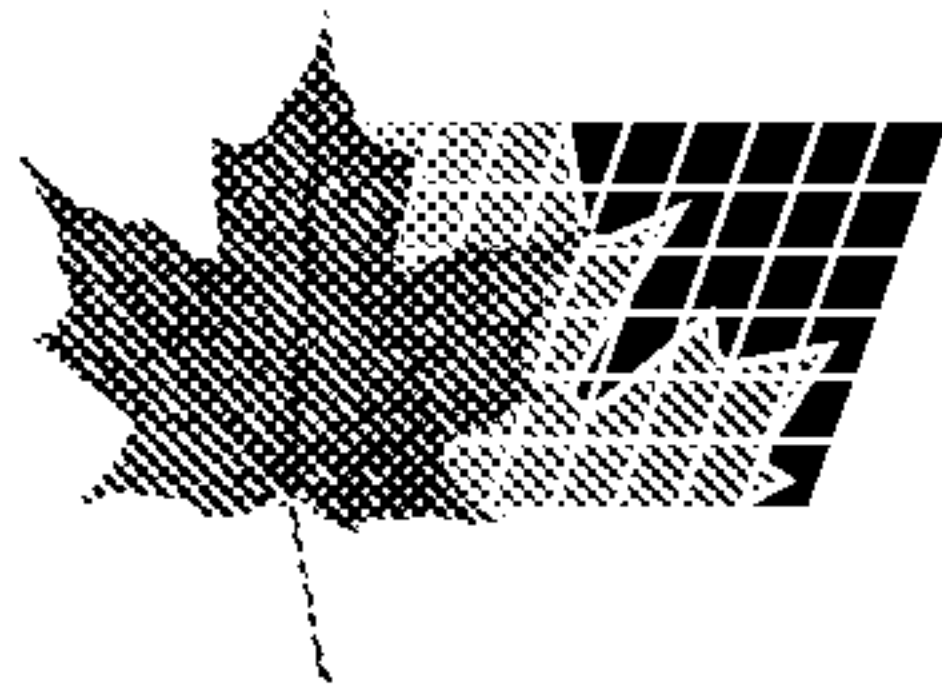




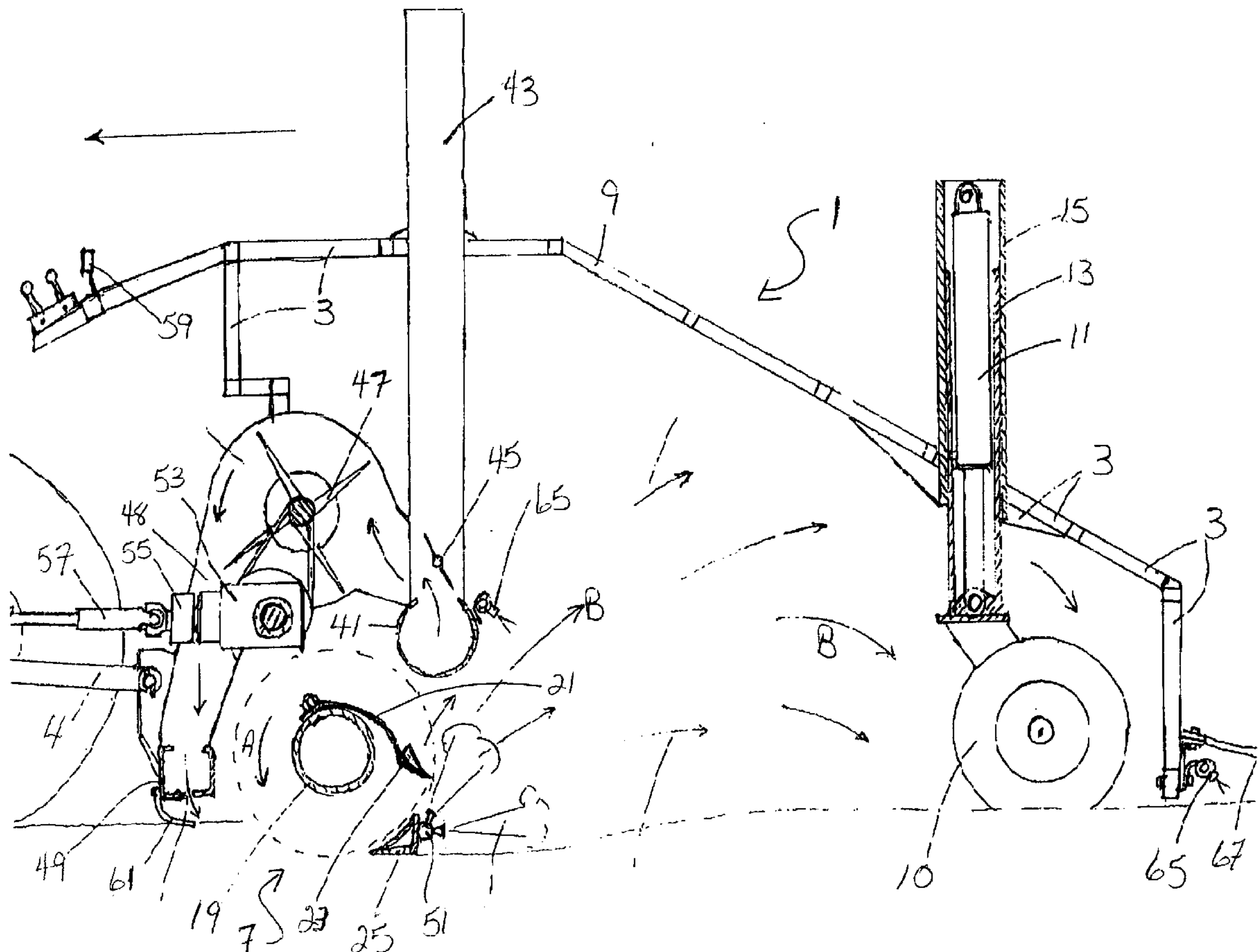
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(54) **APPAREIL ET METHODE POUR LA STERILISATION DU SOL**

