Title: SOIL SCREENING APPARATUS AND A METHOD FOR SCREENING SOIL

Abstract: Apparatus (1) for screening soil comprises a chassis (2) having an upwardly inclined conveyor (10) mounted therein. A forward soil engaging scraper plate (8) is coupled to and extends forwardly from an upstream end (11) of the conveyor (10) for engaging the soil beneath the surface for scraping the soil above the scraper plate (8) and transferring the scraped soil onto the conveyor (10) as the apparatus (1) is urged forwardly. The soil is conveyed to a downstream end (12) of the conveyor (10) and delivered to a first screen (30) which screens material of a first predefined size of 150mm and greater from the material and discharges the screened material into a storage container (32). Material of size less than the first predefined size passes through the first screen (30) to a second screen (35) which retains material of a second predefined size of 20mm and greater and passes material of less than the second predefined size of 20mm, for example, soil fines therethrough, which are deposited on the ground. The second screen (35) is configured to urge the material of the second predefined size of 20mm and greater towards a forward downstream end (37) of the second screen (35) which is deposited onto the ground in advance of the soil fines, so that the fines are deposited on the ground on top of the material of the second predefined size of 20mm and greater.
"Soil screening apparatus and a method for screening soil"

The present invention relates to soil screening apparatus, and in particular, though not limited to soil screening apparatus for screening stones from soil. The invention also relates to a method for screening soil.

Screening of soil of land is necessary in order to produce arable land. Soil screening apparatus for screening soil are known. Such soil screening apparatus typically are suitable for towing behind a prime mover, for example, a tractor. One such soil screening apparatus comprises a forwardly facing scraper blade which is urged into the soil and engages the soil beneath the surface thereof for scraping soil from the ground to a depth at which the scraper blade engages the soil beneath the level of the surface of the soil. The scraped soil is then elevated to a screen which screens the scraped soil, thereby removing rocks and large stones from the soil and returning the remainder of the soil which passes through the screen to the ground. However, in general, the material which passes through the screen, while it includes fines of the soil, may also include stones which may be of relatively large size, although smaller than the size to which the screen is configured to block. The presence of such stones amongst the fines is undesirable, since if seeds fall on the stones, in general, those seeds fail to sprout.

There is therefore a need for soil screening apparatus which addresses this problem. The present invention is directed towards providing soil screening apparatus which addresses the problem of known screening apparatus, and the invention is also directed towards a method for screening soil.

According to the invention there is provided soil screening apparatus comprising a forward soil engaging element for engaging soil beneath a surface thereof, and for directing soil onto an elevating conveying means in response to the apparatus being moved in a forward direction, a first screening means configured to receive soil from the conveying means and configured to prevent material of a first predefined size and greater passing therethrough, and to pass material of size less than the first predefined size therethrough, and a second screening means configured to receive the material of size less than the first predefined size from the first screening means, the second screening means being further configured to discharge the material of the second predefined size and greater to the ground forward of the location at which the material of size less than the second predefined size is
deposited on the ground from the second screening means, so that the material of size less than the second predefined size is deposited on top of the material of the second predefined size and greater as the apparatus is being urged forwardly, the first predefined size of the material being greater than the second predefined size of the material.

In one aspect of the invention the conveying means extends between an upstream end and a downstream end, the soil engaging element being located adjacent the upstream end of the conveying means. Preferably, the downstream end of the conveying means is at an elevated level relative to the upstream end thereof. Advantageously, the conveying means is inclined upwardly from the upstream end to the downstream end thereof.

In one aspect of the invention the conveying means inclines upwardly from the upstream end to the downstream end at an angle lying in the range of 18° to 27° relative to the horizontal. Preferably, the conveying means inclines upwardly from the upstream end to the downstream end at an angle lying in the range of 20° to 25° relative to the horizontal. Advantageously, the conveying means inclines upwardly from the upstream end to the downstream end at an angle of 22° relative to the horizontal.

In another aspect of the invention the first screening means is located relative to the conveying means for receiving soil from the downstream end of the conveying means. Preferably, the first screening means is located adjacent the downstream end of the conveying means. Advantageously, the first screening means is configured to receive the material from the conveying means under gravity. Ideally, the first screening means is located at a level below the level of the downstream end of the conveying means.

In another aspect of the invention the second screening means is located at a level below the level of the first screening means. Preferably, the second screening means is configured relative to the first screening means to receive the material of size less than the first predefined size from the first screening means under gravity. Advantageously, a storage means is provided for receiving and storing the material of the first predefined size and greater from the first screening means. Ideally, the first screening means is configured to discharge the material of the first predefined size and greater to the storage means.

Preferably, the storage means is located rearwardly of the first screening means. Advantageously, the storage means is located at a level below the level of the first screening means.

In one aspect of the invention the storage means is configured to be tippable for discharging the material
of the first predefined size and greater therefrom.

In another aspect of the invention the first screening means comprises a plurality of spaced apart rotatably mounted first rollers, each first roller comprising a plurality of spaced apart first grading wheels mounted fast thereon, the first rollers being spaced apart from each other so that the radial distance between the circumferential surface of one of the first rollers and the peripheral circumferential surface of the first grading wheels of an adjacent first roller, and the axial longitudinal spacing between adjacent first grading wheels of adjacent first rollers is such as to prevent the material of the first predefined size and greater passing through the first screen, and to permit the material of size less than the first predefined size to pass through the first screen. Preferably, the first grading wheels on each of the first rollers extend between adjacent first grading wheels on the adjacent first roller so that the first grading wheels of adjacent first rollers overlap each other. Advantageously, the axial spacing between the first grading wheels of each first roller is adjustable. Ideally, the radial spacing between adjacent ones of the first rollers is adjustable.

