The equipment (1) has been designed primarily for the selective and absolutely damage-free harvesting of mushrooms (2) from nursery beds (3). It is constructed on a mobile frame (7) which is positioned at an appropriate height above the nursery bed (3). This frame (7) is fitted with picking units (12) which are mounted on a rail system (5, 5', 5'') and controlled automatically by a programmed scanning camera (8). The harvested mushrooms (2) are also delivered automatically to the receptacles (10). The scanning camera (8) is a computer vision system. The picking units (12) remove the mushrooms (2) from the nursery beds (3) by means of a rotary suction cup system (24). The mushrooms (2) are cut to size and sorted according to cap diameter.
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EQUIPMENT FOR SELECTIVE HARVESTING OF MUSHROOMS AND OTHER RELATED CROPS.

The invention concerns an equipment for the selective harvesting of mushrooms and related crops from a nursery bed, by which no harvesting damage is caused to the mushrooms, which can be grown obliquely and in clusters.

Similar equipment is known from the Dutch TIL no. 8501733. This equipment is designed for automatic picking of mushrooms cultivated as usual in nursery beds of varying lengths and breadths. The invention as described consists of an automatically controlled car which moves over the nursery bed to observe and determine the size and position of the mushroom to be picked. A video camera is used for observation and picking device for harvesting. According to this patent, this device consists of a sensor and one or more mushroom pickers. The mushroom pickers consist of thin tubes which are guided over the localized mushrooms; within these tubes are adjustable steel wires or strips with which the mushrooms are cut when the tube is rotated 90 degrees. The mushrooms are then removed in a somewhat ambiguous manner by a pusher provided with extremely fine needles.

The mushroom picking equipment described above has certain drawbacks, among which that the thin tube with cutting wire can damage mushrooms grown in clusters and that the pusher with needles used to transport the picked mushroom can damage the cap of the mushroom when it is pulled out. Furthermore, selection on the basis of quality, such as cap diameter and whether the cap/stem junction is open, closed or membranous, is impossible. In short, the equipment described is not suitable for the rapid harvesting of a quality product.

The present invention concerns to remove these drawbacks, whereby such equipment is characterised in that it is constructed onto a near-horizontal frame positioned at a suitable distance above the nursery bed with mushrooms, with at least one scanning camera mounted on a suitable extension.
as well as at least one near-horizontal rail system equipped with at least one picking unit while the rail system at a suitable position under the mushroom harvesting path has an instrument for processing the mushroom stems set up as well as a camera for quality control of harvested mushrooms, while a number of removal systems, depending on the number of mushrooms qualities to be harvested, deliver the product to the appropriate receptacles, while the entire system, from the scanning camera which signals the removal of the mushrooms, is controlled by a specially programmed microprocessor.

Besides the fact that the drawbacks of the design on record have been completely removed, the advantages of the present invention include attainment of an extremely rapid production rate and fewer maintenance problems.

A further development of the equipment in accordance with the invention is, that the above mentioned near-horizontal frame is relatively movable at an appropriate height above the nursery bed, while the frame is on wheels and can be moved along the longitudinal edge of the nursery bed with one of the wheels being driven directly by the microprocessor.

The advantage here is that the device's rate of travel over the nursery bed is incorporated in the total harvesting procedure, i.e. in the software itself.

An additional development included in the equipment in accordance with the present invention is that the scanning camera is part of a "computer vision" system, by which a top view of the diameter and the coordinates of the mushroom's position in the bed is sent to the microprocessor, which in turn via its software guides a picking unit to the reported position and then processes and carries out quality selection on the mushroom concerned.

The advantage here is perfect mushroom harvesting and selec-
Another development included in the equipment in accordance with the invention is that the above-mentioned near-horizontal rail system is, in a preferential version, designed to be endless, consisting of two uprights positioned on a single plane and connected at the extremities by a semicircle, while this endless rail system has a cross-section profile suitable for roller guide rails, with the picking unit on rollers being guided by the programmed microprocessor.

The advantage here is a reliably constructed and therefore also economically sound picking unit path and system.

The equipment in accordance with the present invention has also been designed so that the number of picking units in a preferential version is at least five, while the picking unit consists of a tray mounted on the above-mentioned automatically driven rollers, while a near-vertical guide is mounted on one side of the tray, along which a guide block can be moved on bearings or rollers via a wire or similar flexible element driven by a motor which receives signals from the programmed microprocessor, while a near-horizontal bar with the actual picking instrument is attached to the guide block.

The advantage here is, that the entire picking unit is very efficient.

