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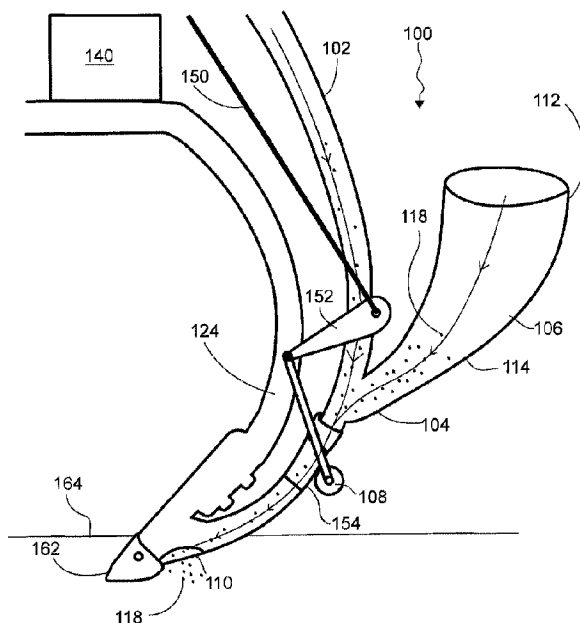
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(54) Titre : APPAREIL ET PROCÉDE POUR ENSEMENCEMENT DANS UNE MATRICE

(54) Title: APPARATUS AND METHOD FOR SEEDING IN A MATRIX



(57) Abrégé/Abstract:

An attachment for an air drill with a hose having an outlet for distribution of seeds from the air drill, a valve moveable between an open position allowing seeds to exit the outlet and a closed position preventing seeds from exiting the outlet, a diverter opening on the hose to divert seeds and air flow when the valve is in the closed position, and a seed collector configured to collect diverted seeds for recirculation is provided. Also provided is a novel method of farming having the steps of sowing seeds of a primary crop in clusters along a plurality of parallel rows and a plurality of parallel columns together forming a matrix and removing weeds across gaps between the parallel rows and across gaps between the parallel columns. The provided method may also be performed using the provided attachment.

ABSTRACT OF THE DISCLOSURE

An attachment for an air drill with a hose having an outlet for distribution of seeds from the air drill, a valve moveable between an open position allowing seeds to exit the outlet and a closed position preventing seeds from exiting the outlet, a diverter opening on the hose to divert seeds and air flow when the valve is in the closed position, and a seed collector configured to collect diverted seeds for recirculation is provided. Also provided is a novel method of farming having the steps of sowing seeds of a primary crop in clusters along a plurality of parallel rows and a plurality of parallel columns together forming a matrix and removing weeds across gaps between the parallel rows and across gaps between the parallel columns. The provided method may also be performed using the provided attachment.

Apparatus and Method for Seeding in a Matrix

TECHNICAL FIELD

[0001] Farming equipment and methods of seeding.

BACKGROUND

[0002] A major challenge for organic farming is maintaining enough nitrogen for the crops without using conventional, non-organic fertilizers.

[0003] In conventional tillage farming, soil is mechanically agitated to loosen and aerate the top layer of soil, and to mechanically destroy weeds. However, tillage also comes with many disadvantages, such as loss of organic material in the soil which causes drying of the soil, loss of nutrients, increased risk of soil erosion, increased costs and increased energy consumption. Due to these disadvantages, there is an increase in use of no till farming, which involves no agitation of the soil. There are many benefits associated with no till farming, such as increased soil biological fertility, increased water retention in the soil, and decreased risk of soil erosion. Additionally, no till farming consumes much less fuel than conventional farming. Tillage slowly reduces the organic material in the soil and also increases consumption of fuel. Organic material is also important for a number of reasons, one being preserving the ability of the soil to hold moisture. It takes 6000 gallons of water to grow a bushel of wheat, and accordingly moisture should be preserved as much as possible.

[0004] On the other hand, no till farming methods typically involve an increase in use in herbicide for weed control, as the mechanical destruction of weed through agitation is no longer possible. This itself comes with disadvantages, and renders organic farming, which involves no use of chemicals, very difficult as weeds (which often grow near the seeded crops) cannot be destroyed mechanically without affecting the seeded crops. Occasionally, secondary or cover crops such as legumes are grown to control weeds and increase nutrients in the soil. However, these secondary crops then need to be killed or controlled as they will otherwise compete with the primary crops for nutrients and sunlight. Removal of these

secondary crops without harming the primary crop can also be difficult, particularly in most cases where secondary crops grow near the primary crop.

SUMMARY

[0005] In some embodiments, the present invention allows large scale no till seeding using a conventional air drill to seed in a matrix into alfalfa sod which fixes nitrogen, which enables continuous no till organic farming.

[0006] In an embodiment there is disclosed an attachment for an air drill having a hose having an outlet for distribution of seeds from the air drill, the hose being connected to an air drill during operation. There is also a valve on the hose upstream from the outlet, the valve being moveable between an open position allowing seeds to exit the outlet and a closed position preventing seeds from exiting the outlet. The valve may be comprised of a flexible material, with mechanical means for actuating the valve, or may be a solenoid valve connected to a GPS receiver to receive actuation signals. There is also diverter opening on the hose upstream from the valve to divert seeds and air flow when the valve is in the closed position; and a seed collector extending from the diverter opening, the seed collector configured to collect diverted seeds for recirculation. The seed collector may be a funnel. The valve and the funnel may be mounted in close proximity to the ground.

[0007] In another embodiment there is also disclosed in some embodiments a method of farming which has the steps of sowing seeds of a primary crop in clusters along a plurality of parallel rows and a plurality of parallel columns together forming a matrix; and removing weeds across gaps between the parallel rows and across gaps between the parallel columns. The spacing between the parallel rows and parallel columns of clusters may be the same. The method may also involve planting a secondary crop in the gaps between the primary crop, or planting a secondary crop before planting the primary crop. The secondary crop may be a legume such as alfalfa. The step of weed control may be performed by using any one of mowers, weed whackers, shovels, liquid nitrogen, heat and light concentrator, high clearance sprayer, high serrated vertical till blades, and lasers.

[0008] In a further embodiment, there is disclosed in some embodiment a method of farming with the steps described above, while using an attachment for an air drill also as described above.

[0009] The foregoing summary is not intended to summarize each potential embodiment or every aspect of the subject matter of the present disclosure.

[0010] These and other aspects of the device and method are set out in the claims.

BRIEF DESCRIPTION OF THE FIGURES

[0011] Embodiments will now be described with reference to the figures, in which like reference characters denote like elements, by way of example, and in which:

[0012] Fig. 1 is a side cross-sectional view of an air drill having an attachment with a trip-activated valve in an open position according to one embodiment.

[0013] Fig. 2 is a side cross-sectional view of an air drill having an attachment with a trip-activated valve in a closed position according to one embodiment.