(54) **APPARATUS AND METHOD FOR STERILIZING SOIL**



(57) The present invention provides for a soil sterilizer and a method for sterilizing soil. The sterilizer comprises a steam generator, tilling device with a ramp for raising a top layer of soil and blades on a rotatable shaft for lifting the soil and projecting it through the air. The steam contacts the soil as it passes through the air and heats it to a temperature sufficient to kill pathogens in the soil. The soil is treated under a hood which keeps the steam in a contained space and allows the soil to heat up to the temperature of the steam.



ABSTRACT

The present invention provides for a soil sterilizer and a method for sterilizing soil. The sterilizer comprises a steam generator, tilling device with a ramp for raising a top layer of soil and blades on a rotatable shaft for lifting the soil and projecting it through the air. The steam contacts the soil as it passes through the air and heats it to a temperature sufficient to kill pathogens in the soil. The soil is treated under a hood which keeps the steam in a contained space and allows the soil to heat up to the temperature of the steam.

APPARATUS AND METHOD FOR STERILIZING SOIL**FIELD OF THE INVENTION**

The present invention relates to the field of soil sterilizers and particularly those sterilizers which use steam.

BACKGROUND OF THE INVENTION

Soil contains a variety of bacteria, pests, and pathogens, some of which are beneficial and others harmful. It is often necessary to rid the soil of harmful bacteria and other pests and pathogens before the land is reused. This is particularly important with farmland where harmful pests and pathogens should be removed before the following year's crops are planted. If harmful pests remain in the soil, the new crops may be severely damaged or destroyed. It is therefore necessary to sterilize the soil to kill harmful pathogens.

U.S. Patent No. 4,873,789 discloses a sterilizer which may be used for this purpose. This sterilizer has a chamber with an inlet and outlet with a conveyor extending therebetween. The sterilizer uses a scalping blade to pick up the soil and deposit it onto the conveyor belt. As the soil passes through the chamber on the belt, it is exposed to radiation which kills any pathogens in the soil. However, this device has a number of drawbacks. The soil often remains in large clumps and pathogens located near the centre of the clumps are not exposed to the radiation and therefore remain viable. When the clumps are deposited back onto the ground, the pathogens will recontaminate the area. Further, the conveyor belt and moving parts come into contact with the soil and particles of soil will settle into joints causing moving parts to seize or work less efficiently.

