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(54) **Machine with artificial sight for automatic separation by colour of recyclable plastics, with multispectral sight**

(57) The machine with artificial vision for automatic separation by colour of recyclable plastic, with multispectral vision, which uses the ultraviolet, visible and infrared zones of the spectrum simultaneously, at wavelengths of less than 400nm, between 400 and 700nm, and greater than 700nm., obtaining for each piece of plastic analysed its spectrogram, which is specific to each type of plastic.

The machine as a whole is made up of a conveyer

belt (1) for the plastics to be analysed, a line module (2) where the multispectral lighting and vision systems are located for image intake, an electronic control module with tactile screen (5) where processing cards are located, a computer system that carries out the multispectral analysis of the pieces of plastic and an electronic interface for controlling the expulsion electrovalves (4), a blowing system (3), and material conveyer belts (7) for extracting the main flow and the separated components.

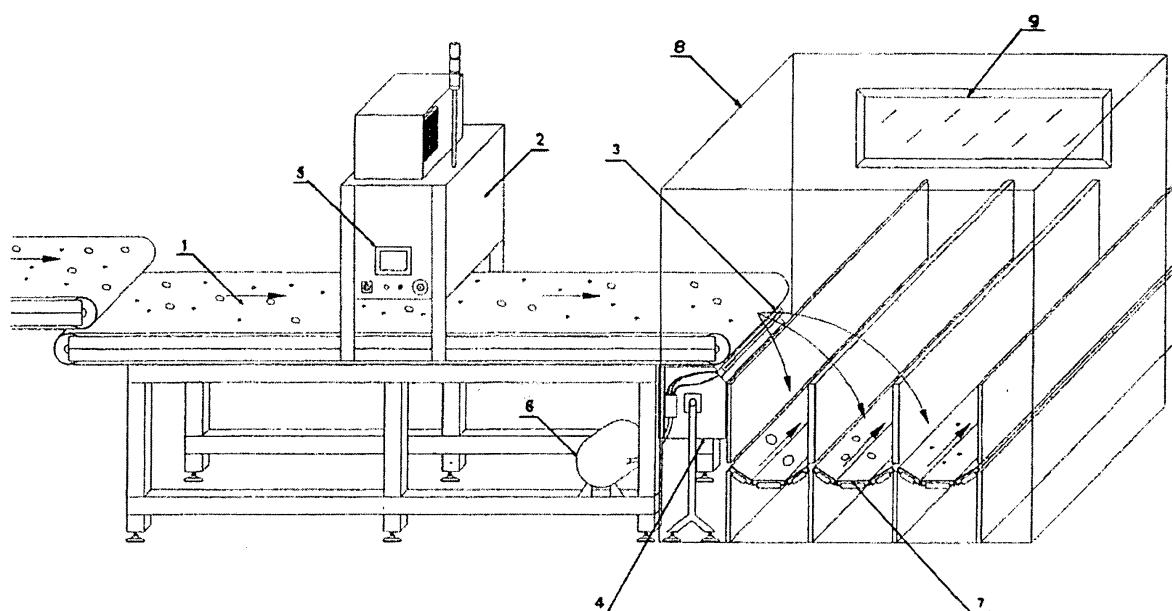


FIG. 1

Description**OBJECT OF THE INVENTION**

[0001] The object of the present invention is related to a machine with artificial vision for automatic separation of coloured plastic, based on multispectral vision analysis technology, which uses the ultraviolet, visible and infrared zones of the spectrum simultaneously, at wavelengths of less than 400nm, between 400 and 700nm, and greater than 700nm. The spectrogram of each part analysed is obtained, which is specific to each type of plastic, facilitating its separation. The pneumatic extraction system with its blower bar facilitates separating more than one component.

BACKGROUND OF THE INVENTION

[0002] Nowadays, plastic that proceeds from urban residue recycling consists above all of different coloured packaging of a variety of compositions. Normally, plastic packaging is found made of PE, PP, PVC, PET, etc., and they can all be different colours.