[0014]

[0015] Fig. 3 is a side cross-sectional view of an air drill having an attachment with an electrically-operated valve according to one embodiment.

[0016] Fig. 4 is a back elevational view of the diverter opening and seed collector of Fig. 1.

[0017] Fig. 5 is a front elevation view of the diverter opening and seed collector of Fig. 4.

[0018] Fig. 6 is a close-up side view of the valve of Fig. 1, where the valve is in an open position.

[0019] Fig. 7 is a close-up side view of the valve of Fig. 1, where the valve is in a closed position.

[0020] Fig. 8 is a bottom view of a tipped opener and outlet on an attachment for an air drill.

[0021] Fig. 9 is a top plan view of a conventional seeding method.

[0022] Fig. 10 is a top plan view of a seeding method according to one exemplary method.

[0023] Fig. 11 is a side view of an attachment for distributing seeds from an air drill.
[0024] Fig. 12 is a side view of an air drill having attachments for distributing seeds in a matrix.
[0025] Fig. 13 is simplified perspective view of a row crop mower.

DETAILED DESCRIPTION

[0026] Immaterial modifications may be made to the embodiments described here without departing from what is covered by the claims.

[0027] In one embodiment as illustrated in Fig. 1, there is an attachment 100 for an air drill 120 (Fig. 12) for planting seeds. The attachment may be connected to a shank 124 of the air drill, which may be mounted on a frame 140 of the air drill 120. Air drill technology in seeders is used to seed directly into the ground on a large scale and not plug with debris from the previous crop, which may be difficult when using conventional seed box drills.

[0028] The attachment 100 has a hose 102 with an outlet 110 for connection with the air drill, which allows for distribution of seeds 118 received from the air drill 120. There is also provided a diverter opening 104 for redirecting seeds 118 and air flow, a seed collector 106 extending from the diverter opening 104, and a valve 108 which may be selectively operated to allow or prevent seeds 118 from exiting outlet 110. A rear view of the seed collector 106 is shown in Fig. 4 and a frontal view of the seed collector 106 is shown in Fig. 5. Although high numbers of seeds 118 are shown in the seed collector 106 for illustration purposes, the number of seeds in the air collector at any given time will generally not exceed the number of seeds per clump. The number of seeds in each clump may be between 2 to 20 seeds depending on the type of crop.

[0029] In Fig. 1, a trip mechanism 152 is connected to the valve to operate the opening and closing of the valve. The trip mechanism 152 is connected to a trip wire 150 which may actuate the mechanism at predetermined intervals. The trip mechanism 152 as shown is spring loaded to move the valve between the open and closed positions. As shown, the trip mechanism may be connected to the shank 124 above the valve so that is away from the ground which reduces the risk it will be damaged by rocks. Various other methods may be used to actuate the valves at predetermined intervals, such as a solenoid valve 116 (Fig. 3)

and by using location information which may be determined by GPS. In Fig. 3, an electrically-operated valve, such as a solenoid valve 156, is actuated to open and close a portion 158 of the flow path between a seed source and the outlet 110. The electrically-operated valve may be actuated by wires 160 which connect to a controller.

[0030] In operation, seeds 118 from a seed storage tank (not shown) are directed into the hose 102 through air pressure generated by the air drill 120 (Fig. 12). In conventional air drills, seeds are deposited typically one by one through the opening of the hose. The valve 108 may be used to block flow of seeds such that seeds may be deposited as clusters instead of individually. By selectively operating the valve, the seeds may be placed in a precise matrix as shown in Fig. 10. When the valve 108 is in a closed position, as shown in Fig. 7, to collect seed clusters, the diverter opening 104 redirects air flow away from the standard flow path. This would prevent a plug of seeds 118 within the hose 102 that would prevent seeds from exiting the outlet and cause seeds to be distributed as a trail rather than a matrix once the valve is opened. Air drills commonly use centrifugal fans, meaning that when lines are plugged, the fan will generally run faster. Accordingly, fan speed can be monitored from the tractor for an indication whether there may be an issue of lines being plugged. Fan speed may be selected based on the size of seeds, with light seeds such as canola generally requiring very low fan speed, whereas heavy seeds like peas generally requiring very high fan speed. Starting and stopping the air stream entirely due to closing the valve without using any means of diverting air would result in a trail of seeds rather than a matrix. Similarly, adding seeds by starting the auger may also increase the fan speed. The seed collector 106 operates to prevent seeds from being blown away by capturing seeds that are diverted through the diverter opening 104. In the embodiment shown in Fig. 1, the seed collector is a funnel that slows down the air velocity of the diverted air, and the funnel also operates to collect diverted seeds for planting. The funnel has a narrower lower portion 114 and a wider upper portion 112, which causes a decrease in the air velocity as the seeds pass from the hose through the funnel. The redirected seeds will remain in the seed collector. The size and shape of the funnel can be chosen so that seeds are not expelled out of the top of the funnel during operation. When the valve 108 is opened, air will flow through the bottom of the valve and through outlet 110, depositing the seeds in clusters into the soil. The seed collector 106 may

have different configurations so long as the seeds can be collected while also diverting excess pressure from the hose when the valve 108 is closed. In some embodiments, the funnel may be enclosed on the top, which will allow air pressure to build up within the funnel prior to the seeds being released into the ground.

[0031] The attachment 100 allows the air flow from the air drill to be constant once the valve is closed. As the air goes through the diverter opening 104, the velocity slows so seeds do not get blown away. The valve 108 is located downstream of the hose 102 and diverter opening 104 and allows for flow of air through the valve 108 when it is open, as air takes the path of least resistance pulling seeds through outlet 110, and into the ground in a cluster when the valve 108 is in an open position, as shown in Fig. 6. In this manner, the funnel is designed to provide a venturi effect similar to that of a carburetor venturi that pulls in gasoline in an internal combustion engine. The direction of air flow through the attachment is shown using a series of arrows in Figs. 1 and 2.

[0032] A ceramic-tipped opener 162 will be inserted below the ground 164 and the seeds will exit the outlet 110 below the surface of the ground. In general, seeds will be placed in a seeding depth between 0 and 4 inches below the ground. Seeding depths may be selected as per a convention drill.

[0033] The seed metering system on the air tank may be a simple auger feeding into an air stream. A seed metering roll may also be used. Using the attachment 100, seeds may be deposited in clusters at defined distances. The desired distance between the clusters, and the size of the clusters may be modified based on the timing of the actuation of the valve 108.

[0034] The valve 108 may be made of a flexible material, such as a thin rubber tubing 154, which may then be mechanically clamped shut from the outside in a default, closed position which is triggered by the mechanical actuation means 152. The mechanical actuation 152 means may also be a trigger mechanism which is connected to a wheel (not shown) of the vehicle supporting the seeder, which, when activated, opens the valve 108 and allows seeds to be deposited. When the trigger mechanism 152 on the valve 108 is released, the valve 108 closes and air/seeds once again flow through the diverter opening 104 into the funnel 106. The valve being actuated between an open and closed position is shown in Figs.