In another aspect of the invention the first rollers are rotatably mounted about first rotational axes, the first rotational axes extending parallel to each other. Preferably, the first axes of the respective first rollers lie in a substantially common plane. Advantageously, the first rollers extend substantially transversely of the direction of normal forward motion of the apparatus.

In another aspect of the invention the first rollers are rotatably driven.

In another aspect of the invention the second screening means comprises a plurality of spaced apart rotatably mounted second rollers, each second roller comprising a plurality of spaced apart second grading wheels mounted fast thereon, the second rollers being spaced apart from each other so that the radial distance between the circumferential surface of one of the second rollers and the peripheral circumferential surface of the second grading wheels of an adjacent second roller, and the axial spacing between adjacent second grading wheels of adjacent second rollers is such as to prevent the material of the second predefined size and greater passing through the second screen, and to permit the material of size less than the second predefined size to pass through the second screen.

Preferably, the second grading wheels on each of the second rollers extend between adjacent second grading wheels on the adjacent second roller so that the second grading wheels of adjacent second
rollers overlap each other. Advantageously, the axial spacing between the second grading wheels of each second roller is adjustable. Ideally, the radial spacing between adjacent ones of the second rollers is adjustable.

In one aspect of the invention the second rollers are rotatably mounted about second rotational axes, the second rotational axes extending parallel to each other. Preferably, the second axes of the respective second rollers lie in a substantially common plane. Advantageously, the second rollers extend substantially transversely of the direction of normal forward motion of the apparatus. Preferably, the second rollers are rotatably driven.

In one aspect of the invention the conveying means comprises a conveyor. Preferably, the conveying means comprises a slatted conveyor.

In one aspect of the invention slats of the conveyor are secured to at least two spaced apart slat carrier belts or chains. Preferably, the slats of the conveyor extend substantially transversely of the slat carrier belts or chains, and advantageously, the slats of the conveyor extend substantially transversely of the direction of normal forward motion of the apparatus.

Alternatively, the conveying means comprises a belt conveyor.

In a further aspect of the invention the speed of the conveying means is adjustable for adjusting the linear speed of the conveying means to match the forward speed of the apparatus over the ground.

In another aspect of the invention the forward soil engaging element comprises a hardened steel element.

Preferably, the forward soil engaging element comprises a plate member of steel material. Advantageously, the forward soil engaging element comprises a forwardly facing forward soil engaging edge for engaging the soil beneath the surface thereof. Ideally, the forward soil engaging edge of the forward soil engaging element extends substantially transversely of the direction of motion of the apparatus.

In another aspect of the invention a soil guide means is mounted on the forward soil engaging element, the soil guide means being configured for directing soil from the forward soil engaging edge of the forward soil engaging element to the conveying means. Preferably, the soil guide means comprises a soil
directing guide plate, the soil directing guide plate being inclined upwardly from the forward soil engaging element to the conveying means.

Preferably, the second screening means is located substantially beneath the conveying means. Advantageously, the first screening means extends rearwardly beyond the conveying means.

In another aspect of the invention a soil loosening element is located forwardly of the forward soil engaging element for breaking up and loosening the soil prior to engagement of the soil by the forward soil engaging element. Preferably, the soil loosening element extends transversely across the apparatus. Advantageously, the soil loosening element extends transversely across the apparatus substantially the width of the forward soil engaging element.

Preferably, the soil loosening element comprises a rotovating means.

In another aspect of the invention the rotovating means comprises a plurality of rotovating elements longitudinally spaced apart and fast on a transversely extending driven shaft.

In one aspect of the invention the apparatus is configured for mounting on a forward end of a prime mover.

In another aspect of the invention the apparatus is configured for mounting on a rearward end of a prime mover.

In a further aspect of the invention the apparatus is carried on a pair of transversely spaced apart ground engaging wheels rotatably mounted on respective opposite sides of the apparatus. Preferably, the ground engaging wheels are located rearwardly on the apparatus, and ideally, are steerably carried on an axle.

In another aspect of the invention the apparatus is configured for towing behind a prime mover.

The invention also provides a method for screening soil comprising scraping soil from the ground by soil screening apparatus as the apparatus is being urged forwardly, elevating the scraped soil on a conveying means of the apparatus and delivering the scraped soil into a first screening means configured to prevent material of a first predefined size and greater passing therethrough, passing the material of size less than
the first predefined size through the first screening means to a second screening means, the second screening means being configured to prevent material of a second predefined size and greater passing therethrough and to permit material of size less than the second predefined size to pass therethrough, depositing the material of size less than the second predefined size on the ground through the second screening means, and depositing the material of the second predefined size and greater on the ground forwardly of the location at which the material of size less than the second predefined size is being deposited on the ground as the apparatus is being urged forwardly.

