AUTOMATIC CLEANING SYSTEM

Technical Field

The present invention relates to the field of construction technology, and in particular to an automatic cleaning system.

Technical Background

In the construction field, a hopper is usually used as a transportation carrier for cement concrete. However, after the hopper is used, it needs to be cleaned to remove materials remaining therein. Currently, the hopper is usually cleaned in a manual manner, causing low operation efficiency and low safety.

Summary of the Invention

The present invention aims to provide an automatic cleaning system, whereby operation efficiency and safety for cleaning a hopper can be both improved, and an operation process with a high degree of automation can be achieved.

The technical solution of the present invention proposes an automatic cleaning system, comprising four stations uniformly distributed along a circumferential direction, and a central circulation device located in the middle of the four stations. The central circulation device includes: an integral support and rail mechanism, a main planetary drive mechanism rotatable on the integral support and rail mechanism, and four hopper carrying devices arranged on the main planetary drive mechanism, wherein said four hopper carrying devices are used to carry a hopper, and driven by the main planetary drive mechanism to move in cycles, so as to enter the four stations in sequence. Said four stations include a first station located under a material feeding device and provided with a weighing mechanism, a second station provided with a lifting platform mechanism, a third station provided with a hopper opening mechanism, and a fourth station is provided with a further hopper opening mechanism and a cleaning mechanism. The first station is configured to load a hopper with

materials, if a cleaned hopper reaches the first station from the fourth station in a current cycle, weigh the hopper through the weighing mechanism, stop to load the hopper when the hopper reaches its designated weight, and circulate the loaded hopper to the second station in a next cycle. The second station is configured to take away a hopper to be cleaned, which is carried by a carrier vehicle, from the carrier vehicle by the lifting platform mechanism, if there is no hopper at the second station in the current cycle, and circulate the hopper to be cleaned to the third station then in the next cycle; or, pick up the loaded hopper by the lifting platform mechanism to the carrier vehicle, if the loaded hopper circulated from the first station is in the second station in the current cycle. The third station is configured to open the hopper to be cleaned through the hopper opening mechanism located at the third station, if the hopper to be cleaned reaches the third station from the second station in the current cycle, for removing remaining materials in the hopper, and circulate the hopper to be cleaned to the fourth station in the next cycle. The fourth station is configured to open the hopper to be cleaned through the further hopper opening mechanism located at the fourth station if the hopper to be cleaned reaches the fourth station from the third station in the current cycle, clean the hopper to be cleaned through a high pressure water stream sprayed from a cleaning mechanism, and circulate the cleaned hopper to the first station in the next cycle.

In order to facilitate consistent control and realize uniform operation of the whole process, the system may be provided with an electric control box, which can collectively control the central circulation device and all of the mechanisms or devices of the four stations. In the electric control box a PLC may be provided as a main controller.

In a possible implementing mode, the integral support and rail mechanism includes a support member with a round rail, a gear arranged at a center of the support member, a hydraulic motor for driving the gear, and an encoder. The main planetary drive mechanism includes an integral bracket with a driven wheel arranged at a center thereof, wherein the integral bracket has four ends corresponding to said four stations, respectively, a bottom surface of each of the ends being provided a moving wheel running on the round rail, and wherein the driven wheel is in engagement with the gear and driven thereby, for realizing rotation of the integral bracket. Four hopper

carrying devices are respectively arranged on said four ends of the integral bracket, respectively, wherein each hopper carrying device includes a liftable platform, which is detachably mounted at a corresponding one of the four ends, and provided with a plurality of limit block assemblies for positioning the hopper placed thereon.

In a possible implementing mode, the weighing mechanism includes an electronic scale and a hydraulic cylinder which is able to lift the electronic scale. The hydraulic cylinder is configured to lift, when it is necessary for weighting, the electronic scale, the hopper carrying device together with the hopper carried thereby, so that the hopper is weighed by the electronic scale.

In a possible implementing mode, the weighing mechanism further includes a main body support frame, on a top of which a plurality of first copper sleeves are arranged, wherein multiple guiding shafts are movably arranged in said first copper sleeves respectively, with the electronic scale being mounted on top ends of the guiding shafts. A position sensing sheet is arranged at a lower end of at least one of the guiding shafts, and the main body support frame is further provided with an ascending in-position sensor and a descending in-position sensor that are both in cooperation with the position sensing sheet.

