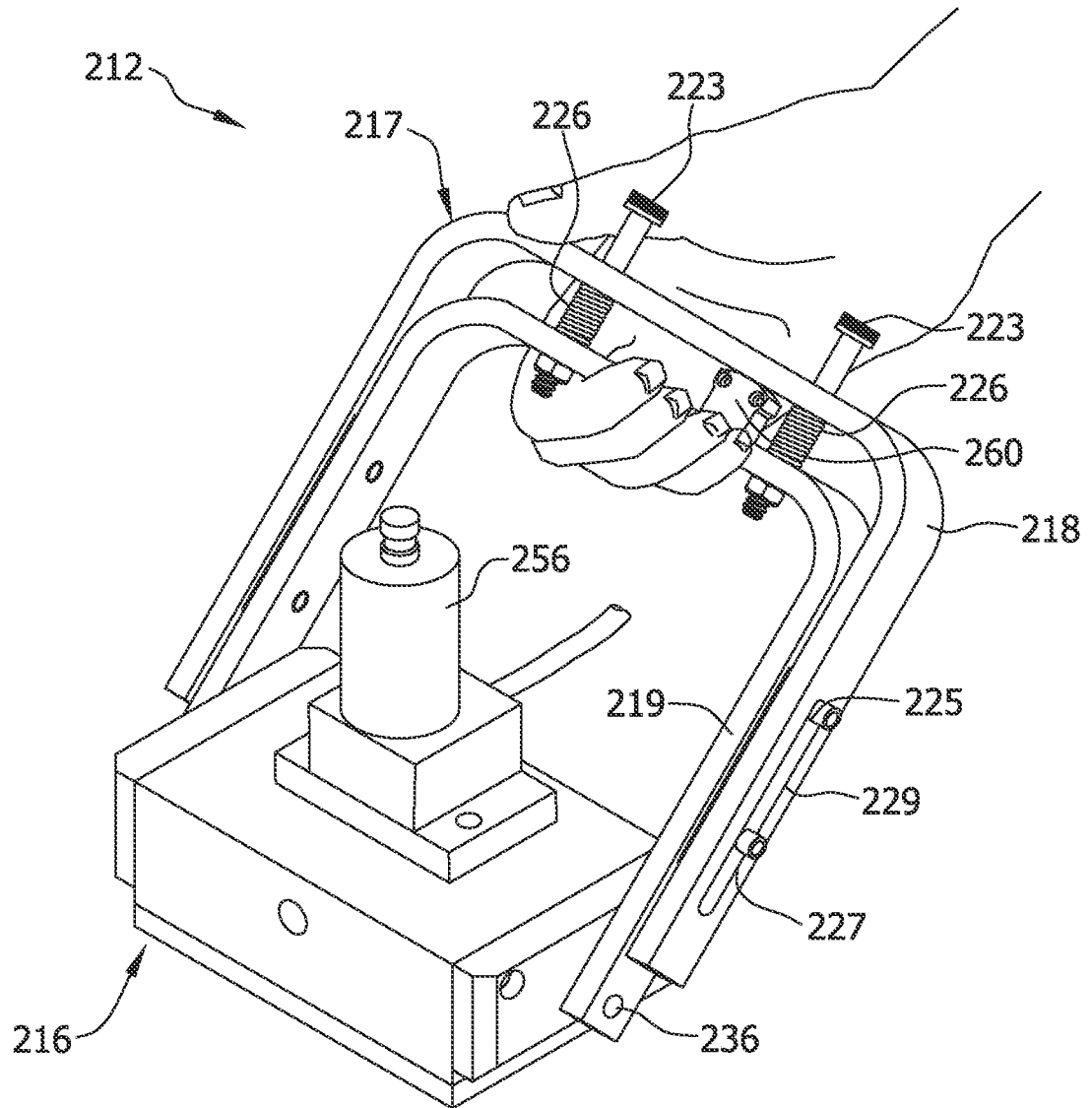
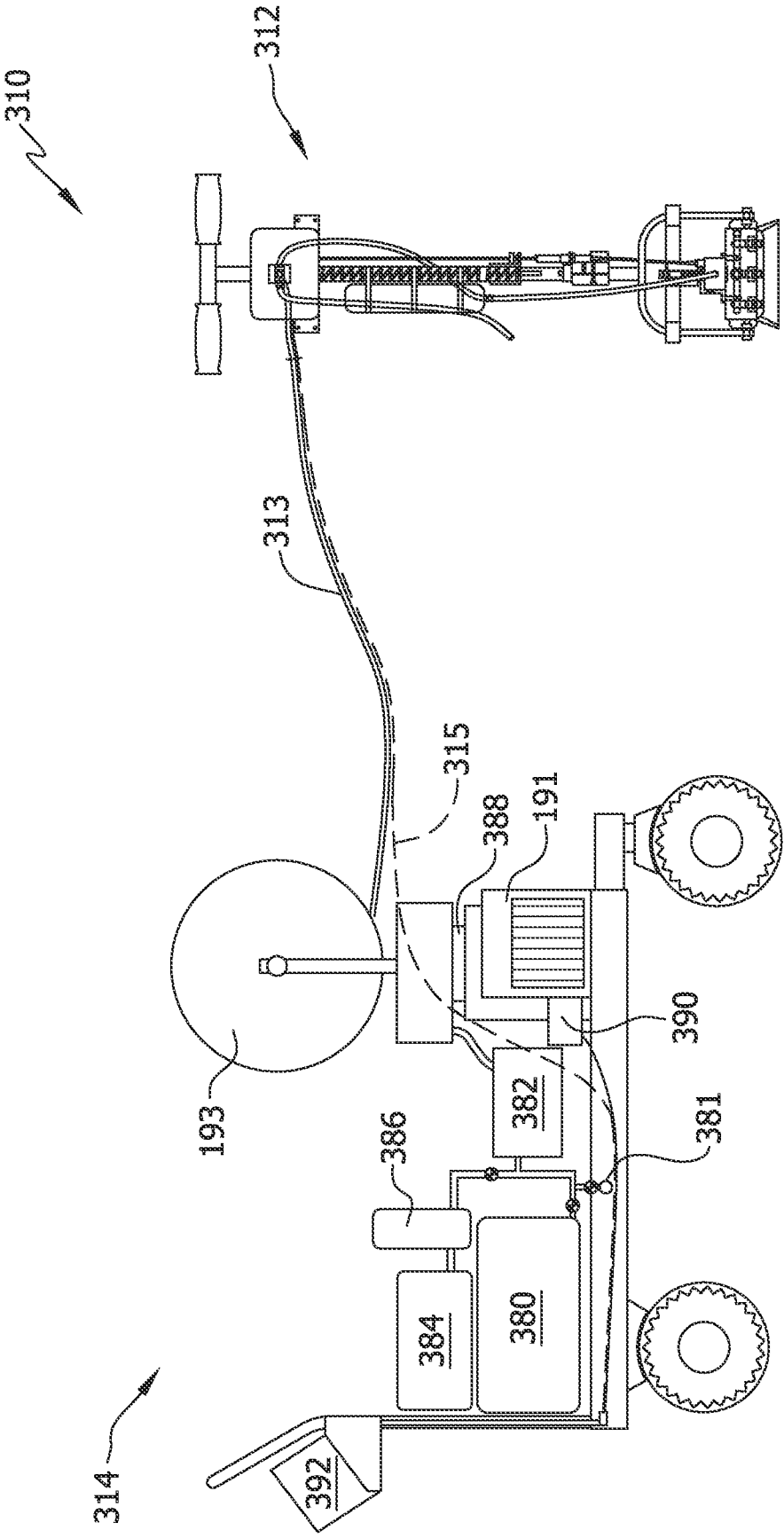