6 and 7. However, other means of opening and closing a valve 108 may be employed. For example, the valve may be an electrically-operated valve, such as a solenoid valve 116 (Fig. 3) connected to a GPS system, which may correspond with a pre-generated field map of the seed clusters and electrically control the solenoid valve such that the clusters are deposited at exact positions based on the field map. Various means may be used to measure distances travelled as the air drill moves through the field which may be transmitted to a controller which opens and closes an electronically actuated valve such as a solenoid valve. In other embodiments, rather than opening and closing a portion of thin rubber tubing 154, the valve may be operated by opening and closing part of the hose 102 itself which may be opened or closed by mechanical or electric means.

[0035] Fig. 8 shows a bottom view of a shank. The opener 162 is at the front of the attachment and the seed outlet 110 is at the base. In some embodiments, the outlet 110 may be 1.5" across and the base of the shank may be $\frac{3}{4}$ " wide.

[0036] Fig. 11 shows an attachment 100 (Fig. 3) connected in a row on multiple shanks 124 on an air drill 120 (Fig. 12). The shanks 124 are mounted on the frames 140 of the air drill. The attachments 100 are actuated by solenoid valves 116. Although a single exemplary attachment having the solenoid valve 116 and seed collector 106 is shown in Fig. 11, it will be understood that similar attachments may be installed on each of the various shanks and hoses shown in the figure. As shown in Fig. 3, an electrically actuated valve 156 may open and close a piece of rubber tubing in the same manner as the embodiments in Figs. 1 and 2. Other types of valving systems may be used, but using flexible piece of tubing is preferable as a very simple valving mechanism that has fewer moving parts to wear out and can also be inexpensively and easily replaced.

[0037] Fig. 12 shows multiple attachments connected in rows on shanks 124 and cutters 122 on the air drill 120. Seed collectors and valves may be installed on each of the various shanks 124 and cutters 122 of the air drill.

[0038] Fig. 13 shows a row crop mower 138 which has a row of mowers 130 which are connected to support frames 132 that extend from a support cross bar 134 and mounted to a tractor 136. The mowers 130 and matrix size can be selected so that the mowers cut weeds in between rows of the clumps of seeds without mowing the primary crop. The

mowers may be any variety of conventional mowers. Although chains are shown in the figure, various different attachment means can be used to connect the mowers to the tractor. Other movers may be used other than a tractor, such as a sprayer or other prime mover.

[0039] Preferably, the valve 108 and outlet 110 are mounted in close proximity to each other and the valve is mounted in close proximity to the ground to promote seeding in clusters, and to avoid a scattering of seeds along a trail as the seeder moves forward. If the valve 108 is placed close to the ground, it preferably has a rugged construction to prevent damage as the seeder encounters uneven terrain along its path. For example, the valve assembly may be mounted between zero to 10 inches away from the ground, and in some cases may be within six inches of the ground. The valve 108 may be placed, for example, four inches from the outlet 110, although various other distances are possible so long as the seeds can be placed in accurate spacing.

[0040] When the attachment 100 is mounted to the air drill 120 (Fig. 12), the air drill may still be used in the normal manner by simply leaving the valve 108 in an open position. This may be advantageous if the season is getting late, and normal, individual seeding needs to be performed.

[0041] In accordance with the present invention, the components of the exemplary attachment, including the hose, diverter opening, seed collector and valve may form a standalone unit for attachment to existing air drills, but may also be directly integrated into air drills during manufacture.

[0042] Exemplary methods provide a method of planting a primary crop in seed clusters 142, as shown in Fig. 6. The seeds clusters may be planted using the air drill attachment 100 as shown in Fig. 3, and may be planted in a matrix 148, which may for example be in rows 144 and columns 146 that each are evenly spaced, such as twelve inch by twelve inch rows, or twenty inch by twenty inch rows or 36 by 36 inch rows. The spacing between the rows may be determined based on the type of crop and available equipment for trimming between rows. In some cases, certain crops may be best suited for row sizes between approximately 12 to 36 inch rows. The spacing between rows may be selected, for example, so that the crop can grow into a canopy over the field and allow weed control underneath. For example, short crops may be planted in 12" by 12" rows, whereas tall crops

such as corn may be planted in 36" by 36" inch rows. When seeds clusters 142 are planted in such a manner, various weed killing methods can be used in a crisscross manner without affecting the seed clusters, in contrast to the conventional seeding method as shown in Fig. 9, in which it is difficult to control weeds growing between the individually planted seeds 128 in rows 126. Methods of weed killing will be discussed in further detail below. Furthermore, sowing the seeds in clusters provides natural competitiveness against weeds.

[0043] According to one exemplary method, seeds of a primary crop are sowed in clusters along a plurality of parallel rows and a plurality of parallel columns together forming a matrix. Weeds are then removed across the gaps between the parallel rows and across gaps between the parallel columns. In one preferred embodiment, the spacing between the parallel rows and parallel columns are the same, e.g., forming a matrix of 12" x 12", or 20" x 20", or even 36" by 36" or other spacing. The terms rows and columns are used for ease of reference and are used to describe the matrix configuration 148 as is shown in Fig. 6.

[0044] In addition, exemplary methods may further include planting a secondary, or cover crop, in the gaps between the primary crop so as to further inhibit weed growth. The secondary crop may be a legume such as alfalfa which fixes nitrogen from the air to improve soil quality and further plant growth. The secondary crop may be planted before or after the primary crop. The secondary crop may be maintained at a short length of growth relative to the primary crop.

[0045] There may be numerous benefits of planting a secondary crop such as a legume. In organic farming, nitrogen will typically be the limiting factor on yield, as compared to conventional farming where it is heat units or rainfall/moisture. A secondary crop, such as alfalfa (legume) is left growing all the time which continually fixes nitrogen from the air. Wheat, peas, canola, barley or oats may then be cluster seeded into the standing alfalfa crop. Weed control may be achieved by mowing between the rows in 2 directions, which is made possible by the cluster seeding. In addition, the clusters are very densely seeded so it is competitive with the weeds. As the clusters grow they will canopy over so the weeds are starved of sunlight. The secondary crop, such as alfalfa, will also be stunted until the crop is harvested.

[0046] When planting with a secondary crop, weed control may still be performed without harming the primary crop. Mechanical weed destruction tools such as mowers or weed whackers can be used on the secondary crop which has the effect of removing the weeds, and also stunting the growth of the secondary crop, allowing the primary crop to become established. Alternatively, laser-based weed control can also be used without affecting the primary crop.