A further development of the equipment in accordance with the present invention is that a near-vertical rotary shaft is fitted through the above mentioned horizontal bar, with a suction cup and accessories on the end nearest the mushrooms and an electric motor controlled by signals from the microprocessor, on the other end, while the near-vertical rotary shaft can be rotated over an angle of circa 90 degrees by the control signals from the programmed microprocessor. The advantage here is that the mushrooms cannot possibly be
damaged and that picking of harvesting by means of rotation is very efficient, since torsion breakage takes place in the stem rather than the roots of the mushroom and no earth is displaced in the bed to soil the other mushrooms.

Another development of the equipment is, that the above-mentioned processing instrument is knife-shaped.

The advantage here is that the stem is cut in a simple and effective manner.

A further development in accordance with the present invention is that the preferential version is equipped with a pair of endless near-horizontal rail systems (first and second rail systems) with the above-mentioned removal system placed between them, while the picking units on the different rail systems can be moved in opposite directions, while the first rail system with picking units is programmed for harvesting large diameter mushrooms or similar crops and the second is programmed to harvest mushrooms with smaller diameters.

The advantages here are that the picking or harvesting capacity is greatly increased and that selection on the basis of cap diameter is facilitated.

A further development of the equipment is that the above-mentioned microprocessor is programmed so that device automatically locates the mushrooms, cuts them to the proper length, harvests and selects them according to quality, then guides them to the appropriate receptacle.

The advantage here is a fully automated device for harvesting mushrooms and sorting them according to cap diameter and quality.

Then a further development of the equipment is that the above-mentioned near-horizontal rail system can, in another version, consist of a single rail which can be mounted on a
movable frame equipped with at least one scanning camera, while the frame can be moved along the rail and is also equipped with at least one picking unit, whose vertical guide is directed towards the mushrooms in the bed or on a sorting line, while the whole system is controlled by the microprocessor and the picking unit can harvest at least one mushroom at a time.

The advantages here are that the rail can be easily positioned much higher above the nursery bed, so that the device can either pick the mushrooms automatically directly from the bed or the mushrooms can be picked by hand and placed on a sorting line, from which the device, using a much simpler programme, can pick them up and place them in the correct receptacle.

An additional advantage is that manual picking can proceed at double the usual rate, for example via boxes moving past the pickers with a sorting line above. Subsequently, the equipment or apparatus in accordance with the invention will be described below by way of examples with reference to the accompanying drawings where:

fig. 1 shows a top view of a preferential version of the mushroom harvester, relatively movable, installed above a mushroom bed;

fig. 2 shows a top view of another version of the mushroom harvester, relatively movable, installed above a mushroom bed;

fig. 3/4 show other versions of the mushroom harvester, relatively movable, installed above a mushroom bed;

fig. 5 shows a cross-section over line V-V in figures 1, 2, 3 and 4 of the picking unit designed to go with the device;

fig. 6 shows a top view of the device from line VI-VI in figure 5;

fig. 7 shows an oblique view of the rail with roller guide system from the device's endless rail system;

fig. 8 shows a top view of a modified version of the mushroom harvester which can be moved over nursery beds
or boxes;

fig. 9 shows the same as figure 8, but with a sorting line above the moving nursery boxes where hand-picked mushrooms are placed to be sorted by the device into sorting boxes;

fig. 10 shows a cross-section over line X-X in figures 8 and 9 showing the harvester's picking unit directed at the nursery bed;

fig. 11 shows a top view from line XI-XI in figure 10 in accordance with the invention.

Figures 1 and 2 show top views of preferential, second and further versions of the equipment in accordance with the present invention, for selective harvesting of mushrooms 2 from a nursery bed 3. The equipment 1 moves in the direction of the arrow 4 over the nursery bed 3. The harvester is made up of the following main components: one or more harvesting sections 5, 5', a main drive 6 for the harvesting equipment 1, a frame 7, a scanning camera 8 for determining position, diameter and if necessary height of the mushroom to be harvested, a removal system 9 with receptacles 10. The harvesting sections 5, 5' consist of an endless near-horizontal rail system 13, 14 along which the picking units 12 move, entirely under computer control. A scanning camera 8 identifies and locates (determines the position and possible the height and diameter of the mushrooms to be harvested) a mushroom 2, the main drive 6 of the devices 1 is activated by the microporcessor and the equipment 1 moves forward over the nursery bed 3. Meanwhile a computer-controlled picking unit 12 moves to the indicated mushroom coordinates and comes to a halt precisely above the indicated mushroom. Harvest section 5 selectively harvests or picks mushrooms with a cap diameter between 40 and 80 mm and harvest section 5' selectively harvests or picks mushrooms with smaller cap diameters. Picking units 12 and 12' travel on endless rail systems 13 and 13'. The endless rail systems 13 and 13' are made up of a pair of uprights consisting of a rail with roller guide 14 (see figures 5, 6 and 7) on which picking units 12 and 12' move on wheels 15. A gear- or cogwheel 16,
for example, is driven on a rack 30 by an electric motor 17 controlled by the above mentioned microprocessor. The up and down motion of the guide block 18 occurs along the right guide 19 by means of a wire or belt 20, which is driven by the electric motor 21 controlled by the microprocessor. A vertical rotary shaft 23 is attached to the guide block 18, with a suction cup 24 with accessories at one end for picking the mushroom 2. On the other end of the shaft 23 is a microprocessor-controlled electric motor 25 used to rotate the mushroom 90 degrees so that it is separated from its root by torsion breakage.