[0003] The main problem is to classify the plastic according to its composition, that is, by type of plastic, for instance, differentiating PVC from PET, whether or not they are the same colour, etc., which implies clearly identifying each type of plastic, and doing this despite the packaging being soiled to different degrees and having different coloured labels.

[0004] Machines can be found on the market based on artificial vision technology and which function within the visible spectrum, that is, they carry out analysis with lighting systems and cameras within the range of 400nm to 700nm wavelengths. With this, plastics can be separated by colour but not by composition. These machines carry out automatic separation of plastics by colour by way of analysing the colour, combined with a pneumatic blowing extraction system. In these machines the vision system acts on the extraction system to separate the colour chosen depending on the circumstances.

[0005] There is another type of machine based also on artificial vision that functions within the infrared zone of the spectrum, that is, with wavelengths of over 700nm. With them, some plastics can be separated by composition, but not all of them can be reliably separated.

[0006] On the other hand, all of the machines currently on the market can only separate a maximum of one type of plastic at each pass by way of a blower bar.

[0007] This leads us to the conclusion that the limitations of the current applications based on artificial vision are due to two factors: firstly, in order to analyse the parts the visible range of the spectrum is used or, at most, the infrared range, so that the possibility of identifying different types of plastic are limited and are not reliable; secondly, at each pass only one component can be separated by way of a blower bar.

[0008] It is, thereby, desirable that a machine with artificial vision for automatic separation of recyclable plastic should be provided that overcomes the drawbacks and faults of the currently available machines, particularly, to improve the separation possibilities and reliability for different types of plastic, and that can separate more than one component at each pass, leading to much greater efficiency and lower costs of the separation.

[0009] A machine with said characteristics is disclosed below and claimed in claim 1.

DESCRIPTION OF THE INVENTION

[0010] In order to solve and improve the limitations of the technology used by existing machines that apply artificial vision, a machine with artificial vision for automatic separation by colour of recyclable plastic with new multispectral analysis technology that uses ultraviolet, visible and infrared zones of the spectrum simultaneously, that is, wavelengths lower than 400nm, between 400 and 700nm and over 700nm. Thereby, a spectrogram is obtained of each part analysed, specific to each type of plastic, and thus the separation possibilities and reliability for each different kind of plastic are much greater. This also has beneficial effects on eliminating environmental pollution, and facilitates using the materials for recycling at a later stage. On the other hand, the machine of the invention is provided with a pneumatic extraction system made up of a blower bar that can separate more than one component at each pass, leading to much greater efficiency and lower costs of the separation.

[0011] The machine of the invention comprises:

- A vibrating input system or conveyer belt for transporting the plastic to be analysed (packaging or pieces of plastic);
- A line module located within a sealed, dustproof case positioned bridging over the conveyer belt, where the multispectral light system and the multispectral vision system for image intake are situated, which uses the ultraviolet, visible and infrared zones of the spectrum simultaneously at wavelengths of less than 400nm, between 400 and 700nm and greater than 700nm, with automatic temperature control; the vision system may have one or several cameras depending on the type of material to be separated;

- A control module, which makes up a separate unit from the line module and is located within said sealed, dustproof case, in which a computer system is contained for processing and analysing the images made by the multispectral analysis of the pieces of plastic, the electronics (processing cards), an electronic interface for commanding the output electrovalves in the extraction system, and a tactile screen where the number of parts separated is registered and the shift statistics, type of material being separated, etc.
- A pneumatic extraction system for removing pieces, made up of a blower system that consists of a blower bar, a pneumatic electrovalve system and a compressed air chamber, located at the end of the vibrating input system or conveyer belt, which is reached by the corresponding electrical signals proceeding from the electronic cards that are connected to the computer system;

[0012] The machine, by way of the vision system, identifies the type of plastic to be separated based on multispectral analysis, that is, on the spectrogram of each piece.

[0013] Within the process, if the result of the analysis is that the piece should be extracted from the main flow, an order is sent by way of the electronic cards for activating the pneumatic output electrovalves.