[0047] There are additional benefits of planting a secondary crop. With conventional farming, where sunlight falls on bare ground, this energy will heat the ground but much of the energy is lost. With a continuous planted cover crop, such as alfalfa, more of the sun's energy is captured. The growth of the alfalfa will be stunted at seeding by mowing the alfalfa very short and/or using a mechanical device such as a heavy harrow to rip top growth from the roots. Alfalfa is a resilient plant, so it will usually recover. After harvest the alfalfa is allowed to grow which fixes nitrogen for the following year and provides a snow cover. One of the negative effects of no till farming may be an increase in alkaline soil which is caused by a buildup of salt due to water movement in the soil. Alfalfa is relatively tolerant of alky soils, and continuous cropping with alfalfa may help fix the soil's alkaline problem. Alfalfa generally lives for ten years, and a rotation wheat, peas, barley, canola may be possible. Finally, the alfalfa may be left growing indefinitely, and if there is a primary crop failure due to frost, disease, bugs etc., the primary crop can be mowed and the alfalfa crop may still be harvested.

[0048] The exemplary methods of planting a primary crop in a matrix may also be performed using a seeder having the air drill attachment 100, as described above, and shown in Figs. 1-4. To carry out the steps of the exemplary methods, a seeder having the exemplary air drill attachment is preferably capable of seeding directly into live sod that seeds in a matrix so that various weed killing methods can be used in a crisscross manner. The seeders may contain mid row banders which deposit fertilizer between the rows, which become unnecessary if employing organic farming. Accordingly, the banders may be moved sideways on the frame to cut the sod directly in front of the opener. In one particular example, the staggered rows may be spaced the same as the shank spacing to seed a cluster matrix. The exemplary seeder may have 9.8" spacing on the rows to block off every second

run. The frame of the drill may be 22" spacing between the air drill beams to form a 20 X 22" matrix. However, square matrices are preferable for ease of weed clearing.

[0049] Furthermore, according to this exemplary method, the seeder is preferably capable of seeding into a viable secondary crop and not become plugged. Preferably, it is also capable of cutting the sod ahead of the opener, to prevent the clusters from being ripped out. A 12" X 12" matrix is provided as an example, and because there are pre-existing air drills that have 12 inch spacing and the narrow tires on typical high clearance sprayers will go between 12 inch rows. The sprayer can be modified implement a weed control program. In other embodiments, other sizes of matrices, such as 20" X 20" matrices may also be used.

[0050] If using a matrix, the weed killing equipment may be mounted on a modern high clearance sprayer. There may be a need to change the boom and gear ratio so the sprayer could move very slowly with skinny tires on. An operator may sit in the machine for the outside passes, and then a GPS may guide the machine without an operator, and may be able to send a signal with a picture to the operator's phone.

[0051] The above method is a preferred method to seed in a matrix, however another method may be to have an old-style gravity style seed box, then start and stop the seed roll, however since the control is at a distance from the ground and the shanks are ideally spaced for trash clearance, accurate seed placement may not be possible. Also, a seed box holds very little seed compared to an air drill.

[0052] In addition, various methods of synchronizing the passes of the seeder may be used such that the distances between the plurality of parallel rows and parallel columns of seed clusters are the same. For example, the synchronization method may be completely mechanical, such that once the air drill is turned around the operator may stop the machine and reposition the trip mechanism to synchronize. Each of the outside shanks has a foamer on it which leaves a small amount of foam at the beginning of the pass and then every 50 ft which is used to keep the spacing consistent on both passes. In some cases, this system may still require an accurate GPS system.

[0053] Synchronization of each pass may also be achieved by electronic sensors that can sense where the seed clusters are, for example, various tools can be used such as oilfield instruments that use moisture (laterlog or induction tool), natural radiation (gamma log) or

artificial radiation (neutron tool), sound (acoustic tool). The location of the clusters may then be fed into the trip mechanism to synchronize the next pass.

[0054] Furthermore, the synchronization may be achieved using completely electronic means with a high accuracy GPS making a seed map of where the clusters had been placed. Then on subsequent passes the computer generated map can signal to the openers where to deposit the seeds.

[0055] In the claims, the word “comprising” is used in its inclusive sense and does not exclude other elements being present. The indefinite articles “a” and “an” before a claim feature do not exclude more than one of the feature being present. Each one of the individual features described here may be used in one or more embodiments and is not, by virtue only of being described here, to be construed as essential to all embodiments as defined by the claims.

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

1. An attachment for an air drill comprising:
 - a hose having an outlet for distribution of seeds from the air drill, the hose being connected to an air drill during operation;
 - a valve on the hose upstream from the outlet, the valve being moveable between an open position allowing seeds to exit the outlet and a closed position preventing seeds from exiting the outlet;
 - a diverter opening on the hose upstream from the valve to divert seeds and air flow when the valve is in the closed position; and
 - a seed collector extending from the diverter opening, the seed collector configured to collect diverted seeds for recirculation.
2. The attachment of claim 1 in which the seed collector is a funnel.
3. The apparatus of claim 1, wherein the valve is comprised of a flexible material.
4. The apparatus of any one of claims 1 to 3, wherein the valve comprises a mechanical actuating means for moving the valve between the open and closed positions.
5. The apparatus of claim 4, wherein the actuating means comprises a trip wire activated spring load configured to move the valve between the open and closed positions.
6. The apparatus of claim 1, wherein the valve comprises a solenoid valve.
7. The apparatus of claim 6, further comprising a GPS receiver in communication with the solenoid valve, whereby the solenoid valve is movable between an open and closed position based on the GPS location of the outlet.

8. The apparatus of claim 2, wherein the valve and the funnel are mounted in close proximity to the ground.
9. The apparatus of claim 8, wherein the valve and the funnel are mounted between 5 to 7 inches away from the ground.
10. A method of farming using an air drill, the air drill comprising a hose having an outlet for distribution of seeds from the air drill; a valve on the hose upstream from the outlet, the valve being moveable between an open position allowing seeds to exit the outlet and a closed position preventing seeds from exiting the outlet; a diverter opening on the hose upstream from the valve to divert seeds and air pressure when the valve is in the closed position; and a seed collector extending from the diverter opening, the seed collector configured to collect diverted seeds for recirculation; the method of farming comprising:
 - using the air drill to sow seeds of a primary crop in clusters along a plurality of rows forming a matrix, such that the seed clusters form substantially parallel lines along and across each row; and
 - removing weeds in a crisscross manner in gaps defined between the parallel lines along and across each row of seed clusters.
11. The method of claim 10, wherein the spacing between parallel rows and parallel columns is the same.
12. The method of any one of claims 10 to 11, further comprising the step of planting a secondary crop in gaps defined by the seed clusters of the primary crop.
13. The method of any one of claims 10 to 11, wherein the seed clusters of the primary crop are planted over a pre-existing secondary crop.
14. The method of any of claims 11, wherein the equal spacing between each parallel row and each parallel column is between 12 to 36 inches.