U.S. Patent No. 5,406,747 discloses an alternate sterilizer. The device disclosed in this patent has a screw conveyor located within a treatment chamber. A feed funnel is

located near the upper end of the treatment chamber. Soil is fed into the screw conveyor and passes through the chamber at an inclined angle. Soil is deposited into the funnel and fed into the screw conveyor to ensure a constant feed of soil through the treatment chamber. As the soil passes through the chamber, steam is released into the chamber through orifices in the chamber. Again, this device has a number of disadvantages. In particular, it is necessary to utilize a backhoe or tractor device to scoop up soil and deposit large loads into the feed funnel. This step requires that the soil be transported to the feed funnel and then returned to its location after treatment. The sterilizer does not move over a field but is stationary during treatment. It is therefore very impractical to treat soil in a field or over a large area. As well, this device does not heat all of the soil as it passes through the screw conveyor. The steam is applied to the outer surface of the soil. When the conveyor is full of soil, the layer may be too thick for the steam to heat the bottom portion of the soil layer to a temperature sufficient to kill pathogens. Areas of soil may pass through the conveyor without being fully treated.

Other soil sterilizers also do not treat the soil reliably. Existing methods using pans or injectors apply heat unevenly. Soil is a good insulator and with the pan method, the surface will reach high temperatures but the bottom of the treated layer may not reach a temperature sufficient to kill pathogens. Steam injectors on a horizontal plain have a similar drawback.

Steam is known for the treatment and sterilization of soil. However, the prior art devices are either not suitable or not efficient for treating soil in a field or over large areas of ground. It is therefore desirable to have a device which may be moved over a field to treat the soil to kill pathogens and bacteria in the soil. It is also desirable to

have a device which is easy to use and efficient when sterilizing large tracts of land.

SUMMARY OF THE INVENTION

5 The present invention overcomes the disadvantages of the prior art and provides a sterilizer which may be used for treating large tracts of land in an efficient and cost-effective manner.

10 It provides for a sterilizer which causes heat to be applied evenly to the soil killing the bacteria and other pathogens in the soil. It also breaks up clumps of soil to improve efficiency.

15 The present invention requires little contact between moving parts on the sterilizer and the soil thereby reducing or eliminating mechanical failures caused by soil interference.

20 There, therefore, is provided an apparatus for sterilizing earth comprising: a frame having a ground engaging wheel; a cover connected to the frame; projecting means on the frame for lifting the earth and projecting it through the air under the cover; and steam generating means on the frame for applying steam to the earth as it moves through the air thereby heating the soil to a temperature sufficient to kill pathogens contained in the soil.

25 There is also provided an apparatus for killing pathogens in earth in a field comprising: a frame having a ground engaging wheel; a cover attached to the frame; projecting means on the frame for lifting the earth and moving it through the air under the cover; and steam
30 generating means for creating steam and applying it to earth as it travels through the air thereby heating the steam.

 There is further provided an apparatus for sterilizing earth on the ground, the apparatus movable across the ground, the apparatus comprising: a frame having a ground engaging

wheel; a cover on said frame; tilling means on the frame having at least one blade for projecting earth through the air under the cover; lifting means on the frame for raising a pre-determined depth of earth from the ground and passing it through the air; and steam generating means having generating means for creating steam and nozzle means for applying steam to the earth as it travels through the air thereby heating the earth to a pre-determined temperature to kill pathogens in the earth.

In a further aspect of the present invention, there is provided a method for sterilizing earth comprising the steps of: tilling the earth; causing the earth to move through the air; and applying steam to the earth as it moves through the air for heating the earth to a temperature sufficient to kill pathogens contained in the earth.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention will now be described and may be better understood when read in conjunction with the following drawings in which:

Figure 1 is a side cross-sectional perspective view through the centre portion of one embodiment of the soil-sterilizer of the present invention.

Figure 2 is a cross-sectional perspective view showing the steam generator of the sterilizer shown in Figure 1.

DETAILED DESCRIPTION OF THE INVENTION

With reference to the Figures, there is provided a movable sterilizer 1 for treating earth to kill pathogens contained therein. The sterilizer 1 comprises a frame 3 with a hood 9, a steam generator unit 5, and tilling device 7.