The advantages of the soil screening apparatus according to the invention are many. A particularly important advantage of the soil screening apparatus results from the fact that the second screen deposits the material of the second predefined size and greater on the ground at a location in advance of the location at which the soil fines of size less than the second predefined size are deposited on the ground as the apparatus is urged forward. Since the material of the second predefined size and greater up to a size just less than the first predefined size typically comprises agglomerated clumps of soil, this material is deposited on the ground in advance of the soil fines being deposited on the ground, and thus, the soil fines are deposited on top of the material of the second predefined size and greater. This provides a particularly important advantage in that, in general, prior to treating the ground with the apparatus, the ground is normally pre-treated with a fertiliser. The fertiliser, in general, remains with the top part of the soil, which in general comprises the soil fines. Thus, the fertiliser is retained with the soil fines, which are located adjacent the top of the soil to the growing depth where it is most required.

Additionally, the grades of the first and second screens being adjustable permits the first and second screens to be adjusted to grades to suit local conditions.

A further advantage of the invention is achieved by the provision of the storage container located adjacent the first screen for collecting material of the first predefined size and greater, so that this material can be collected and stored for disposing of remotely of the ground being prepared by the apparatus.

The invention will be more clearly understood from the following description of some preferred embodiments thereof, which are given by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic side elevational view of soil screening apparatus according to the
invention,

Fig. 2 is a schematic top plan view of the soil screening apparatus of Fig. 1,

Fig. 3 is a view similar to Fig. 1 of soil screening apparatus according to another embodiment of the invention,

Fig. 4 is a view similar to Fig. 2 of the soil screening apparatus of Fig. 3,

Fig. 5 is a perspective view of a part of the soil screening apparatus of Fig. 3, and

Fig. 6 is a front elevational view of a detail of the part of Fig. 5 of the soil screening apparatus of Fig. 3.

Referring to the drawings, and initially to Figs. 1 and 2, there is illustrated soil screening apparatus according to the invention, indicated generally by the reference numeral 1, for screening soil, and in particular, for removing stones from soil. The apparatus 1 comprises a main chassis 2 of steel illustrated in broken lines in Figs. 1 and 2 extending between a forward end 3 and a rearward end 4. A tow hitch 5 extends forwardly from the forward end 3 of the chassis 2 for hitching the apparatus to a prime mover, for example, a tractor (not shown) so that the apparatus 1 may be towed behind the tractor in the direction of normal forward motion of the apparatus 1, namely, in the direction of the arrow A. A pair of transversely spaced apart steerable ground engaging wheels 6 are rotatably and steerable carried on an axle (not shown), which is mounted on the chassis 2 adjacent the rear end 4 thereof. The axle (not shown) extends transversely of the chassis 2, and in turn transversely of the direction of normal forward motion of the apparatus 1, and carries the ground engaging wheels 6 on respective opposite sides of the chassis 2.

A forward soil engaging element, in this embodiment of the invention a forward soil engaging scraper plate 8 of hardened steel plate material is located within the chassis 2 and terminates in a forwardly facing transversely extending forward soil engaging edge 9 for engaging soil beneath the surface of the ground, and typically, for engaging soil at a level of approximately 250mm below the surface of the soil, and for scraping the soil from the ground above the forward soil engaging scraper plate 8 as the apparatus 1 is being urged forwardly in the direction of the arrow A by the tractor.
An elevating conveying means, in this embodiment of the invention a slatted conveyor 10 is mounted in the chassis 2 and is inclined upwardly from an upstream end 11 adjacent the forward soil engaging scraper plate 8 to a downstream end 12 at an angle of inclination a to the horizontal, the angular value of which is adjustable, and typically is adjustable between 18° and 27° for a purpose to be described below.

A carrier shaft 14 carried on the chassis 2 and extending transversely of the direction of normal forward motion of the apparatus 1 pivotsally carries the conveyor 10 adjacent the downstream end 12 thereof for facilitating adjusting the angle of inclination a of the conveyor 10 relative to the horizontal. The carrier shaft 14 defines a tilt axis 15 about which the conveyor 10 is tiltable for varying the angle of inclination a of the conveyor 10.

The forward soil engaging scraper plate 8 is coupled to the conveyor 10 adjacent the upstream end 11 and extends forwardly from the upstream end 11 of the conveyor 10. The forward soil engaging scraper plate 8 is of width, in a direction transversely of the direction of normal forward motion of the apparatus 1, substantially similar to the width of the conveyor 10. A soil guide means comprising a soil directing guide plate 17 is mounted on the forward soil engaging scraper plate 8 rearwardly of the forward soil engaging edge 9 thereof and extends substantially the width of the soil engaging scraper plate 8. The soil directing guide plate 17 inclines upwardly from the soil engaging scraper plate 8 and extends to the upstream end 11 of the conveyor 10 for guiding and directing soil from the forward soil engaging scraper plate 8 onto the conveyor 10 as the apparatus 1 is being towed forwardly in the direction of the arrow A by a tractor. A first double-acting hydraulic ram 18 acting between the conveyor 10 and the chassis 1 pivots the conveyor 10 about the carrier shaft 14 and in turn about the tilt axis 15 for adjusting the angle of inclination a of the conveyor 10 relative to the horizontal, and for in turn raising and lowering the forward soil engaging scraper plate 8 in order to adjust the depth beneath the surface of the ground at which the forward soil engaging edge 9 of the forward soil engaging scraper plate 8 engages the soil.