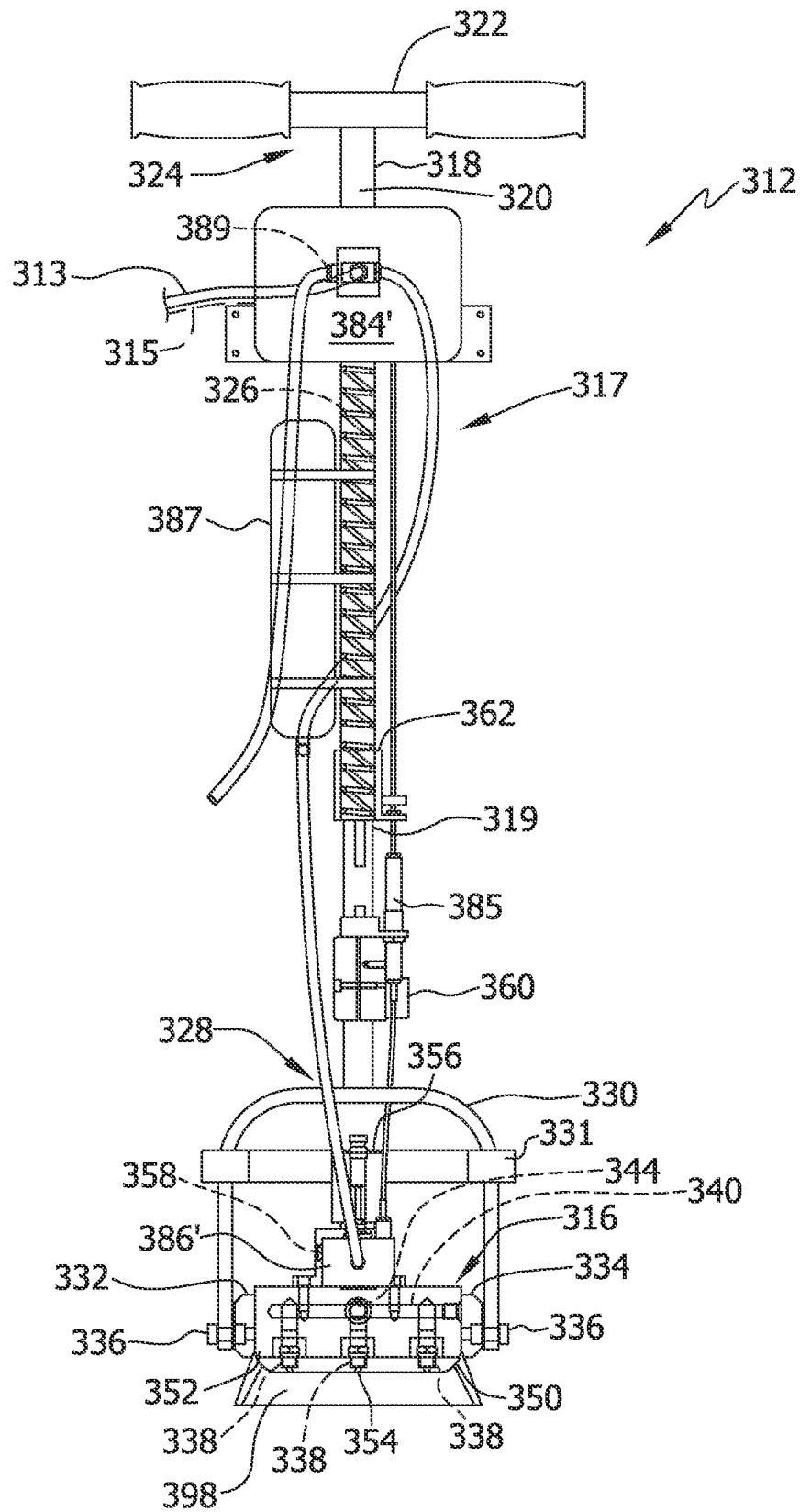