The sterilizer 1 may be attached to a moving vehicle such as a tractor and transported across a field or another area where the soil is to be sterilized. As the sterilizer

moves over the field treating the soil, the soil is lifted from the ground and heated by steam to a temperature sufficient to kill bacteria and other pathogens contained in the soil. The sterilizer therefore acts as an airborne heat exchanger.

As shown in Figure 1, the sterilizer 1 has a frame 3 including a cover or hood 9. The hood 9 surrounds and covers the sterilizer to maintain the earth and steam within an enclosed area for treatment. The hood may be insulated to reduce heat loss. Attached to the rear end of the frame 3 is a ground engaging wheel 10. The wheel 10 is attached to the frame 3 through a piston type arrangement. It allows the hood to be raised and lowered to a desired level as required as well as allowing the wheel to swivel. The piston type arrangement shown in Figure 1 comprises a hydraulic cylinder 11 telescopingly received in a tube member 13 positioned in part within an open-ended tube 15. This arrangement is well known in the art and other suitable arrangements or devices may be employed. The front end of the frame has a hitching device 4 for attaching to a tractor or other vehicle for towing across a field or other treatment area. It is also contemplated in the present invention that a driving means may be incorporated directly into the sterilizer to eliminate the need for attaching the sterilizer to a vehicle for towing.

The tilling device 7 has a main shaft assembly shown in part in Figures 1 and 2. The rotatable main shaft 19 is supported at each end by suitable bearing and drive sprockets with a slip clutch. The sprocket chain-speed reduction and slip clutch assembly 17 is shown in Figure 2. Any suitable assembly known in the art may be used. The main shaft 19 of the tilling device extends laterally across the sterilizer 1 near the forward, hitched end. Mounted on the shaft are a number of blades 21. The blades 21 are spring mounted on the

shaft 19. They are fixed to the shaft at one end and have a scoop portion at their free end 23. The blades are preferably fastened to the shaft at approximately 15 degree spacing behind the preceding blade. This spacing provides a smooth load on the drive train. As the main shaft 19 rotates, the blades 21 will travel in a path marked by arrow A. As the free ends 23 of the blades 21 contact the earth and scoop up a quantity of earth, the spring is compressed. As the shaft 19 continues to rotate and the free ends 23 of the blades 21 no longer contact the ground, the spring will return to its resting position forcing the free end 23 of the blades 21 outward and projecting the soil through the air underneath the hood 9. The trajectory of the soil is shown by arrows B. By adjusting variables such as the length and position of the numerous blades, diameter of the main tiller shaft, spring compression characteristics, and other factors, the trajectory of the earth can be pre-determined to allow the earth to travel through the air in an optimum trajectory and for a maximum time to allow for complete heating of the earth.

The tilling device 7 also includes a ramp 25. The ramp 25 extends laterally across the frame and is positioned rearwardly of the main tiller shaft 19. The ramp 25 has a wedge shape and is designed to deflect the top layers of the earth upwardly to increase the amount scooped up by the free end 23 of the blades 21. Any earth which was not scooped up by the blades will travel over the ramp and come into contact with steam ejecting from the steam nozzles described in more detail below. The position of the ramp 25 may be adjusted to contact more or less of the top layer of earth to allow varying depths of the earth to be sterilized. It is preferably set to allow the top 8 to 10 inches of earth in a field to be sterilized. The ramp is connected to a ground engaging wheel 27 shown in Figure 2. This wheel 27 is

adjusted in relation to the frame 3 to obtain the desired depth of the ramp 25. The blades 21 and ramp 25 will break up clumps of earth prior to contacting the steam. The steam heats the earth to a temperature sufficient to kill any pathogens. When sandy soil is broken up into fine grains, it needs to be exposed to the steam for a short time, a matter of fractions of a second, to reach a temperature equal to the steam. The term pathogens includes any living organisms in the earth whether harmful or beneficial and may include bacteria, pests, fungi, microorganisms, germs and the like which may be killed by exposure to high temperatures. The earth is heated to a temperature sufficient to kill pathogens contained in it. This temperature will vary depending upon the organism but is generally above 90 degrees Celsius and preferably above 95-100 degrees Celsius.