The conveyor 10 comprises a slatted conveyor 16 comprising a plurality of transversely extending slats 20 carried on four spaced apart slat carrier belts 19. The slat carrier belts 19 are of reinforced rubber or reinforced synthetic rubber. The slat carrier belts 19 extend around an upstream roller 21 and a downstream roller 22 located adjacent the upstream end 11 and the downstream end 12, respectively, of the conveyor 10, which are rotatably carried in a framework 23 of the conveyor 10. The upstream roller 21 is an idler roller and is rotatably mounted on a shaft 24 carried in the framework 23 of the conveyor 10. The downstream roller 22 is rotatably mounted on the carrier shaft 21 and is driven by a first drive means, namely, a first hydraulic motor (not shown), for in turn driving the slatted conveyor 16 in the direction of
the arrow B for conveying the soil from the upstream end 11 to the downstream end 12 of the conveyor 10. The first hydraulic motor (not shown) is a variable speed motor for matching the speed of the slatted conveyor 16 of the conveyor 10 to the speed of the apparatus 1 over the ground.

A first screening means comprising a first screen 30 is located on the chassis 2 adjacent the downstream end 12 of the conveyor 10 for receiving soil conveyed by the conveyor 10 from the forward soil engaging scraper plate 8. The first screen 30, particulars of which will be described below, is configured to prevent material, in particular stones and other matter of a first predefined size and greater, which in this embodiment of the invention is approximately 150mm, passing therethrough, and to permit material of size less than the first predefined size of 150mm to pass therethrough. The first screen 30 is located at a level below the level of the downstream end 12 of the conveyor 10 for receiving the soil from the conveyor 10 under gravity, and the first screen 30 extends in a generally rearwardly direction from the conveyor 10.

A storage means, in this embodiment of the invention a storage container 32 is located on the chassis 2 at a level below and towards the rear of the first screen 30 for receiving stones and other matter of the first predefined size of 150mm and greater from the first screen 30. The storage container 32 is pivotally mounted on the chassis 2 about a transversely extending pivot axis 33 to facilitate tipping of the storage container 32 for discharging the stones and other matter therefrom. A second urging means, namely, a second double-acting hydraulic ram 34 acting between the storage container 32 and the chassis 2 pivots the storage container 32 about the pivot axis 33 for discharging stones and other matter therefrom.

A second screening means, namely, a second screen 35, particulars of which will be described below, is located on the chassis 2 at a level below the first screen 30 for receiving the material of size less than the first predefined size of 150mm which has passed through the first screen 30. The second screen 35 extends beneath and in a forward direction towards the conveyor 10, and is configured to prevent material of a second predefined size and greater, which in this embodiment of the invention is approximately 20mm, passing therethrough, and to permit material of size less than the second predefined size to pass therethrough. The material which is of size less than the second predefined size of 20mm, in general, is soil fines, and is deposited on the ground after passing through the second screen 35. The second screen 35 extends from a rear upstream end 36 to a forward downstream end 37, and is configured for urging the material of the second predefined size of 20mm and greater in a generally forwardly direction, namely, in the direction of the arrow C, so that the material of the second predefined size of 20mm and greater is discharged from the second screen 35 adjacent the forward downstream end 37, and deposited
on the ground at a location forward of the location at which the material of size less than the second predefined size of 20mm is deposited. Thus, as the apparatus 1 is being towed in the forward direction, namely, in the direction of the arrow A by a tractor, the material of the second predefined size of 20mm and greater is deposited on the ground in advance of the material of less than the second predefined size of 20mm, so that the soil fines of size less than the second predefined size of 20mm which pass through the second screen 35 are deposited on top of the material of the second predefined size of 20mm and greater.

A pair of spaced apart coulter wheels 38 are rotatably mounted on the chassis 2 adjacent the forward end 3 thereof and are angled for directing soil into and towards the forward soil engaging edge 9 of the forward soil engaging scraper plate 8 as the apparatus 1 is being towed behind a tractor.

Returning now to the first screen 30, the first screen 30 comprises a first frame (not shown) which is secured to the chassis 2 at the level below the downstream end 12 of the conveyor 10. A plurality of parallel spaced apart first grading rollers 40 are rotatably carried in the first frame (not shown) and extend transversely of the direction of normal forward motion A of the apparatus 1. Each first grading roller 40 carries a plurality of axially spaced apart first grading wheels 41 mounted thereon, and in this case, the first grading wheels 41 are of star configuration and are commonly referred to as grading stars. Such grading wheels will be well known to those skilled in the art. The first grading wheels 41 are spaced apart axially along the corresponding first grading rollers 40 by spacing sleeves (not shown) located on the first grading rollers 40. The spacing sleeves and the first grading wheels 41 are tightly secured together in order to secure the first grading wheels 41 rigidly on the corresponding first grading rollers 40. The spacing between the first grading rollers 40 is such that the first grading wheels 41 of adjacent first grading rollers 40 slightly overlap each other. The axial spacing between adjacent ones of the first grading wheels 41 of adjacent ones of the first grading rollers 40 and the spacing between adjacent first grading rollers 40 is such as to permit material of size less than the first predefined size of 150mm to pass through the first screen 30, and to prevent material of the first predefined size of 150mm and greater passing therethrough.