FIG. 15



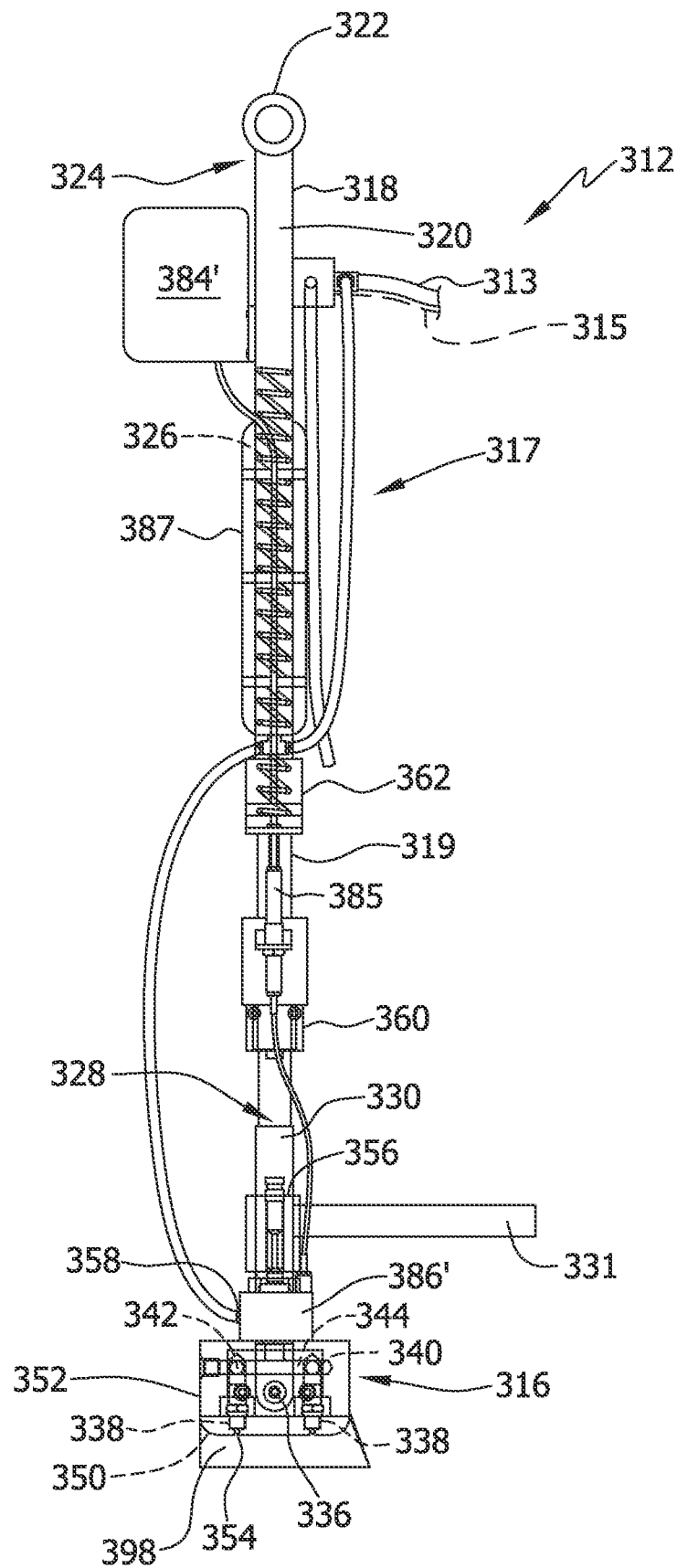
14/20

FIG. 16



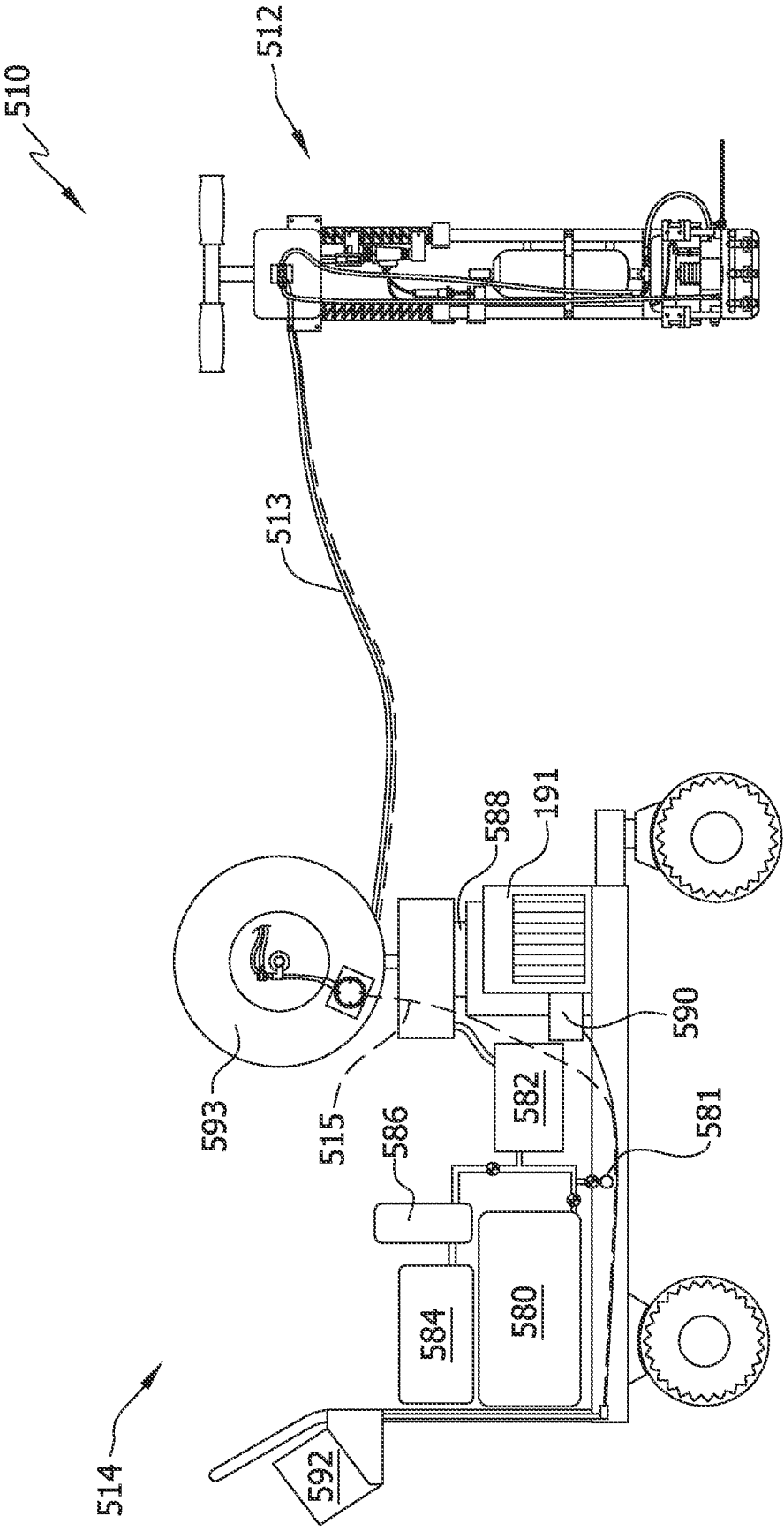
15/20

FIG. 17



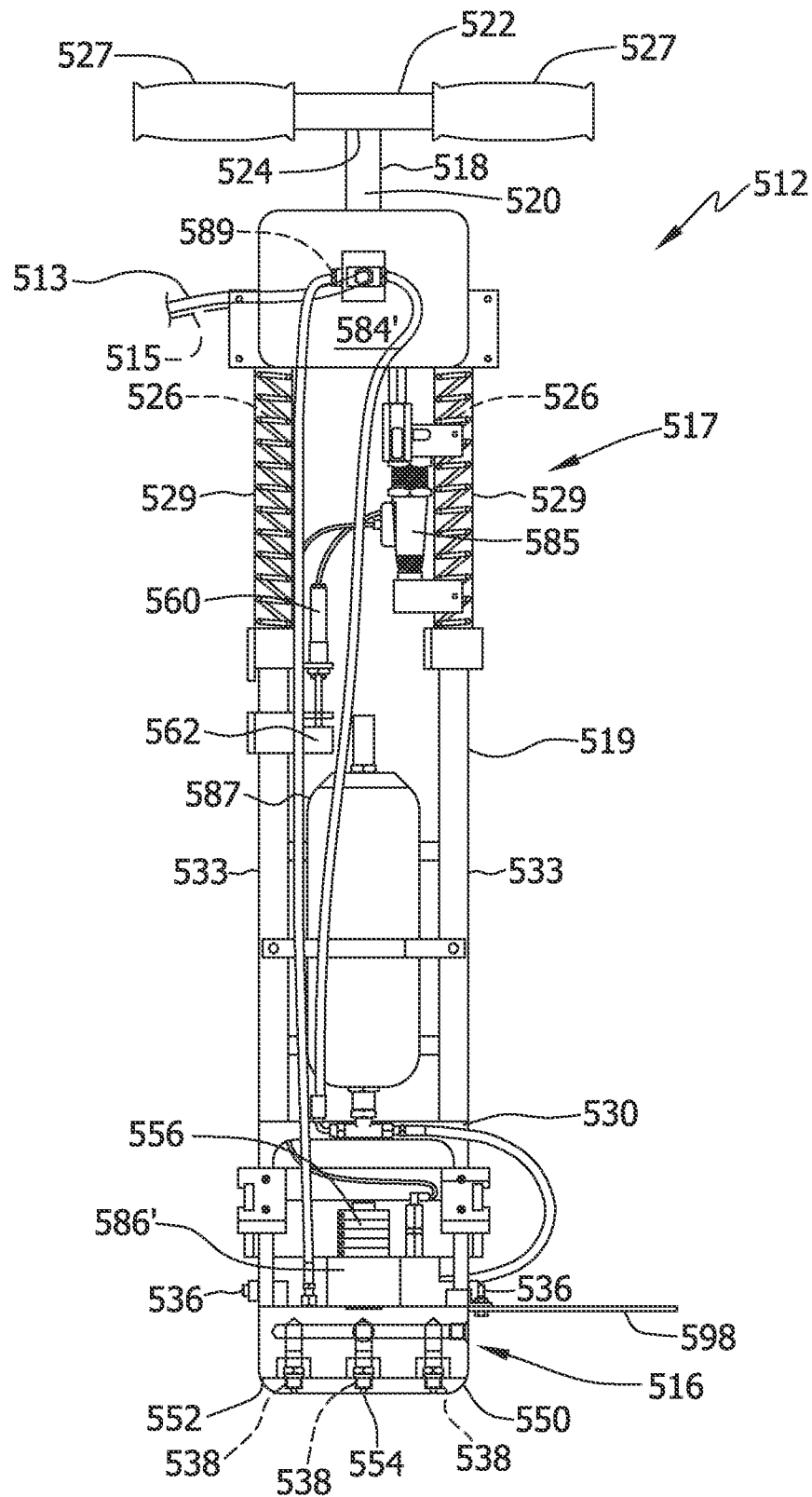
16/20

FIG. 18



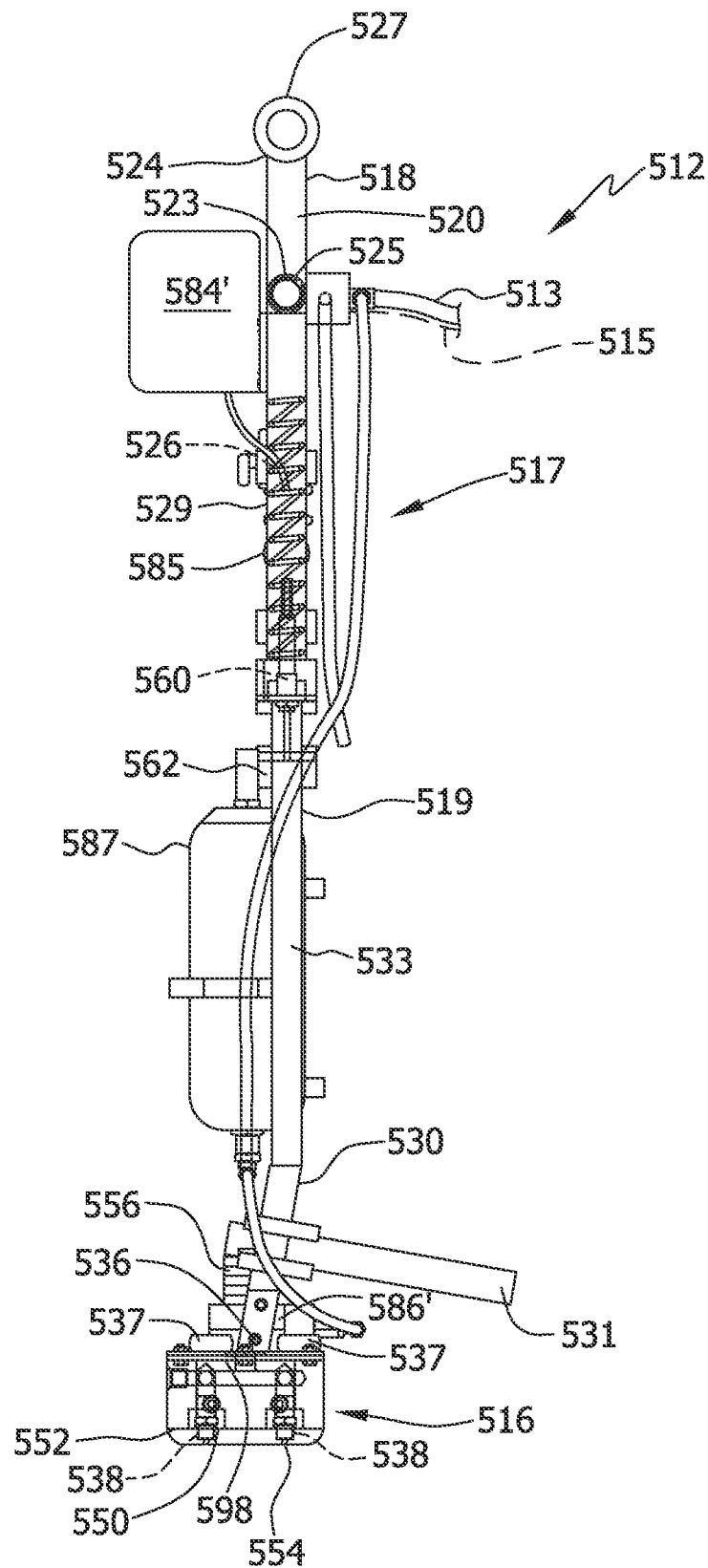