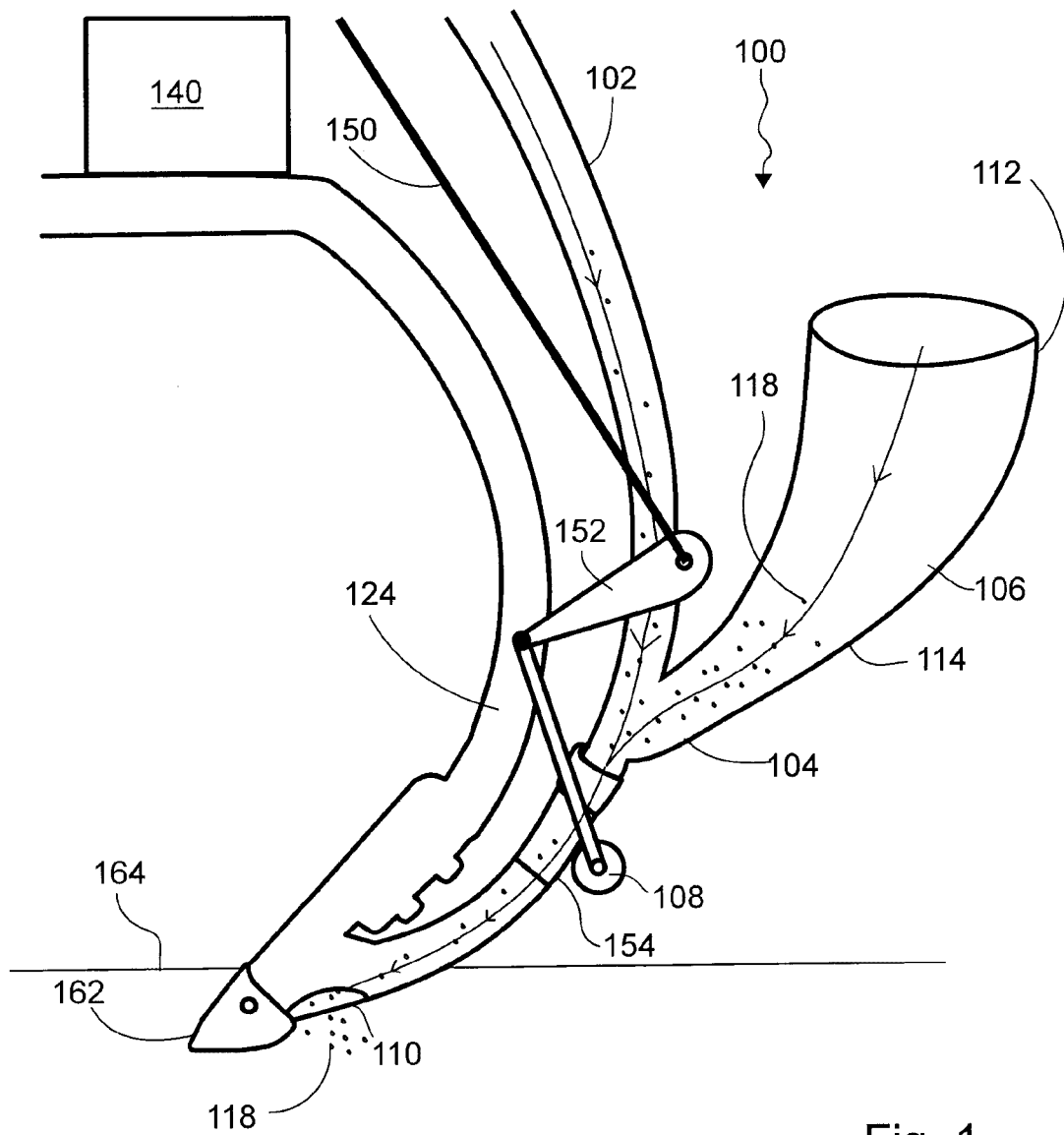


Fig. 1

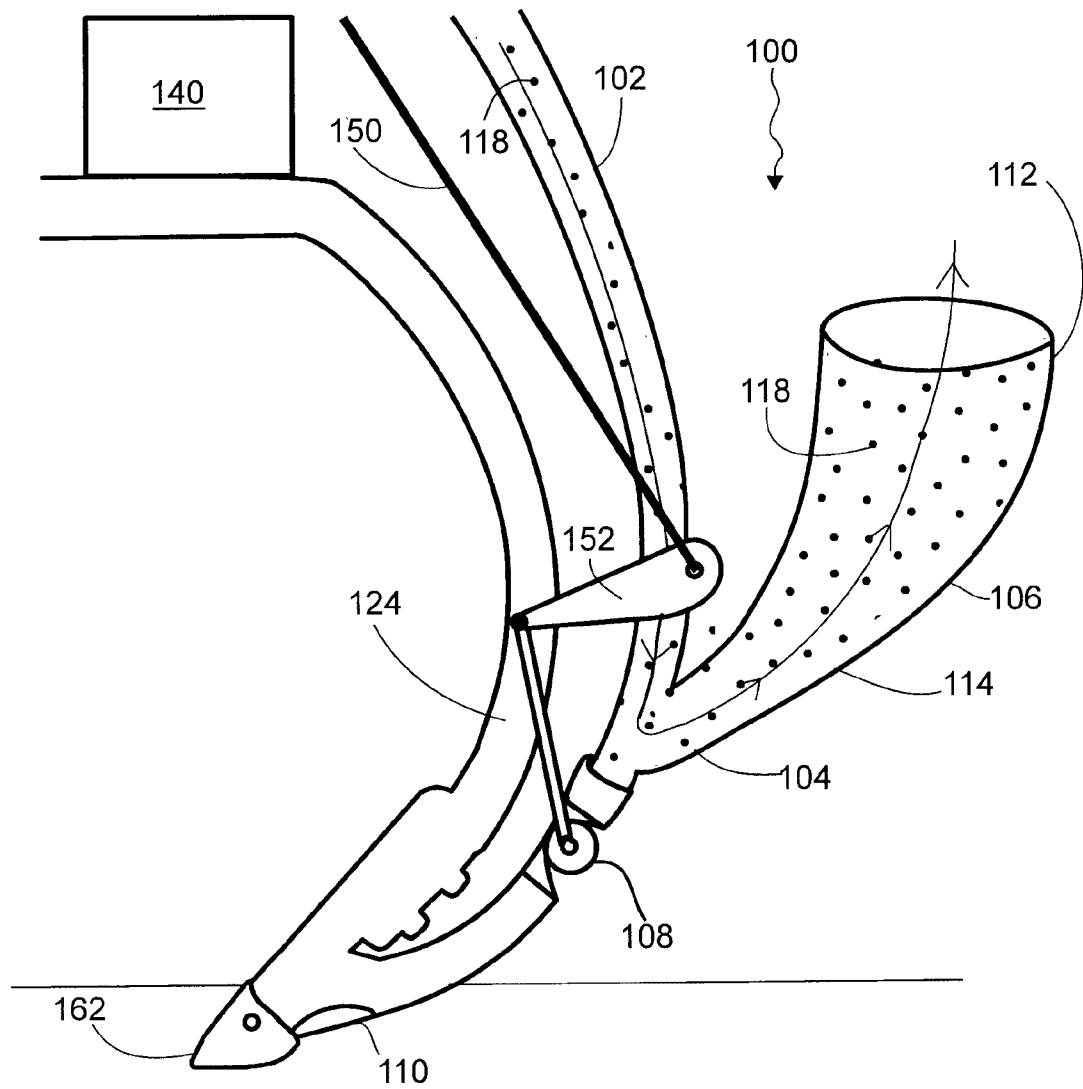


Fig. 2