[0014] Once the pieces to be separated have been identified, they are blown with air from the compressed air chamber by the pneumatic extraction system.

[0015] One of the innovation that this machine offers is that the blower bar facilitates separating more than one type of plastic at a time, which is possible thanks to the use of either of the two possible embodiments of the pneumatic extraction system: a) using a single type of pneumatic electrovalves and regulating the flow and pressure of each blow the pieces can be moved different distances depending on the type of plastic, and b) in another embodiment, using different types of valves with regards their air flow and blow pressure and alternating them with a mechanical determining device according to the pieces to be separated.

[0016] The pieces separated by blowing are gathered on conveyer belts or in different containers that the machine provides in the final process. These final conveyer belts or containers are inside a booth in order to prevent the selected plastics from falling off said belts; said booth is provided with a display window as well as an opening on its lower side as an exit for the extraction conveyer belts.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] For an improved understanding of the invention, a preferred embodiment of this invention is provided below, accompanied by the attached, non-limiting and illustrative drawings:

- Figure 1 shows a perspective view of a preferred embodiment of the machine with artificial vision for automatic separation of recyclable plastic with multispectral vision of the invention, where the conveyer belt (1), the sealed case that houses the line module (2) and the control module where the tactile screen is located (5), the pneumatic extraction system for pieces with its system of electrovalves (4), the chamber for storing compressed air (6) and the blower system (3), the set of conveyer belts or containers for extraction from the main flow and of the separate components (7), the booth (8) and the window (9) for viewing the plastic;
- Figure 2 shows a lengthways raised lateral view of the machine with artificial vision for automatic separation of recyclable plastic with multispectral vision of the invention, displaying the configuration of all of the equipment, its location, the entrance for the material deposited on the conveyer belt, and its collection once it has been selected.
- Figure 3 shows a plane view of the machine with artificial vision for automatic separation of recyclable plastic, in which the exit of the already selected material can be seen.

PREFERRED EMBODIMENT OF THE INVENTION

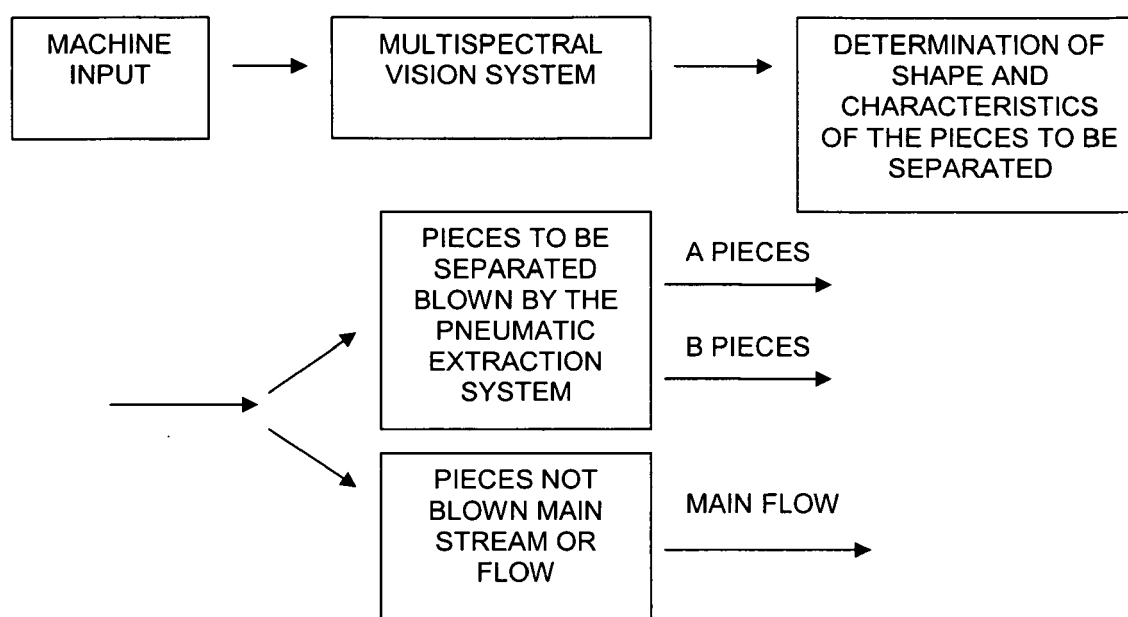
[0018] Shown in Fig. 1 is a preferred embodiment of the assembly that makes up the machine with artificial vision for automatic separation of recyclable plastic with multispectral vision of the invention that uses ultraviolet, visible and infrared zones of the spectrum simultaneously, at wavelengths of less than 400nm, between 400 and 700nm and greater than 700nm.