17/20

FIG. 19



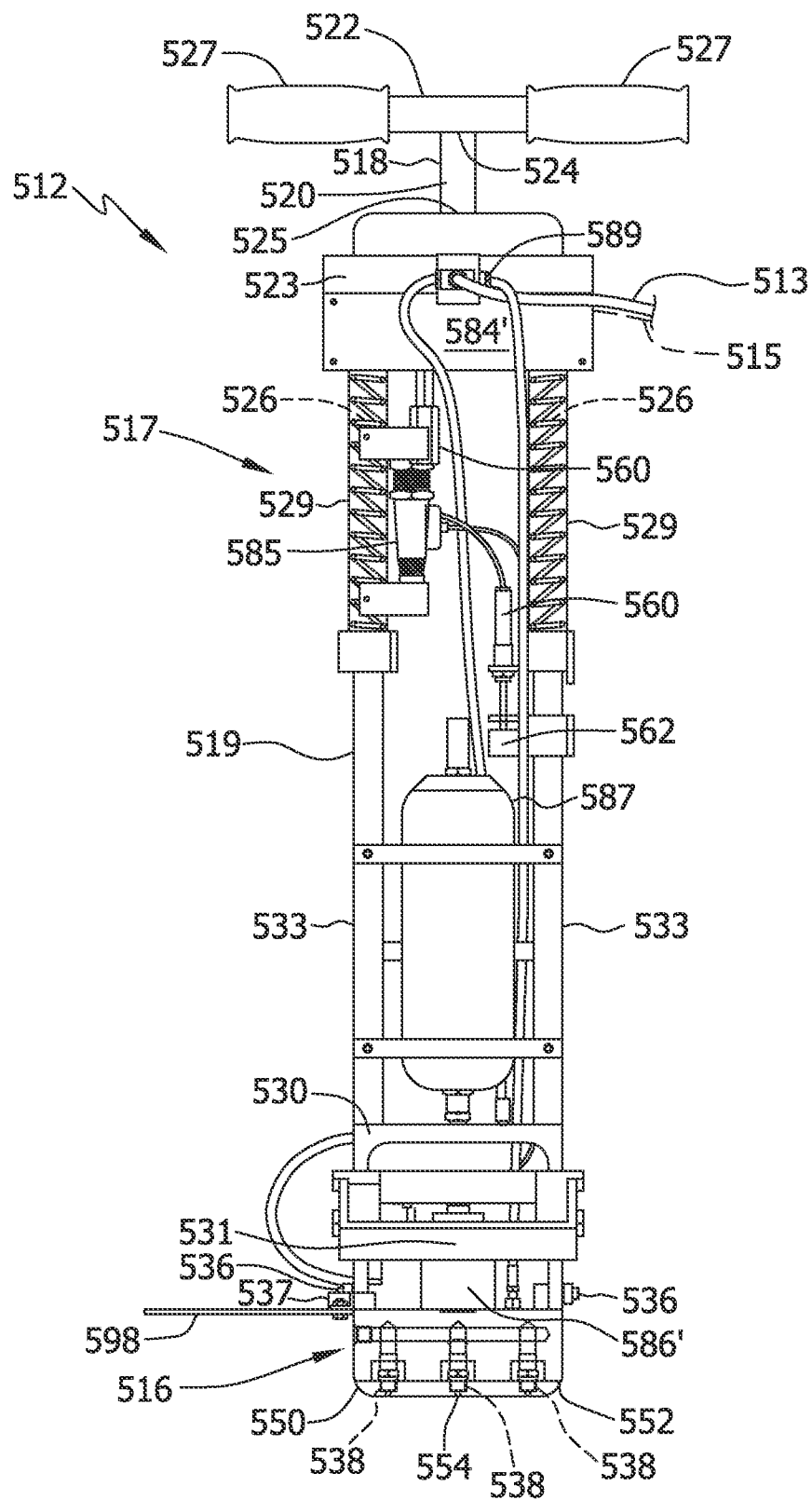
18/20

FIG. 20



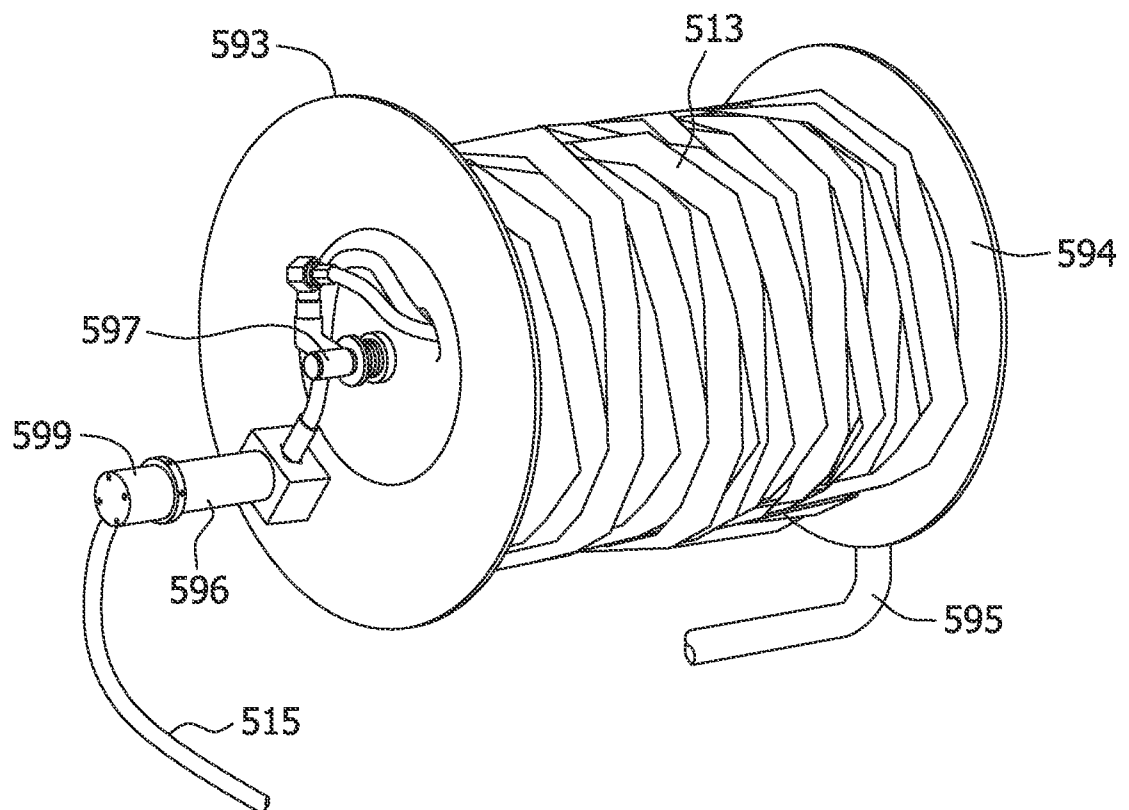
19/20

FIG. 21



20/20

FIG. 22



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/049940

A. CLASSIFICATION OF SUBJECT MATTER

INV. A01B1/00 A01M17/00 A01M25/00 A01C5/02 A01G29/00
A01C15/02 A01C23/02

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A01B A01M A01C A01G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 3 148 643 A (MUSSETT HARRY L ET AL) 15 September 1964 (1964-09-15) column 1, line 52 - column 3, line 11; figures -----	1,4,5 9,11,13
X A	US 2011/203162 A1 (CINK JAMES H [US] ET AL) 25 August 2011 (2011-08-25) paragraph [0076] - paragraph [0095]; figures 15-17 -----	13,14 1-12
X A	EP 0 198 589 A1 (MAC ENG CO LTD [JP]) 22 October 1986 (1986-10-22) page 4, line 25 - page 9, line 22 page 18, line 17 - page 20, line 6; figures 1-4 ----- -/--	13,14 1,9,11