In a possible implementing mode, the lifting platform mechanism includes a lifting device movable along a vertical direction, a hydraulic cylinder for driving the lifting device to move up and down through a connector, and a support for supporting the lifting device and the hydraulic cylinder. The support is further provided with a descending sensor for detecting whether the lifting device descends to a designated position, and an ascending sensor for detecting whether the lifting device ascends to a corresponding designated position.

In a possible implementing mode, the second station is further provided with a blocking mechanism for blocking and positioning the main planetary drive mechanism. The blocking mechanism includes a fixed stand, which is provided with a second copper sleeve, in which a blocking shaft is arranged, an air cylinder for lifting or lowering the blocking shaft, and an ascending in-position sensor and a descending in-position sensor both for detecting movement of the blocking shaft, which blocks

and positions the main planetary drive mechanism when being lifted. The main planetary drive mechanism is provided with at least one cushioning rubber column in cooperation with the blocking shaft.

In a possible implementing mode, the hopper opening mechanism comprises a hook opening push block driven by a cylinder, for pushing open a hook of the hopper, a hopper opening arm driven by a motor, for pressing or pushing a linkage mechanism of the hopper to open or close a hopper port, a sensor for detecting whether the cylinder moves forward or backward, and a sensor for detecting a position of the hopper opening arm when it is moving.

In a possible implementing mode, the hook opening push block is provided at front ends of two push rods, which are arranged in two linear bearings respectively. A spring is wound around each push rod between the hook opening push block and a corresponding linear bearing. Said two linear bearings are fixed to a slidable base arranged on a sliding rail, so that the slidable base is driven by a cylinder to move on the sliding rail, thus driving the hook opening push block to move.

In a possible implementing mode, the cleaning mechanism includes a hopper cover for covering the hopper port, a nozzle for spraying a high pressure water flow to the hopper, a water pipe joint connected to the nozzle, a lifting cylinder for driving the nozzle and the hopper cover to move up and down, and an ascending in-position sensor and a descending in-position sensor both for detecting movement of the lifting cylinder.

In a possible implementing mode, each of said four stations is further provided with a hopper in-position sensor for detecting whether the hopper is in place.

It can be seen from the foregoing that the embodiments of the present invention have the following advantages. The automatic cleaning system according to the present invention is provided with four stations, including the first station for loading and weighing materials, the second station for supplying and receiving the hopper, the third station for cleaning remaining materials in the hopper, and the fourth station for cleaning the hopper. In the system, the hopper is circulated among the four stations

through the central circulation device and seamlessly connected with the carrier vehicle and the material feeding device, thus realizing a fully automatic operation process including receiving the hopper, cleaning the hopper, loading materials into the hopper, and conveying the hopper. In this manner, operation efficiency and safety can be both improved.

The system also has the following characteristics. First, the hopper and the carrier vehicle are separate from each other, thus do not affect each other. While the hopper is cleaned, the carrier vehicle can still be in operation, thus improving efficiency of transportation. Second, the four stations can be in operation at the same time, without conflict with each other. Thus, operation time is saved and efficiency is improved. Third, if during use any one of the hoppers is out of order, only said hopper needs to be removed, without affecting other stations. Fourth, the amount of concrete for production can be weighed according to actual needs, so that materials can be accurately supplied with no concrete wasted.

Brief Description of the Drawings

In the following, the drawings that are necessary for illustrating the embodiments and the prior arts will be briefly introduced, in order to explain the technical solutions of embodiments of the present invention more clearly. In the drawings:

Figure 1 schematically shows, in an exploded manner, the structure of an automatic cleaning system according to an embodiment of the present invention;

Figure 2 schematically shows the overall structure of the automatic cleaning system according to the embodiment of the present invention;

Figure 3 schematically shows the structure of a weighing mechanism according to the embodiment of the present invention;

Figure 4 schematically shows the structure of a lifting platform mechanism according to the embodiment of the present invention;

Figure 5 schematically shows the structure of a blocking mechanism according to the embodiment of the present invention;

Figure 6 schematically shows the structure of a hopper opening mechanism according to the embodiment of the present invention;

Figure 7 schematically shows the structure of a cleaning mechanism according to the embodiment of the present invention;

Figure 8 schematically shows the structure of an integral support and rail mechanism according to the embodiment of the present invention; and

Fig. 9 schematically shows the structure of a main planetary drive mechanism and a hopper carrying device according to the embodiment of the present invention.