[0019] The machine consists of a conveyer belt (1), line module (2), control module with tactile screen (5) and pneumatic extraction system (4) for removing pieces. The system is completed with a drum (6) for storing compressed air and one or several separating walls depending on the number of components to be separated at one pass, all of them being adjustable in inclination and height.

[0020] Fig. 1 shows the machine as a whole, in which the conveyer belt (1), vibrator, carries the plastic to be analysed (packaging or pieces of plastic). On the conveyer belt (1) a sealed, dustproof case IP65 is situated, containing a line module (2) in which the multispectral lighting system and the multispectral vision system for processing and analysing images; the control module with the tactile screen (5) is also located in said sealed case. At the end of the conveyer belt

(1) is the blower system (3) where the blower bar is located and the pneumatic electrovalve system (4). The system of pneumatic electrovalves (4) is made up of different types of valves. As for the pneumatic extraction system in a preferred embodiment it is made up of different types of valves as regards the flow and pressure according to the number of components to be separated. These valves are alternated so as to create a blow resolution in the blower bar according to the type and sizes of the pieces to be separated. The system is completed with a chamber (6) for storing compressed air and one or several separating walls according to the number of plastics to be separated in a single pass, all being adjustable in inclination and height. The separated material is collected on the conveyer belts (7) for extracting the main flow and the separated plastics. These conveyer belts (7) are covered by a booth (8) so as to prevent the pieces (plastics) from going outside the collection area, this booth (8) including an inspection window (9) as well as an opening on its lower side as an exit for the extraction conveyer belts (7).

[0021] In order to complement the preferred embodiment a block diagram is shown of the operating mode of the machine with artificial vision for separating recyclable plastics with multispectral vision.



[0022] Having sufficiently described the nature of the present invention, as well as a preferred embodiment of the same, it only needs to be added that modifications may be introduced in its shape, materials and disposition, as a whole and the in parts of which it is composed, as long as said alterations do not substantially affect the characteristics of the invention as claimed below.

Claims

1. Machine with artificial vision for automatic separation by colour of recyclable plastics, **characterized in that** it comprises:

- A vibrating input system or conveyer belt (1) for transporting the plastics to be analysed (packaging or pieces of plastic);
- A line module (2) located inside a sealed, dustproof case with automatic temperature control and positioned bridged over said conveyer belt (1), where a multispectral lighting system and a multispectral vision system for image intake are located, which use ultraviolet, visible and infrared zones of the spectrum simultaneously, at wavelengths of less than 400nm, between 400 and 700nm, and greater than 700nm; said vision system having optionally one or several cameras depending on the type of material to be separated;
- A control module with tactile screen (5), that forms a unit separate from said line module (2) and is located within said sealed, dustproof case, in which a computer system is contained for processing and analysing images obtained by said line module (2), processing cards, an electronic interface for controlling a set (4) of electrovalves for expelling the separated pieces of plastic; and

- A pneumatic extraction system for removing pieces made up of a blower system (3) that consists of a single blower bar for separating more than one type of plastic simultaneously, a set (4) of pneumatic electrovalves and a deposit of compressed air (6), located at the end of the vibrating input system of conveyer belt (1), said set (4) of pneumatic electrovalves receiving electrical signals proceeding from said electronic cards that are connected to said computer system.