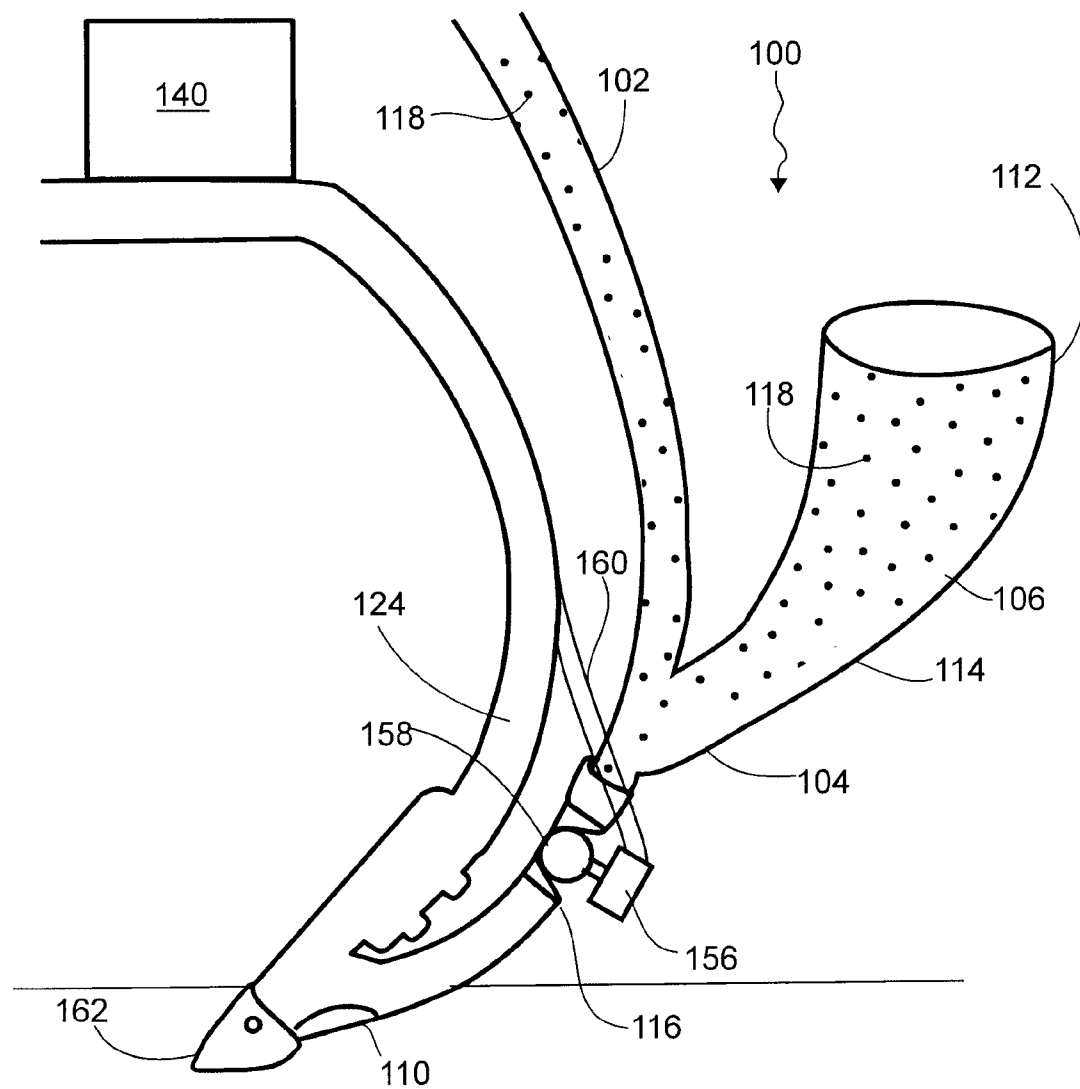


Fig. 3

Fig. 4

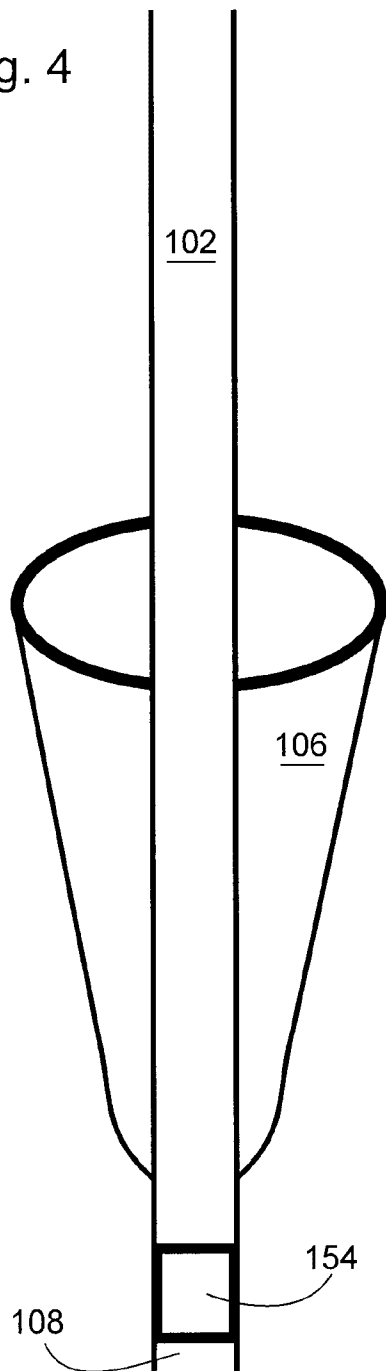


Fig. 5