The first grading rollers 40 are rotatably driven in the directions of the arrow D for configuring the first screen 30 to urge the material of the first predefined size of 150mm and greater rearwardly in the direction of the arrow E along the first screen 30 for discharging the material of the first predefined size of 150mm and greater from the first screen 30 into the storage container 32. A second drive means, namely, a
second hydraulic motor (not shown) rotatably drives the first grading rollers 40 in the direction of the arrow D through a drive transmission system (also not shown). The second hydraulic motor (not shown) is a variable speed motor for varying the rotational speed with which the first grading rollers 40 are driven in order to match the speed at which the material of the first predefined size of 150mm and greater is urged along the first screen 20 to the storage container 22 with the forward speed of the apparatus 1 over the ground, and to suit site conditions.

The spacing between the first grading wheels 41 on the first grading rollers 40 is adjustable by varying the number and/or size of the spacing sleeves (not shown) between the first grading wheels 41 on the corresponding first grading rollers 40, and the spacing between the first grading rollers 40 is also adjustable for varying the grade of the first screen 30 for in turn varying the size of material which is passed through the first screen 30.

Turning now to the second screen 35, the second screen 35 is substantially similar to the first screen 30 and comprises a second frame (not shown) and a plurality of spaced apart second grading rollers 43 rotatably mounted in the second frame (not shown). The second grading rollers 43 extend parallel to each other and transversely of the direction A of forward motion of the apparatus 1. Each second grading roller 43 carries a plurality of spaced apart second grading wheels 44 which in this case are also of star configuration, and which are rigidly secured to the corresponding second grading roller 43. The spacing between the adjacent ones of the second grading rollers 43 and the axial spacing between adjacent ones of the second grading wheels 44 on adjacent ones of the second grading rollers 43 is such as to prevent the material of the second predefined size of 20mm and greater passing through the second screen 35, while at the same time permitting fines of the soil of size less than the second predefined size of 20mm pass through the second screen 35.

The second grading rollers 43 are rotatably driven in the direction of the arrows F for urging the material of the second predefined size of 20mm and greater along the second screen 35 in a forward downstream direction, namely, the direction of the arrow C towards the forward downstream end 37 of the second screen 35 for discharging the material of the second predefined size of 20mm and greater onto the ground in advance of the fines of the soil which are subsequently deposited onto the ground over the material of the second predefined size of 20mm and greater as the apparatus 1 is being towed in the forward direction, namely, in the direction of the arrow A. A third drive means, namely, a third hydraulic motor (not shown) through a drive transmission (also not shown) rotates the second grading rollers 43 in the direction...
of the arrow F. The third hydraulic motor (not shown) is of variable speed for varying the rotational speed of the second grading rollers 43 in order to match the speed at which the material of the second predefined size of 20mm and greater is urged along the second screen 35 to the forward downstream end 37 to the forward speed of the apparatus 1 over the ground, and to suit soil conditions. The spacing between the second grading wheels 44 and between the second grading rollers 43 is adjustable for altering the grade of the second screen 35 for in turn varying the size of material which passed through the second screen 35.

A forward soil engaging roller 45 is rotatably carried on the forward end 3 of the chassis 2 for compacting the soil in front of the forward soil engaging plate 8.

The first hydraulic motor (not shown) for driving the conveyor 10, and the second and third hydraulic motors (not shown) for driving the first and second grading rollers 40 and 43, respectively, are powered by a pressurised hydraulic system (also not shown) located on the chassis 2 of the apparatus 1, which is powered by the power-take-off shaft of the tractor or prime mover to which the apparatus 1 is hitched. The first hydraulic ram 18 for varying the angle of inclination a of the conveyor 10 relative to the horizontal and the second hydraulic ram 34 for tipping the storage container 32 are both powered by the hydraulic power supply of the tractor or other towing vehicle.

In use, the apparatus 1 is hitched to a prime mover, for example, a tractor. The hydraulic system of the apparatus 1 is connected to the power-take-off shaft of the tractor for pressurisation thereof, and the first and second hydraulic rams 18 and 34 are connected to the hydraulic power supply of the tractor. The apparatus 1 is then ready for use. The angle of inclination a of the conveyor 10 relative to the horizontal is adjusted and set relative to the chassis 2 by the first hydraulic ram 18 so that the forward soil engaging edge 9 of the forward soil engaging scraper plate 8 engages the soil at the desired level below the surface of the ground for removing the soil to the desired depth from the surface thereof, which typically would be 250mm below the surface of the ground. The speed of the conveyor 10 is adjusted to match the speed over the ground at which the apparatus 1 is to be towed by the tractor. The speeds of the first and second grading rollers 40 and 43 are also adjusted to suit the soil conditions, and the speed at which the apparatus 1 is to be towed over the ground.

As the apparatus 1 is being towed by the tractor, the forward soil engaging edge 9 of the forward soil engaging scraper plate 8 engages the soil at the desired depth below the surface thereof, and the forward
movement of the apparatus 1 urges the soil over the guide plate 17 and onto the conveyor 10, which
conveys and elevates the soil to the downstream end 12 of the conveyor 10 where it is discharged onto
the first screen 30. The coulter wheels 38 engage and part the soil on respective opposite sides of the
forward soil engaging scraper plate 8, and direct the parted soil towards the forward soil engaging scraper
plate 8.