2. Machine with artificial vision for automatic separation by colour of recyclable plastics according to claim 1, **characterized in that** the vision system has one or several cameras depending on the type of material to be separated.
3. Machine with artificial vision for automatic separation by colour of recyclable plastics according to claim 1, **characterized in that** the separated materials are collected on conveyer belts (7) covered by a booth (8) so as to prevent the pieces (plastics) from going out of the collection area, this booth (8) including an inspection window (9) as well as an opening on its lower side as an exit for the extraction conveyer belts (7).
4. Machine with artificial vision for automatic separation by colour of recyclable plastics according to claim 1, **characterized in that** said set of pneumatic electrovalves (4) is made up of a single type of pneumatic electrovalves that regulate the flow and the pressure of each blowing so as to send the selected pieces to different points depending on the type of plastic.
5. Machine with artificial vision for automatic separation by colour of recyclable plastics according to claim 1, **characterized in that** said set of pneumatic electrovalves (4) is made up of different types of valves with regards to the air flow and blow pressure alternated in accordance with the size of the pieces to be separated.

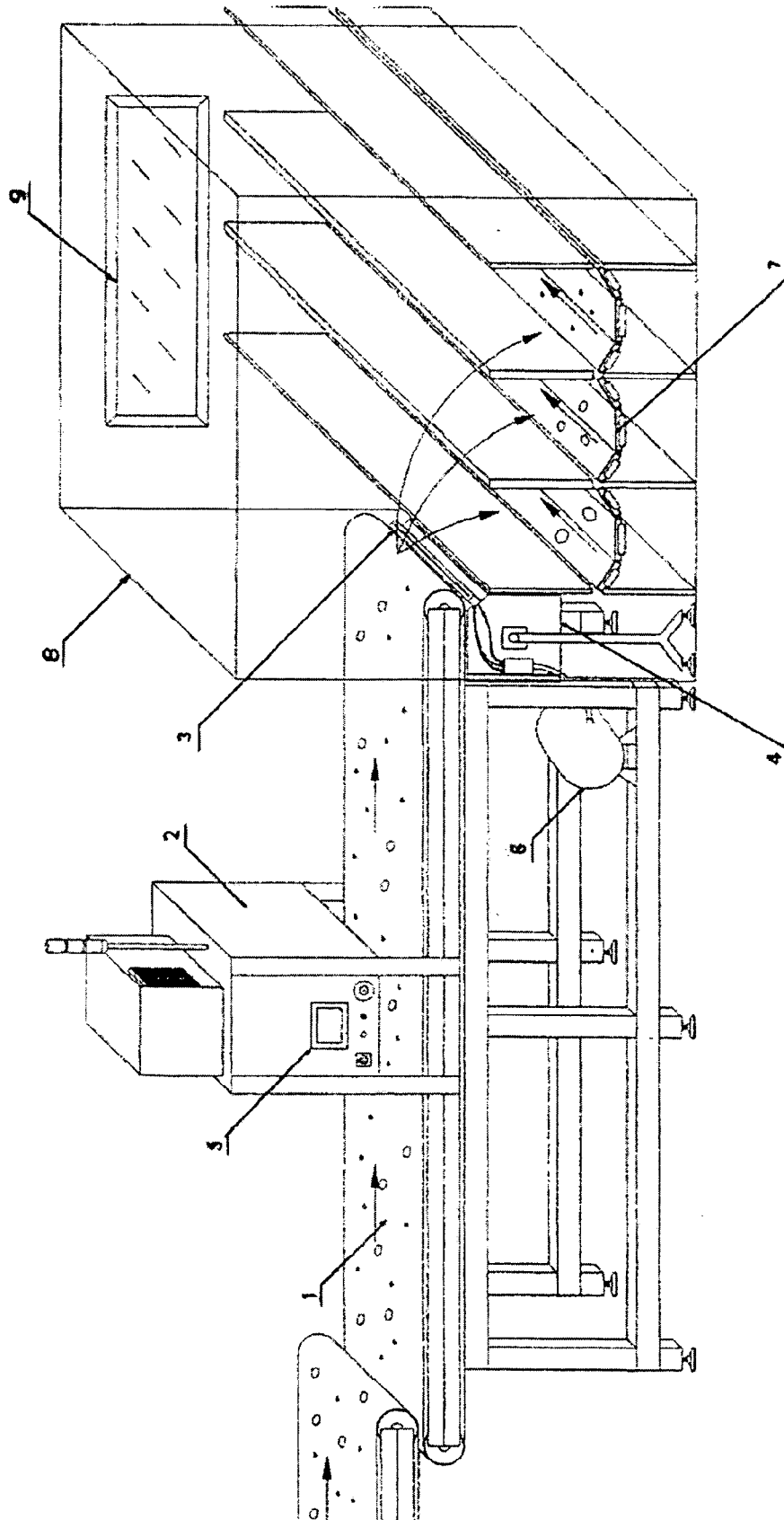


FIG. 1

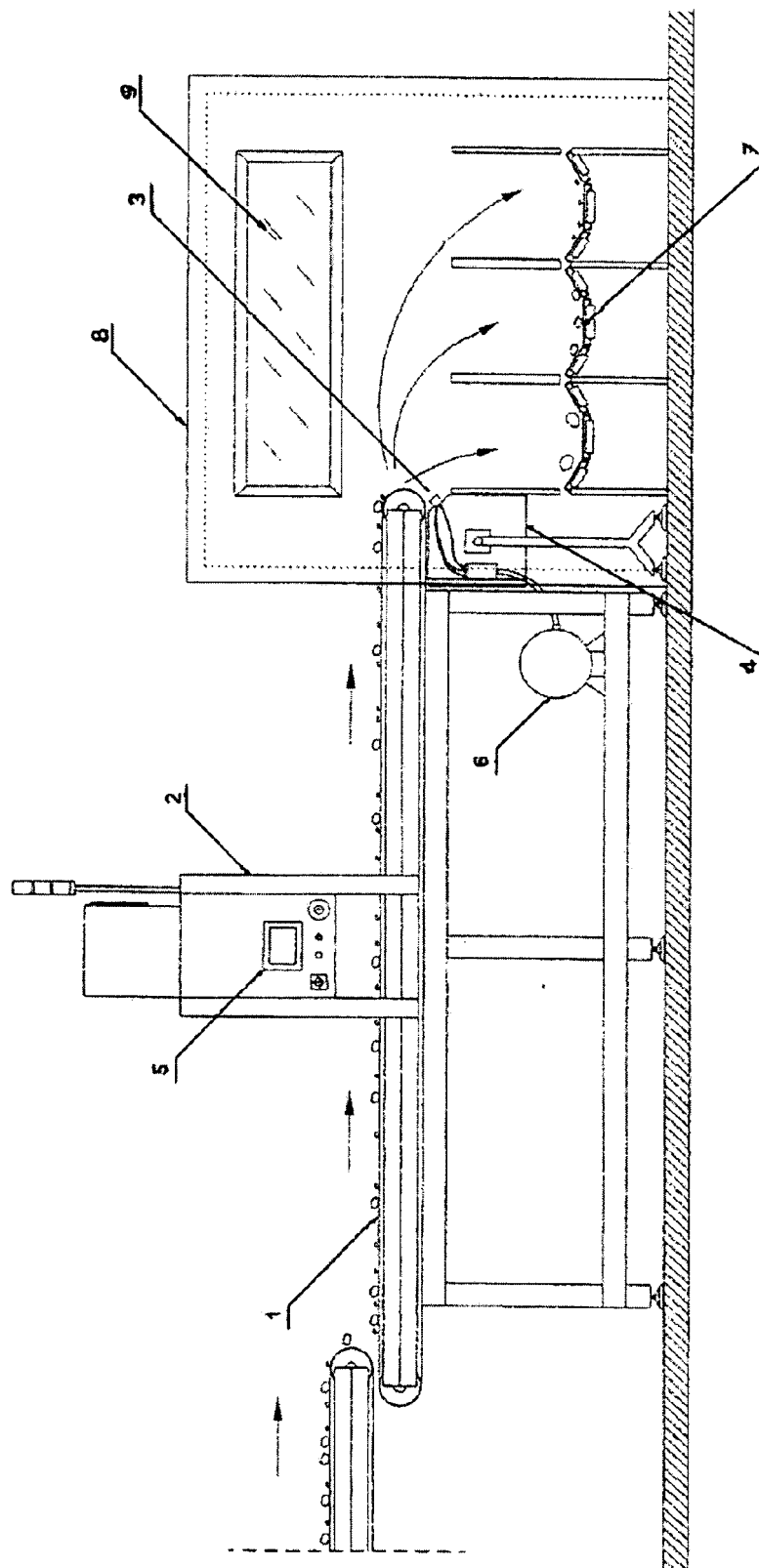


FIG.2

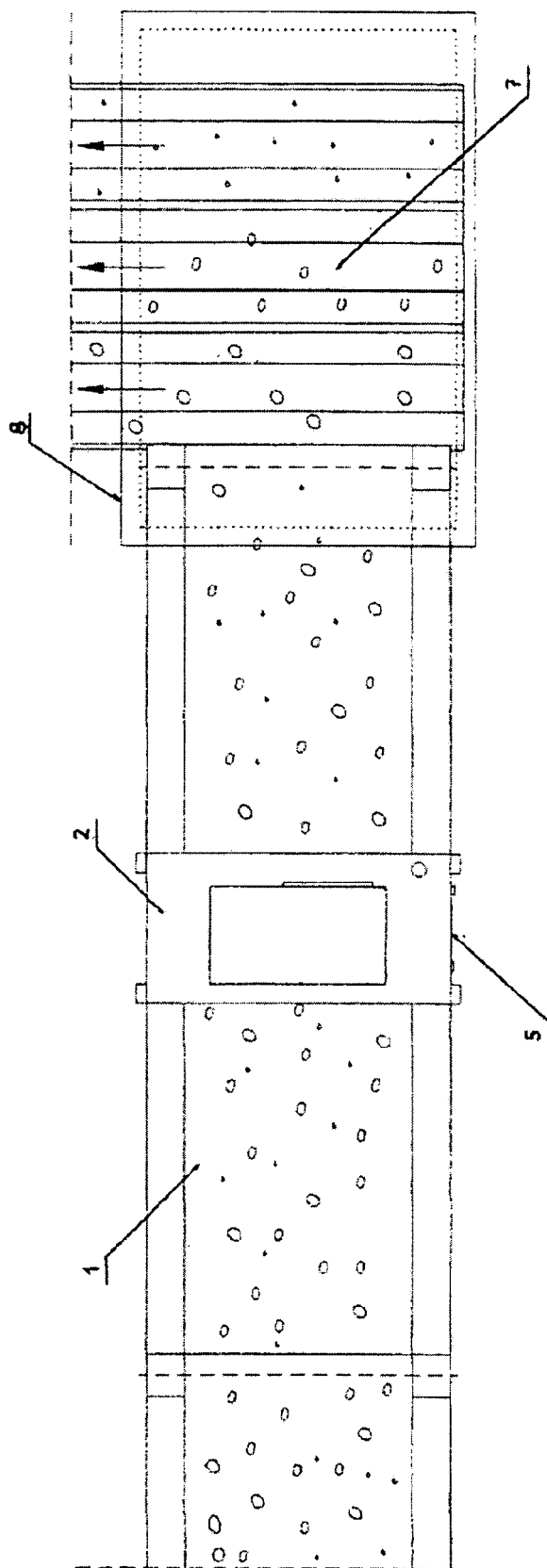


FIG.3