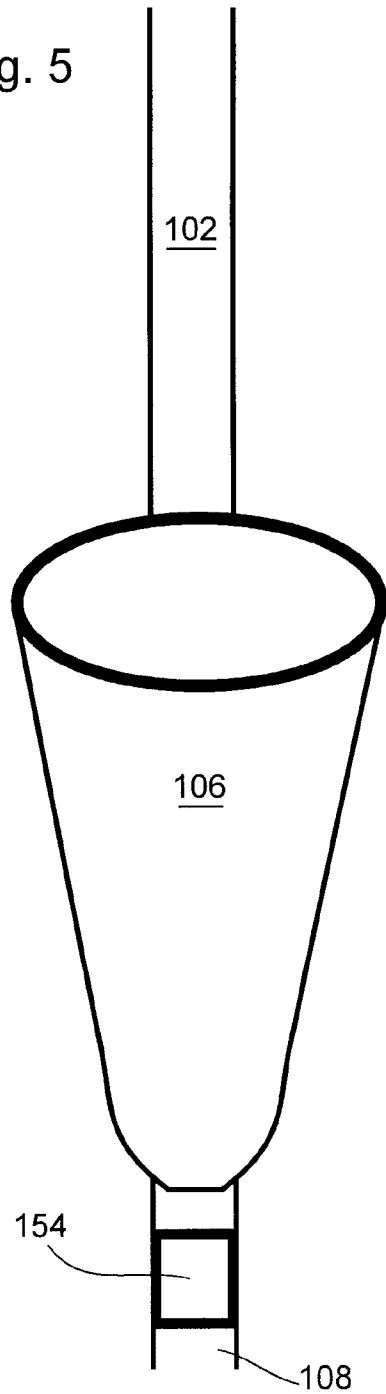


Fig. 6

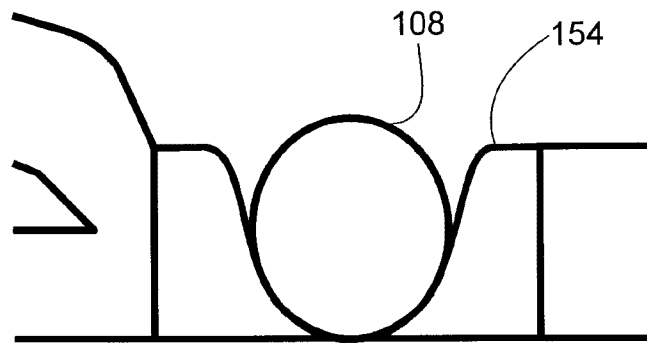
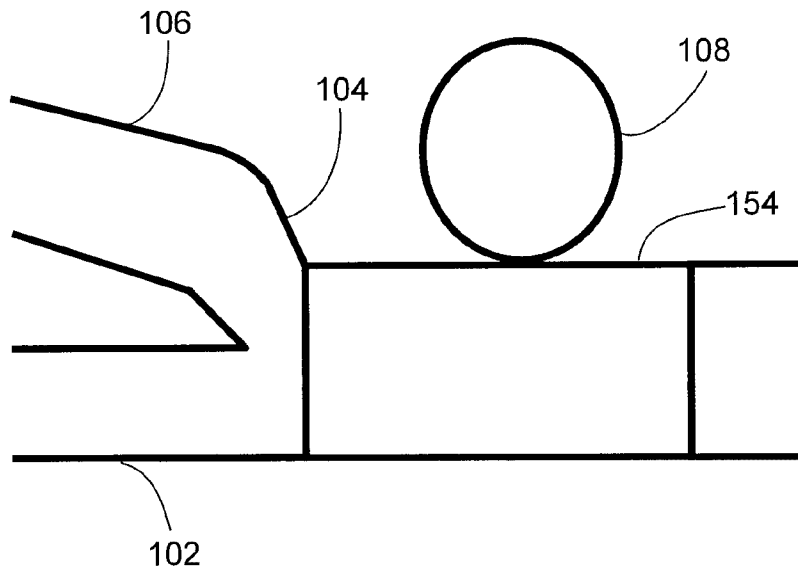