The sterilizer also includes a steam generating unit shown in more detail in Figure 2. This unit includes a steam generator comprising a heater, water source, canister, exhaust, and nozzles. The heater shown in Figure 2 is a commercial size oil burner 29. Although only one burner is shown, the sterilizer may utilize two burners or possibly more if needed. The burner 29 is connected to a canister 31 by a duct 35. The duct 35 has a centre passage 36 for forcing heat generated from the oil burner to a centre passage 32 in the canister 31. It also has an outer passage 37 for water to be pumped from a water source (not shown) to an outer passage 33 in the canister 31 through a pre-heater 30. The outer passage in the canister contains coils 39. The water is heated as it contacts the coils 39 and becomes steam. The air heated by the oil burner 29 and passing through the centre passage 32 of the canister 31 is expelled through an exhaust manifold 41 and exhaust stack 43. Inside the exhaust stack 43 is a damper 45 for regulating the air flow. Fumes from the air heated by the oil burner may taint

the earth being treated and it is preferable that this air not come into contact with the soil. The steam created in the canister 31 is forced from the top of the coils 39 through piping to the steam nozzles 51. The pressure in the canister caused by the conversion of the water into steam drives the steam through the piping. Steam exhausted from the nozzles 51 is released under the hood 9. It heats the earth as the earth passes through the air in its pre-determined trajectory projected by the blades or as it passes over the ramp.

Because the soil is moving through the air, the steam will contact all of the surface area of the earth thereby providing for a more efficient and reliable result. The nozzles 51 may be positioned in any location rearward of the ramp 25 as long as the steam is exhausted in such a manner that it comes into contact with the earth as it passes through the air and heats the earth to kill pathogens and other pests. Although the figures show only one oil burner for easy reference, the sterilizer utilizes two burners both of which exhaust through the manifold 41 and stack 43. The manifold 41 may also act as a frame cross member joining the side walls of the sterilizer. The sterilizer also includes a circulating fan 47 and duct 48 connecting to a hollow frame member 49. The frame member 49 has a series of openings along its length. The fan 47 draws hot air off of the manifold and out the openings in the frame member 49 onto the soil. This provides additional heating of the soil before it contacts the steam released from the steam nozzles 51.

Power to run the steam generator and circulating fan may be provided through a connection to the towing vehicle or other means may be installed on the sterilizer. For example, the blower and oil pump of the oil burner may be driven by the hydraulics of the tractor towing the sterilizer. The fuel ignitor may use an inverter to receive voltage from the tractor. Figure 1 shows the sterilizer 1 run through a gear

box 53 and ramp clutch 55 arrangement connected to the towing vehicle through a power take off 57. The sterilizer 1 also includes a control panel 59 for adjusting its various components.

5 Located behind the depth adjustor wheel 27 for the ramp 25 is a flap 61. This flap 61 may smooth out the earth entering the sterilizer 1 before the earth engages the blades 21 and ramp 25. It will also prevent steam and heat from escaping from the forward end of the sterilizer.

10 The frame 3 may include a door 63 on one side to allow for maintenance of the sterilizer 1.

 The sterilizer 1 may also include nozzles 65 for introducing pathogens into the sterilized earth. Since both harmful and beneficial pathogens will be removed by the sterilization, it may be desirable to introduce beneficial
15 pathogens into the earth after sterilization. These nozzles 65 may be positioned at any location on the sterilizer after the steam has treated the earth since pathogens artificially introduced back into the soil will also be killed by the
20 temperatures created by the steam. Some suitable positions are shown in Figure 1 although the preferred position is at the far rearward end of the sterilizer 1. It may also be desirable to have an insulating mat 67 at the rear of the
sterilizer to maintain the temperature of the earth for a
25 longer period of time. The mat may also improve contact of the pathogens from the nozzle 65 with the earth particularly on windy days.

 The above-described embodiments of the present invention are meant to be illustrative of preferred embodiments of the
30 present invention and are not intended to limit the scope of the present invention. Various modifications, which would be readily apparent to one skilled in the art, are intended to be within the scope of the present invention. The only

limitations to the scope of the present invention are set out in the following appended claims.