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

7 October 2013

Date of mailing of the international search report

06/12/2013

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Bunn, David

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/049940

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CH 294 586 A (BODEN UND FUTTERMITTELDIENST E [DE]) 30 November 1953 (1953-11-30) page 2, line 71 - page 3, line 46; figures -----	1
A	US 3 815 525 A (ZANDMAN B ET AL) 11 June 1974 (1974-06-11) column 4, line 12 - column 6, line 36; figures -----	1
A	US 2006/230997 A1 (KIRK HAL E [US]) 19 October 2006 (2006-10-19) paragraph [0010] - paragraph [0012]; figures -----	1,13
X	DE 10 50 108 B (KARL KÖHLER) 5 February 1959 (1959-02-05) -----	9
A	column 3, line 3 - column 4, line 2; figures -----	10
X	US 6 308 454 B1 (POWELL RONNIE F [US]) 30 October 2001 (2001-10-30) -----	9
A	column 4, line 66 - column 5, line 15 column 3, line 61 - column 4, line 3; figures 8,9 -----	10
X	US 4 637 161 A (TURNER LOREN J [US]) 20 January 1987 (1987-01-20) -----	13,14
Y	column 2, line 25 - line 53; figure 1 -----	9
A	-----	10
Y	GB 280 012 A (JOHN HAMPSON) 10 November 1927 (1927-11-10) -----	9
A	page 3, line 92 - line 110; figures 1,2 -----	10
A	US 2007/113924 A1 (PHILLIPS J A JR [US] PHILLIPS JR J ANDREW [US]) 24 May 2007 (2007-05-24) paragraph [0064]; figures 1,2 -----	9
A	US 8 166 677 B1 (WOYAK THOMAS L [US]) 1 May 2012 (2012-05-01) column 6, line 20 - line 42; figures 1,4a,4b -----	9,10
A	GB 932 114 A (RANSOMES SIMS & JEFFRIES LTD; ARTHUR BIXBY PLUMB) 24 July 1963 (1963-07-24) page 1, line 64 - page 2, line 18; figures -----	9
X	US 2005/155278 A1 (RAWLS HUGH M [US]) 21 July 2005 (2005-07-21) paragraph [0039] - paragraph [0042]; figures 6,7 -----	11
	----- -/--	

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/049940

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2 808 013 A (DEAN JOHN A) 1 October 1957 (1957-10-01) column 1, line 48 - column 2, line 6; figures -----	11
X	FR 2 934 116 A1 (BEGOUEN JEAN PAUL [FR]) 29 January 2010 (2010-01-29) page 1, line 29 - line 32; figure 1 -----	11
X	US 4 624 070 A (QUERY GRADY W [US] ET AL) 25 November 1986 (1986-11-25) column 3, line 10 - line 57; figures 1-3 -----	11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/049940

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-14

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-14

Apparatus comprising a handle and high pressure nozzle for injecting soil treatment into soil, whereby:

- upper and lower portions of the handle have two spaced-apart tubular shafts, those of the lower portion being connected to those of the upper portion (claim 1); or
- a pair of hand grips are movable between first and second positions on the handle (claim 9); or
- the lower portion of the handle is angled relative to the upper portion, the nozzle being carried by the lower portion (claim 11), or
- a kick guard extends outward from the manifold head (claim 13).

2. claim: 15

A system comprising a supply cart, an application tool connected thereto via a conduit defining a fluid passageway and an electrical connection, and a hose reel mounted on the cart comprising a spool, mounting bracket and handle for rotating the spool relative to the bracket and including a rotary electrical connector for feeding the electrical connection to the conduit wound about the spool.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2013/049940

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3148643	A	15-09-1964	NONE
US 2011203162	A1	25-08-2011	AU 2011220817 A1 13-09-2012
			CA 2790497 A1 01-09-2011
			CN 103068224 A 24-04-2013
			CO 6602162 A2 18-01-2013
			CR 20120439 A 03-01-2013
			EA 201201166 A1 30-04-2013
			EP 2538776 A1 02-01-2013
			JP 2013520178 A 06-06-2013
			KR 20130102454 A 17-09-2013
			US 2011203162 A1 25-08-2011
			US 2011203502 A1 25-08-2011
			WO 2011106420 A1 01-09-2011
EP 0198589	A1	22-10-1986	DE 3671350 D1 28-06-1990
			EP 0198589 A1 22-10-1986
			US 4850291 A 25-07-1989
CH 294586	A	30-11-1953	NONE
US 3815525	A	11-06-1974	NONE
US 2006230997	A1	19-10-2006	NONE
DE 1050108	B	05-02-1959	NONE
US 6308454	B1	30-10-2001	NONE
US 4637161	A	20-01-1987	NONE
GB 280012	A	10-11-1927	NONE
US 2007113924	A1	24-05-2007	NONE
US 8166677	B1	01-05-2012	NONE
GB 932114	A	24-07-1963	NONE
US 2005155278	A1	21-07-2005	NONE
US 2808013	A	01-10-1957	NONE
FR 2934116	A1	29-01-2010	NONE
US 4624070	A	25-11-1986	NONE