The soil at this stage which comprises stones and other matter as well as heavy agglomerated clumps of
soil and soil fines is delivered from the downstream end 12 of the conveyor 10 onto the first screen 30.
The material, typically, stones and other matter of the first predefined size of 150mm and greater are
discharged by the first screen 30 into the storage container 32. Material of size less than the second
predefined size of 150mm passes through the first screen 30 and is deposited on the second screen 35.
The material, typically, agglomerated clumps of soil and other matter of the second predefined size of
20mm and greater is prevented from passing through the second screen 35 and is urged by the second
grading rollers 43 along the second screen 35 to the forward downstream end 37 where it is deposited on
the ground at the forward downstream end 37 of the second screen 35. The soil fines and other matter of
size less that the second predefined size of 20mm which pass through the second screen 35 is then
deposited on top of the material of the second predefined size and greater which has already been
deposited on the ground in advance of the soil fines.

On completion of the treatment of the soil by the apparatus 1, the apparatus 1 is then towed by the tractor
to a suitable location where the stones and other matter are discharged from the storage container 32 by
tipping the storage container 32 by the second ram 34.

Referring now to Figs. 3 to 6, there is illustrated soil screening apparatus according to another
embodiment of the invention, indicated generally by the reference numeral 50. The screening apparatus
50 is substantially similar to the soil screening apparatus 1, and similar components are identified by the
same reference numerals. The main difference between the soil screening apparatus 50 and the soil
screening apparatus 1 is that in the soil screening apparatus 50 a soil loosening element 52 is mounted
on the chassis 2 forwardly of the forward soil engaging scraper plate 8 for breaking up and loosening the
soil prior to engagement of the soil by the forward soil engaging scraper plate 8. The soil loosening
element 52 comprises a driven shaft 54 which is rotatably carried on a pair of spaced apart mounting
brackets 55 which extend in a generally forwardly downwardly direction from a forward portion of the
chassis 2. A rotovating means, namely, a plurality of spaced apart rotovating elements 56 are mounted
fast on the driven shaft 54. Each rotovating element 56 comprises a flange 57 which is mounted fast on the driven shaft 54. A plurality of radially extending ground engaging arms 58 extend in a generally radial direction outwardly from the corresponding flange 57 at equi-spaced apart angular intervals around the flange 57. In this embodiment of the invention five radially extending ground engaging arms 58 extend from each flange 57. Each ground engaging arm 58 terminates in a transversely extending ground engaging member 59 which extends substantially perpendicularly from the corresponding arm 58 and extends substantially parallel to the driven shaft 54 see Figs. 5 and 6. The flanges 57 of the rotovating elements 56 are spaced apart along the driven shaft 54. The rotovating elements 56 are configured on the driven shaft 54 so that the ground engaging arms 58 of adjacent rotovating elements 56 are angularly offset from each other.

The driven shaft 54 is driven by the power-take-off shaft of the tractor or other towing vehicle for rotating the rotovating elements 56 to break up the soil as the apparatus 50 is being towed behind a tractor or other suitable prime mover, so that the soil is broken up by the rotovating element 56 prior to engagement of the soil by the forward soil engaging scraper plate 8.

Otherwise, the soil screening apparatus 50 is similar to the soil screening apparatus 1 and its use is likewise similar.

While the apparatus have been described as comprising first and second screens of a particular type and construction, any other suitable screens may be provided, for example, mesh screens, vibratory screens or the like. While the conveyor has been described as being a slatted conveyor, any other suitable conveyor, for example, a chain slatted conveyor, a plain belt conveyor, a vibrating conveyor or the like may be used. Needless to say, while it is desirable, it is not essential that the angle α of the conveyor relative to the horizontal be adjustable.

While the first and second screens have been described for preventing material of respective first and second predefined sizes and greater passing therethrough of specific values, it will be readily apparent to those skilled in the art, that depending on soil conditions, the spacing between the first and second grading rollers and the spacing between the first and second grading wheels may be varied for altering the respective first and second predefined sizes of material which is prevented from passing through the respective first and second screens.
While the provision of coulter wheels is desirable, it is not essential.

While the screening apparatus have been described with the forward soil engaging element engaging the soil at a depth of approximately 250mm below the surface, by adjusting the angle of inclination $a$ of the conveyor the depth at which the soil engaging element engages the soil may be varied to any desired depth.

Additionally, any other forward soil engaging element besides a plate member may be provided.

It will also be appreciated that other suitable soil loosening means besides a rotovating means may be provided for loosening and breaking up the soil prior to engagement of the soil by the forward soil engaging element, as in the soil screening apparatus of Figs. 3 to 6 besides rotovating elements.

While the apparatus according to the invention has been described for hitching to a tractor or other prime mover, it is envisaged that the apparatus according to the invention could be adapted for mounting on a tractor or other prime mover, for example, the apparatus could be mounted on the front or rear of the tractor or prime mover, and would be carried by the tractor or other prime mover, and typically would be rigidly coupled to the tractor or other prime mover. In which case it is possible that the ground engaging wheels may be dispensed with.
Claims

1. Soil screening apparatus comprising a forward soil engaging element for engaging soil beneath a surface thereof, and for directing soil onto an elevating conveying means in response to the apparatus being moved in a forward direction, a first screening means configured to receive soil from the conveying means and configured to prevent material of a first predefined size and greater passing therethrough, and to pass material of size less than the first predefined size therethrough, and a second screening means configured to receive the material of size less than the first predefined size from the first screening means, the second screening means being configured to prevent material of a second predefined size and greater passing therethrough, and to pass material of size less than the second predefined size therethrough to the ground, the second screening means being further configured to discharge the material of the second predefined size and greater to the ground forward of the location at which the material of size less than the second predefined size is deposited on the ground from the second screening means, so that the material of size less than the second predefined size is deposited on top of the material of the second predefined size and greater as the apparatus is being urged forwardly, the first predefined size of the material being greater than the second predefined size of the material.