EMBODIMENTS OF THE PRESENT INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE AS FOLLOWS:

1. An apparatus for sterilizing earth comprising:
 - a frame having a ground engaging wheel;
 - a cover connected to the frame;
 - projecting means on the frame for lifting the earth and projecting it through the air under the cover; and
 - steam generating means on the frame for applying steam to the earth as it moves through the air thereby heating the soil to a temperature sufficient to kill pathogens contained in the soil.
2. The apparatus of claim 1 wherein the steam generating means includes a steam generator for creating steam.
3. The apparatus of claim 2 wherein the steam generator comprises a heater unit for heating water to a temperature sufficient to create steam and nozzles for ejecting the steam onto the earth as the earth passes through the air.
4. The apparatus of claim 1 wherein the projecting means comprises a rotatable shaft and a plurality of blades mounted on the shaft wherein the blades contact the earth as the shaft rotates and projects the earth through the air.
5. The apparatus of claim 4 wherein each of the plurality of blades are spring mounted onto the shaft.
6. The apparatus of claim 5 wherein the projecting means further includes a ramp on the frame for lifting earth, the ramp positioned between the blades and the steam

nozzles wherein earth passing over the ramp contacts steam ejected from the nozzles.

7. The apparatus of claim 1 further including connecting means on the frame for connecting the apparatus to a drive means for moving the apparatus across the ground.
8. The apparatus of claim 7 further including drive means for moving the apparatus across the ground.
9. An apparatus for killing pathogens in earth in a field comprising:
 - a frame having a ground engaging wheel;
 - a cover attached to the frame;
 - projecting means on the frame for lifting the earth and moving it through the air under the cover; and
 - steam generating means for creating steam and applying it to earth as it travels through the air thereby heating the earth.
10. The apparatus of claim 9 wherein the projecting means comprises a rotatable shaft, and a plurality of blades spring mounted on the shaft, each of said blades contacting the earth as the shaft rotates.
11. The apparatus of claim 10 wherein the blades have a fixed end mounted to the shaft and a free end having a scoop portion for engaging the earth and projecting it through the air.
12. The apparatus of claim 11 wherein the steam generating means comprises a generator for creating steam, and a plurality of nozzles for ejecting steam into the path of the earth as the earth passes through the air to heat

the earth to a temperature sufficient to kill pathogens in the earth.

13. The apparatus of claim 12 further including connecting means on the frame for connecting to a drive means for moving the apparatus across the ground.
14. An apparatus for sterilizing earth on the ground, the apparatus movable across the ground, the apparatus comprising:
 - a frame having a ground engaging wheel;
 - a cover on said frame;
 - tilling means on the frame having at least one blade for projecting earth through the air under the cover;
 - lifting means on the frame for raising a pre-determined depth of earth from the ground and passing it through the air; and
 - steam generating means having generating means for creating steam and nozzle means for applying steam to the earth as it travels through the air thereby heating the earth to a pre-determined temperature to kill pathogens in the earth.
15. The apparatus of claim 14 wherein the tilling means comprises a rotatable shaft and a plurality of blades spring mounted on the shaft, the blades contact the earth and project it through the air as the shaft rotates.
16. The apparatus of claim 15 wherein the blades have a fixed end mounted to the shaft and a free end having a scoop portion for engaging the earth.

17. The apparatus of claim 16 wherein the steam generating means comprises a generator for creating steam, and a plurality of nozzles for ejecting steam into the path of the earth as the earth passes through the air to heat the earth to a temperature sufficient to kill pathogens in the earth.
18. The apparatus of claim 14 further including connecting means on the frame for connecting the apparatus to a drive means for moving the apparatus across the ground.
19. The apparatus of claim 18 further including drive means for moving the apparatus across the ground.
20. A method for sterilizing earth comprising the steps of:
 - (a) tilling the earth by contacting the earth with at least one blade for projecting the earth through the air in a pre-determined trajectory;
 - (b) contacting the earth with steam as the earth moves through the air after contacting the at least one blade wherein the earth is heated to a temperature sufficient to kill pathogens contained therein.
21. The method of claim 20 further comprising the step of further tilling the earth by contacting the earth with a ramp for causing the earth to travel over the ramp and contacting the earth with steam after it passes over the ramp.
22. A method of sterilizing earth comprising the steps of:
 - tilling the earth;
 - causing the earth to move through the air;
 - applying steam to the earth as it moves through the air for heating the earth to a temperature sufficient to kill pathogens contained in the earth.