Fig. 7

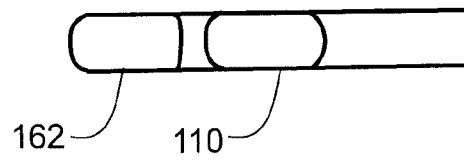


Fig. 8

PRIOR ART

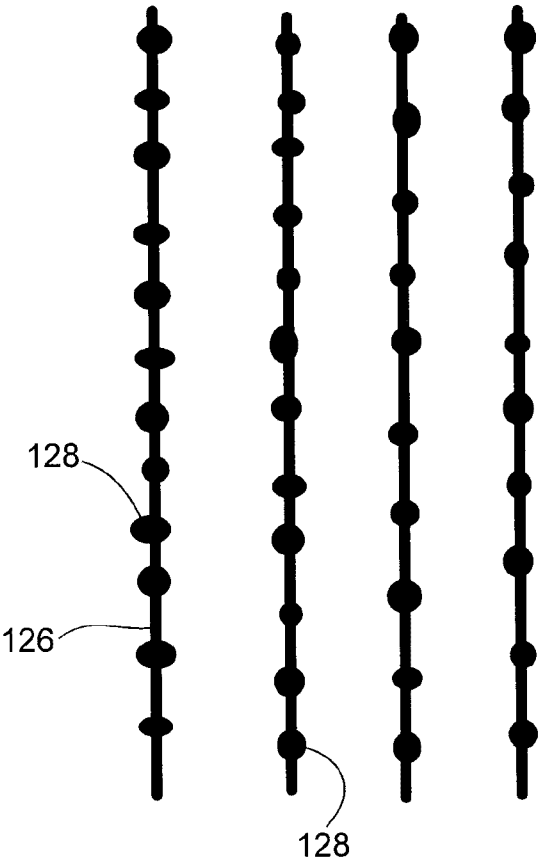


Fig. 9

Fig. 10

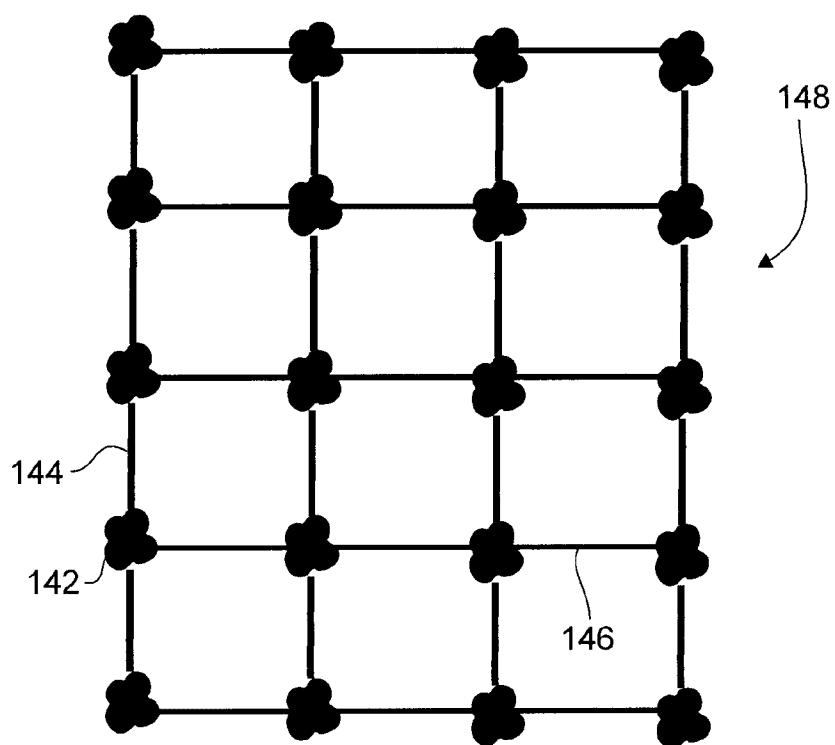


Fig. 11

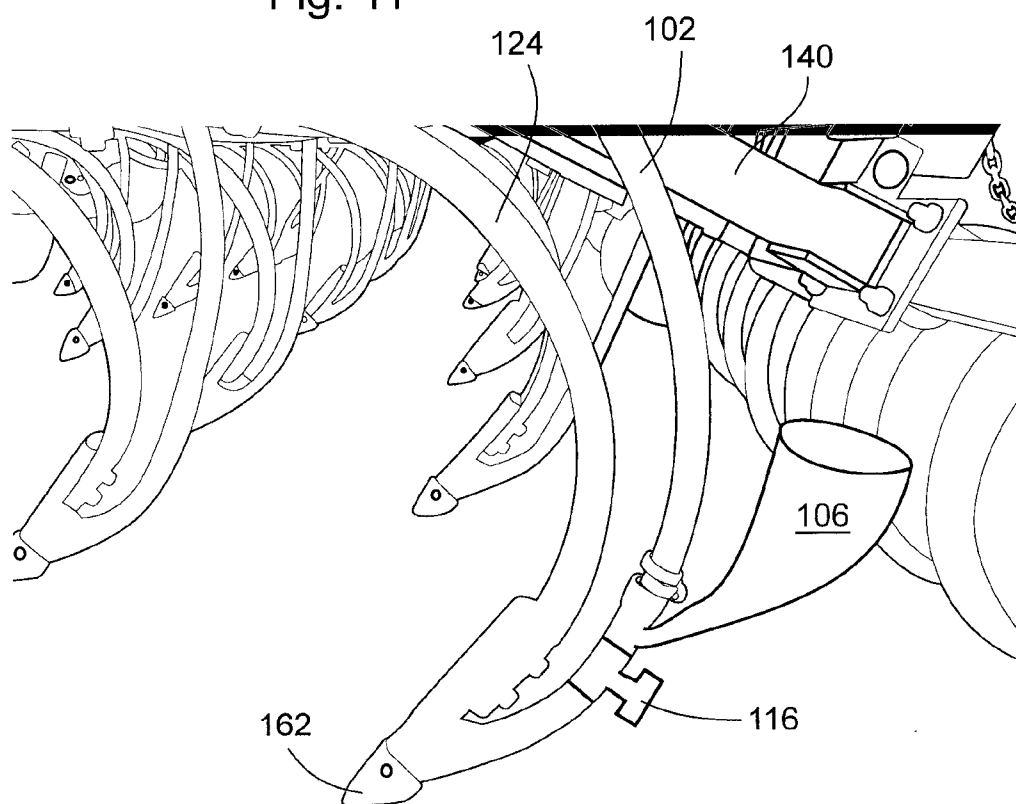


Fig. 12

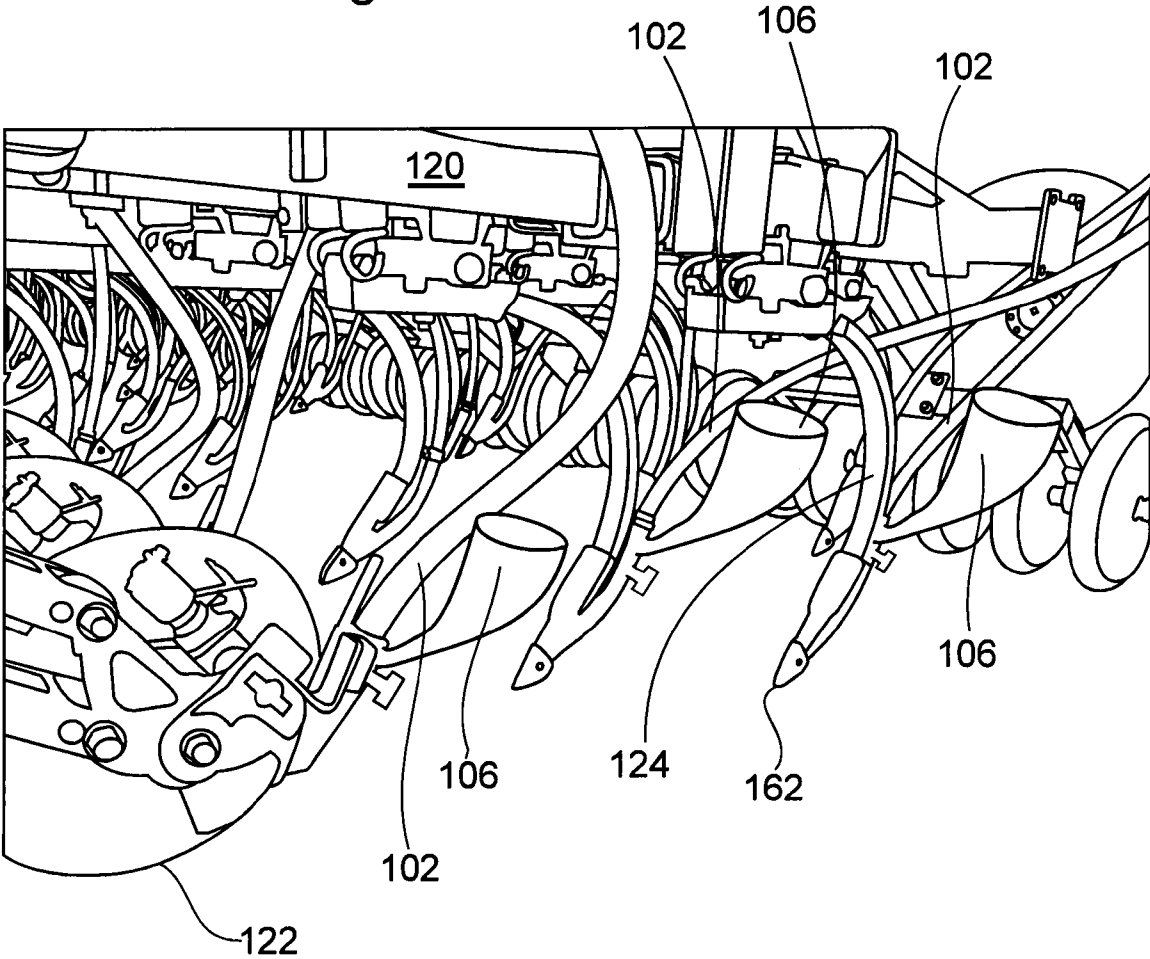


Fig. 13