As shown in figures 1, 2, 3 and 4, the broken mushroom stem is moved to the knife-shaped instrument 26, 26' to be neatly cut, after which a camera 27, 27' examines the mushrooms on the stem side to sort them according to cap-stem junction. This junction can be open, closed or membranous. After this the mushroom, controlled by the microprocessor software, is placed on one of the removal systems 9 to be finally sorted into one of the receptacles 10. A perfect sorting of the mushrooms to be harvested or picked is the result of this procedure. The removal systems 9 can be conveyor belts. The scanning cameras 8, the harvesting sections 13, 13' with all accessories are fitted on the frame 7 mentioned above, which can be equipped with wheels to travel over an edge 29 of the nursery bed 3.

In figures 3 and 4 an optional element 31 is fitted in the rectangular rail 14, 14', by means of which the picking unit 12 can also be rotated 180 degrees on a vertical axis in order to deposit the mushroom 2 on the removal system 9.

In figures 8 and 9, a top view is shown of another modified version of the mushroom harvester. The mushrooms 2 are located in the nursery bed. The harvesting unit consists of a single rail 5", along which a picking unit 12 can be moved. As can be seen in figures 10 and 11, the picking unit 12 harvests the mushrooms 2 directed at the nursery bed below.
In figure 8, the picking unit 12 harvests the mushrooms 2 directly from the nursery bed 3 and lets them drop into the receptacles 10.

In figure 9, the mushrooms are picked by hand 33 and placed in the sorting line 34. The picking unit 12 takes up at least one mushroom 2 each time and sorts it into the receptacles 10. In this version the processor instrument 26 can be rotary blades.

There should be a final mention, that the text stated above, gives a preferential construction and it goes without saying that modifications are possible without abandoning the protection limits of this patent specification.
1. Equipment for selective harvesting of mushrooms and similar plants from a nursery bed, by which the mushrooms suffer practically no harvesting damage and can be grown obliguely and in clusters, characterized in that the equipment (1) is constructed onto a near-horizontal frame (7) positioned at a suitable distance above the nursery bed (3) with mushrooms (2), with at least one scanning camera (8) mounted on a suitable extension, as well as at least one near-horizontal rail system (5, 5', 5") equipped with at least one picking unit (12) while the rail system (5, 5', 5") at a suitable position under the mushroom harvesting path, has an instrument for processing the mushroom stems (26) set up as well as a camera for quality control of harvested mushrooms (2) while a number of removal systems (9), depending on the number of mushroom qualities to be harvested, deliver the product to the appropriate receptacles (10) while the entire system, from the scanning camera (8) which signals the removal of the mushrooms (2), is controlled by a specially programmed microprocessor.

2. Equipment as claimed in claim 1, wherein the above mentioned near-horizontal frame (7) is relatively movable at an appropriate height above the nursery bed (3), while the frame is on wheels (28) and can be moved along the longitudinal edge (29) of the nursery bed (3), with one of the wheel being driven directly by the microprocessor.

3. Equipment as claimed in claim 1, wherein the scanning camera (8) is part of a "computer vision" system, by which a top view of the diameter and the coordinates of the mushroom's (2) position in the bed (3) is sent to the microprocessor, which in turn via its software guides a picking unit (12) to the reported position (2) and then processes and carries out quality selection on the mushroom concerned.
4. Equipment as claimed in claim 1, wherein the above-mentioned near-horizontal rail system (5,5',5'') is, in a preferential version, designed to be endless, consisting of two uprights positioned on a single plane and connected at the extremities by a semicircle.