23. The method of claim 23 wherein the step of tilling the earth comprises the step of moving an apparatus over the earth, the apparatus comprising:
- a frame having a ground engaging wheel;
 - a cover attached to the frame;
 - projecting means on the frame for lifting the earth and moving it through the air under the cover; and
 - steam generating means for creating steam and applying it to earth as it travels through the air thereby heating the earth.
24. The method of claim 24 wherein the projecting means includes at least one blade for contacting the earth and moving it through the air and a ramp for contacting the earth and moving the earth over the ramp.

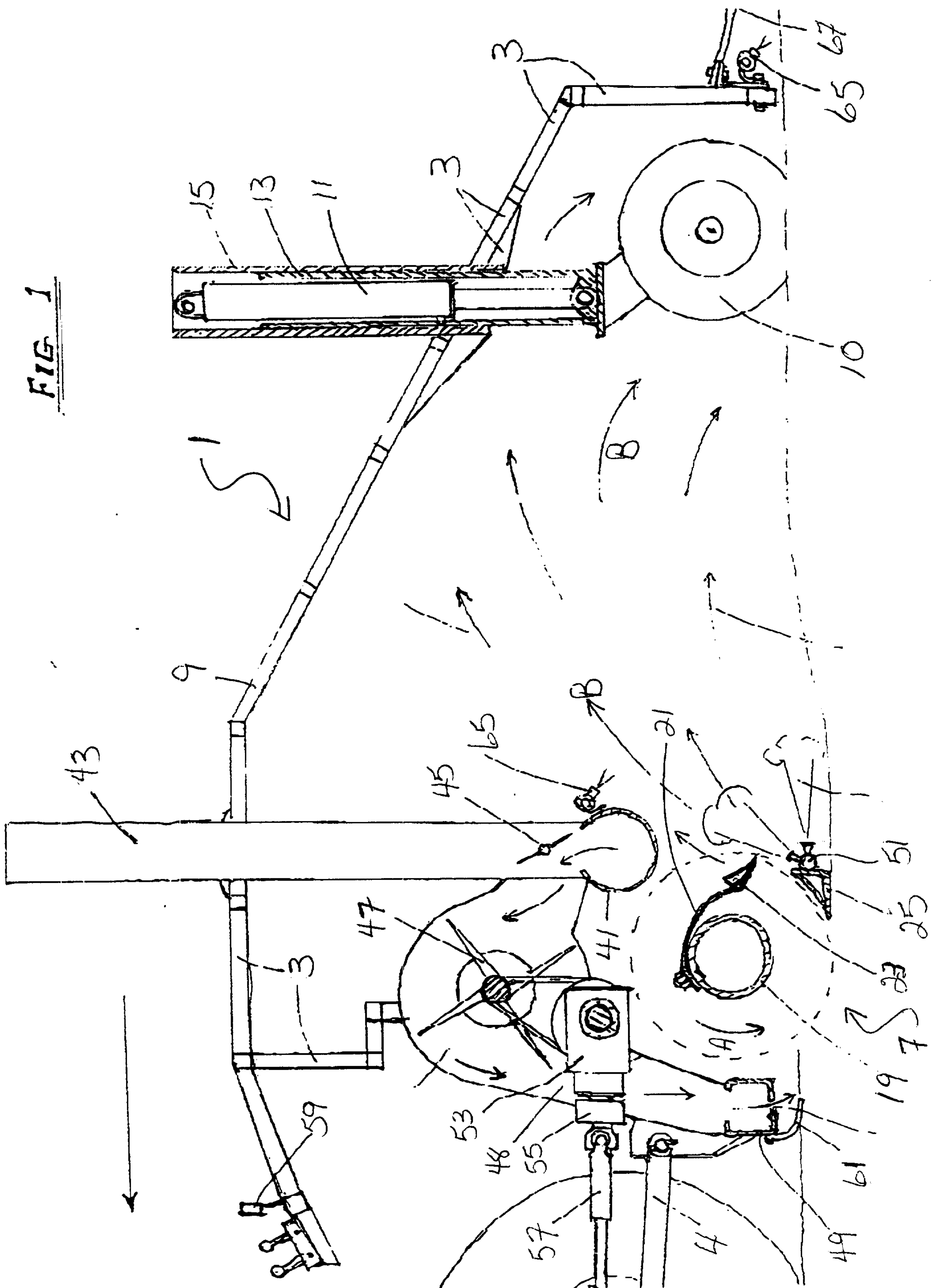


FIG 2