2. Soil screening apparatus as claimed in Claim 1 in which the conveying means extends between an upstream end and a downstream end, the soil engaging element being located adjacent the upstream end of the conveying means.

3. Soil screening apparatus as claimed in Claim 1 or 2 in which the downstream end of the conveying means is at an elevated level relative to the upstream end thereof.

4. Soil screening apparatus as claimed in any preceding claim in which the conveying means is inclined upwardly from the upstream end to the downstream end thereof.

5. Soil screening apparatus as claimed in any preceding claim in which the conveying means inclines upwardly from the upstream end to the downstream end at an angle lying in the range of 18° to 27° relative to the horizontal.

6. Soil screening apparatus as claimed in any preceding claim in which the conveying means inclines upwardly from the upstream end to the downstream end at an angle lying in the range of 20° to
25° relative to the horizontal.

7. Soil screening apparatus as claimed in any preceding claim in which the conveying means inclines upwardly from the upstream end to the downstream end at an angle of 22° relative to the horizontal.

8. Soil screening apparatus as claimed in any preceding claim in which the first screening means is located relative to the conveying means for receiving soil from the downstream end of the conveying means.

9. Soil screening apparatus as claimed in any preceding claim in which the first screening means is located adjacent the downstream end of the conveying means.

10. Soil screening apparatus as claimed in any preceding claim in which the first screening means is configured to receive the material from the conveying means under gravity.

11. Soil screening apparatus as claimed in any preceding claim in which the first screening means is located at a level below the level of the downstream end of the conveying means.

12. Soil screening apparatus as claimed in any preceding claim in which the second screening means is located at a level below the level of the first screening means.

13. Soil screening apparatus as claimed in any preceding claim in which the second screening means is configured relative to the first screening means to receive the material of size less than the first predefined size from the first screening means under gravity.

14. Soil screening apparatus as claimed in any preceding claim in which a storage means is provided for receiving and storing the material of the first predefined size and greater from the first screening means.

15. Soil screening apparatus as claimed in Claim 14 in which the first screening means is configured to discharge the material of the first predefined size and greater to the storage means.
16. Soil screening apparatus as claimed in Claims 14 or 15 in which the storage means is located rearwardly of the first screening means.

17. Soil screening apparatus as claimed in any of Claims 14 to 16 in which the storage means is located at a level below the level of the first screening means.

18. Soil screening apparatus as claimed in any of Claims 14 to 17 in which the storage means is configured to be tippable for discharging the material of the first predefined size and greater therefrom.

19. Soil screening apparatus as claimed in any preceding claim in which the first screening means comprises a plurality of spaced apart rotatably mounted first rollers, each first roller comprising a plurality of spaced apart first grading wheels mounted fast thereon, the first rollers being spaced apart from each other so that the radial distance between the circumferential surface of one of the first rollers and the peripheral circumferential surface of the first grading wheels of an adjacent first roller, and the axial longitudinal spacing between adjacent first grading wheels of adjacent first rollers is such as to prevent the material of the first predefined size and greater passing through the first screen, and to permit the material of size less than the first predefined size to pass through the first screen.

20. Soil screening apparatus as claimed in Claim 19 in which the first grading wheels on each of the first rollers extend between adjacent first grading wheels on the adjacent first roller so that the first grading wheels of adjacent first rollers overlap each other.

21. Soil screening apparatus as claimed in Claim 19 or 20 in which the axial spacing between the first grading wheels of each first roller is adjustable.

22. Soil screening apparatus as claimed in any of Claims 19 to 21 in which the radial spacing between adjacent ones of the first rollers is adjustable.

23. Soil screening apparatus as claimed in any of Claims 19 to 22 in which the first rollers are rotatably mounted about first rotational axes, the first rotational axes extending parallel to each other.

24. Soil screening apparatus as claimed in any of Claims 19 to 23 in which the first axes of the respective first rollers lie in a substantially common plane.
25. Soil screening apparatus as claimed in any of Claims 19 to 24 in which the first rollers extend substantially transversely of the direction of normal forward motion of the apparatus.

26. Soil screening apparatus as claimed in any of Claims 19 to 25 in which the first rollers are rotatably driven.

27. Soil screening apparatus as claimed in any preceding claim in which the second screening means comprises a plurality of spaced apart rotatably mounted second rollers, each second roller comprising a plurality of spaced apart second grading wheels mounted fast thereon, the second rollers being spaced apart from each other so that the radial distance between the circumferential surface of one of the second rollers and the peripheral circumferential surface of the second grading wheels of an adjacent second roller, and the axial spacing between adjacent second grading wheels of adjacent second rollers is such as to prevent the material of the second predefined size and greater passing through the second screen, and to permit the material of size less than the second predefined size to pass through the second screen.

28. Soil screening apparatus as claimed in Claim 27 in which the second grading wheels on each of the second rollers extend between adjacent second grading wheels on the adjacent second roller so that the second grading wheels of adjacent second rollers overlap each other.