5. Equipment as claimed in claim 4, wherein the above-mentioned endless rail system (13,13') has a cross-section profile suitable for roller guide rails, with the picking unit (12) on rollers (15) being guided by the programmed microprocessor.

6. Equipment as claimed in claims 1 and 5, wherein the number of picking units (12) for a preferential version is at least five.

7. Equipment as claimed in claims 1, 3 and 6, wherein the picking unit (12) consists of a tray (17) mounted on the above mentioned automatically driven rollers (15) while a near-vertical guide (19) is mounted on one side of the tray, along which a guide block (18) can be moved on bearings or rollers via a wire (20) or similar flexible element driven by a motor (21) which receives signals from the programmed microprocessor, while a near-horizontal bar (22) with the actual picking instrument is attached to the guide block.

8. Equipment as claimed in claim 7, wherein the above-mentioned horizontal bar (22) can be rotated on its axis via computer control.

9. Equipment as claimed in claim 7, wherein a near-vertical rotary shaft is fitted through the above-mentioned horizontal bar (22), with a suction cup (24) and accessories on the end nearest the mushrooms (2) and an electric motor (25), controlled by signals from the microprocessor, on the other end.
10. Equipment as claimed in claim 9, wherein the near-vertical rotary shaft can be rotated over an angle of approx. 90 degrees by the control signals from the programmed microprocessor.

11. Equipment as claimed in claim 1, wherein the described processing instrument (26) is knife-shaped.

12. Equipment as claimed in claim 1, wherein the described processing instrument (26) is scissor-shaped.

13. Equipment as claimed in claim 1, wherein the described processing instrument (26) is a set of rotary blades.

14. Equipment as claimed in claim 1, wherein the preferential version is equipped with a pair of endless near-horizontal rail systems (first and second rail systems) with the above mentioned removal system placed between them, allowing the picking units on the different rail systems to be moved in opposite directions.

15. Equipment as claimed in claims 1 to 4, wherein an alternate version is equipped with a pair of endless near-horizontal rail systems (first and second rail systems) on which the picking units (12) move in the same direction and where the above-mentioned removal system is located towards the end of the second rails system.

16. Equipment as claimed in claims 14 and 15, wherein the first rail system with picking units (12) is programmed for harvesting large diameter mushrooms (2) or similar crops and the second is programmed to harvest mushrooms with smaller diameters.

17. Equipment as claimed in claim 16, wherein the larger mushroom diameter is at least 40 mm and the smaller diameter less than the aforesaid 40 mm.

18. Equipment as claimed in claim 1, wherein the nursery bed
(3) is relatively movable under the described device.

19. Equipment as claimed in the foregoing claims, wherein the above-mentioned microprocessor is programmed so that the described device automatically locates the mushrooms, harvests and cuts them to the proper length, selects them according to quality, then guides them to the appropriate receptacle.

20. Equipment as claimed in claim 19, wherein mushroom selection is based on cap diameter and on camera (8) views of the opened, closed or membranous quality of the underside.

21. Equipment as claimed in claims 1 to 4, wherein the above-mentioned near-horizontal rail system in another version consists of a pair of uprights positioned on a single plane at a suitable distance from and parallel to each other with a so-called optional element (31) fitted onto the extremities between them.

22. Equipment as claimed in claims 1, 3, 4, 5, 7 and 21, wherein the above-mentioned tray with vertical guide can be rotated over approx. 180 degrees on a vertical axis.

23. Equipment claimed in claim 1, wherein the above-mentioned near-horizontal rail system (5") can, in another version, consist of a single rail (5") which can be mounted on a movable frame (7) equipped with at least one scanning camera (8); that the frame can be moved along the rail (5") and is also equipped with at least one picking unit (12), whose vertical guide (19) is directed towards the mushrooms (2) in the bed or on a sorting line (34); and that the whole system is controlled by a microprocessor.

24. Equipment as claimed in claim 23, wherein at least one mushroom (2) can be picked at a time by the above-mentioned picking unit (12).
### International Search Report

**International Application No.** PCT/NL 91/00024

### I. Classification of Subject Matter

According to International Patent Classification (IPC) or to both National Classification and IPC:

- **Int.Cl. 5**
- **A01D 045/00**

### II. Fields Searched

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

### III. Documents Considered to be Relevant

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### IV. Certification

Date of the Actual Completion of the International Search: 16 MAY 1991

Date of Mailing of this International Search Report: 25.06.91

International Searching Authority: EUROPEAN PATENT OFFICE

Signature of Authorized Officer: DE LAMEILLIEURE
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