29. Soil screening apparatus as claimed in Claim 27 or 28 in which the axial spacing between the second grading wheels of each second roller is adjustable.

30. Soil screening apparatus as claimed in any of Claims 27 to 29 in which the radial spacing between adjacent ones of the second rollers is adjustable.

31. Soil screening apparatus as claimed in any of Claims 27 to 30 in which the second rollers are rotatably mounted about second rotational axes, the second rotational axes extending parallel to each other.

32. Soil screening apparatus as claimed in any of Claims 27 to 31 in which the second axes of the respective second rollers lie in a substantially common plane.
33. Soil screening apparatus as claimed in any of Claims 27 to 32 in which the second rollers extend substantially transversely of the direction of normal forward motion of the apparatus.

34. Soil screening apparatus as claimed in any of Claims 27 to 33 in which the second rollers are rotatably driven.

35. Soil screening apparatus as claimed in any preceding claim in which the conveying means comprises a conveyor.

36. Soil screening apparatus as claimed in any preceding claim in which the conveying means comprises a slatted conveyor.

37. Soil screening apparatus as claimed in Claim 36 in which the slats of the conveyor are secured to at least two spaced apart slat carrier belts or chains.

38. Soil screening apparatus as claimed in Claim 36 or 37 in which the slats of the conveyor extend substantially transversely of the direction of normal forward motion of the apparatus.

39. Soil screening apparatus as claimed in any preceding claim in which the conveying means comprises a belt conveyor.

40. Soil screening apparatus as claimed in any preceding claim in which the speed of the conveying means is adjustable for adjusting the linear speed of the conveying means to match the forward speed of the apparatus over the ground.

41. Soil screening apparatus as claimed in any preceding claim in which the forward soil engaging element comprises a hardened steel element.

42. Soil screening apparatus as claimed in any preceding claim in which the forward soil engaging element comprises a plate member of steel material.

43. Soil screening apparatus as claimed in any preceding claim in which the forward soil engaging element comprises a forwardly facing forward soil engaging edge for engaging the soil beneath the
44. Soil screening apparatus as claimed in Claim 43 in which the forward soil engaging edge of the forward soil engaging element extends substantially transversely of the direction of motion of the apparatus.

45. Soil screening apparatus as claimed in any preceding claim in which a soil guide means is mounted on the forward soil engaging element, the soil guide means being configured for directing soil from the forward soil engaging edge of the forward soil engaging element to the conveying means.

46. Soil screening apparatus as claimed in Claim 45 in which the soil guide means comprises a soil directing guide plate, the soil directing guide plate being inclined upwardly from the forward soil engaging element to the conveying means.

47. Soil screening apparatus as claimed in any preceding claim in which the second screening means is located substantially beneath the conveying means.

48. Soil screening apparatus as claimed in any preceding claim in which the first screening means extends rearwardly beyond the conveying means.

49. Soil screening apparatus as claimed in any preceding claim in which a soil loosening element is located forwardly of the forward soil engaging element for breaking up and loosening the soil prior to engagement of the soil by the forward soil engaging element.

50. Soil screening apparatus as claimed in Claim 49 in which the soil loosening element extends transversely across the apparatus.

51. Soil screening apparatus as claimed in Claim 49 or 50 in which the soil loosening element extends transversely across the apparatus substantially the width of the forward soil engaging element.

52. Soil screening apparatus as claimed in any of Claims 49 to 51 in which the soil loosening element comprises a rotovating means.
53. Soil screening apparatus as claimed in Claim 52 in which the rotovating means comprises a plurality of rotovating elements longitudinally spaced apart and fast on a transversely extending driven shaft.

54. Soil screening apparatus as claimed in any preceding claim in which the apparatus is configured for mounting on a forward end of a prime mover.

55. Soil screening apparatus as claimed in any preceding claim in which the apparatus is configured for mounting on a rearward end of a prime mover.

56. Soil screening apparatus as claimed in any preceding claim in which the apparatus is carried on a pair of transversely spaced apart ground engaging wheels rotatably mounted on respective opposite sides of the apparatus.

57. Soil screening apparatus as claimed in Claim 56 in which the ground engaging wheels are located rearwardly on the apparatus.

58. Soil screening apparatus as claimed in any preceding claim in which the apparatus is configured for towing behind a prime mover.

59. A method for screening soil comprising scraping soil from the ground by soil screening apparatus as the apparatus is being urged forwardly, elevating the scraped soil on a conveying means of the apparatus and delivering the scraped soil into a first screening means configured to prevent material of a first predefined size and greater passing therethrough, passing the material of size less than the first predefined size through the first screening means to a second screening means, the second screening means being configured to prevent material of a second predefined size and greater passing therethrough and to permit material of size less than the second predefined size to pass therethrough, depositing the material of size less than the second predefined size on the ground through the second screening means, and depositing the material of the second predefined size and greater on the ground forwardly of the location at which the material of size less than the second predefined size is being deposited on the ground as the apparatus is being urged forwardly.
**INTERNATIONAL SEARCH REPORT**

PCT/IE2015/000004

A. **CLASSIFICATION OF SUBJECT MATTER**

INV. B07B1/00 B07B1/04 B07B1/15 B07B13/16

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)

B07B

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

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

EPO-Internal, WPI Data

C. **DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>paragraph [0023] paragraphs [0026], [0027] paragraph [0029] figure 3a</td>
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