Detailed Description of the Embodiments

In order to enable those skilled in the art to better understand the technical solutions of the present invention, the technical solutions of the embodiments of the present invention will be described clearly and completely with reference to the accompanying drawings in the embodiments of the present invention. Obviously, the embodiments as described are only part of, rather than all, the embodiments of the present invention. All other embodiments obtained by those ordinarily skilled in the art based on the embodiments of the present invention provided here but without creative labor shall fall within the scope of protection of the present invention.

In the following, the present invention will be further illustrated with reference to specific embodiments.

With reference to Figures 1 and 2, an embodiment according to the present invention provides an automatic cleaning system. The system includes four stations that are uniformly distributed along a circumferential direction, and a central circulation device located in the middle of the four stations. The central circulation device can drive a hopper to move in cycles, thus entering the four stations in

sequence. The four stations include a first station for loading and weighing materials, a second station for supplying and receiving the hopper, a third station for cleaning remaining materials in the hopper, and a fourth station for cleaning the hopper. In the system, the hopper is circulated among the four stations through the central circulation device, thus realizing a fully automatic operation process including receiving the hopper, cleaning the hopper, loading materials into the hopper, and conveying the hopper. In this manner, operation efficiency and safety can be both improved.

The central circulation device includes: an integral support and rail mechanism 5, a main planetary drive mechanism 4 rotatable on the integral support and rail mechanism 5, and four hopper carrying devices 6 arranged on the main planetary drive mechanism 4. The four hopper carrying devices 6 are used to carry the hopper, and driven by the main planetary drive mechanism 4 to move in cycles, so as to enter the four stations in sequence.

In the four stations, the first station is located under a material feeding device, and provided with a weighing mechanism 1. The second station is provided with a lifting platform mechanism 2. The third station is provided with a hopper opening mechanism 7. The fourth station is provided with another hopper opening mechanism 7, and a cleaning mechanism 8. The functions of these stations are as follows.

The first station is a station for loading materials and weighing. If a cleaned hopper reaches the first station from the fourth station in a current cycle, the hopper will be loaded with materials, and then weighed by the weighing mechanism 1. The loading will be terminated when the hopper reaches its designated weight. Then, in a next cycle, the loaded hopper will be circulated to the second station.

The second station is a station for supplying and receiving the hopper. If there is no hopper at the second station in the current cycle, a hopper to be cleaned, which is carried by a carrier vehicle, will be taken away from the carrier vehicle by the lifting platform mechanism 2, and then in the next cycle the hopper to be cleaned will be circulated to the third station. Alternatively, if a loaded hopper has circulated to the second station from the first station in the current cycle, it will be picked up by the lifting platform mechanism 2 to the carrier vehicle.

The third station is a station for clearing remaining materials in the hopper. If a hopper to be cleaned reaches the third station from the second station in the current cycle, the hopper to be cleaned will be opened by the hopper opening mechanism 7 of the third station, so that the remaining materials in the hopper can be removed. Then, the hopper to be cleaned will be circulated to the fourth station in the next cycle.

The fourth station is a station for cleaning the hopper. If a hopper to be cleaned reaches the fourth station from the third station in the current cycle, the hopper to be cleaned will be opened by the hopper opening mechanism 7 of the fourth station. Then, the cleaning mechanism 8 sprays a high pressure water stream to clean the hopper to be cleaned, and the cleaned hopper will be circulated to the first station in the next cycle.

Further, a blocking mechanism 3 can be provided at the second station, for blocking and positioning the main planetary driving mechanism 4 in each cycle.

Further, each station is also provided with several hopper in-position sensors, for detecting whether the hopper is in place. More specifically, the hopper in-position sensors include a hopper in-position sensor 902 for detecting whether the hopper is in place in the second station, a hopper in-position sensor 903 for detecting whether the hopper is in place in the third station, a hopper in-position sensor 904 for detecting whether the hopper is in place in the fourth station, and a hopper in-position sensor 901 for detecting whether the hopper is in place in the first station.

Further, in order to facilitate consistent control and realize uniform operation of the whole process, the system may be provided with an electric control box, which can collectively control the central circulation device and all of the mechanisms or devices of the four stations.

In the following, the components of the system will be further described.

Figure 3 schematically shows the structure of the weighing mechanism 1 according to an embodiment of the present invention. The weighing mechanism 1 is

mainly used for weighing the hopper, and providing data of concrete weight when unloading materials. By means of the weighing mechanism 1, the production amount of materials can be calculated precisely, thus reducing the waste of materials. The weighing mechanism 1 mainly includes the following components.

(1) Electronic scale 101. The electronic scale 101 is used to weigh the hopper. In use, a total weight of the hopper carrying device 6 and the hopper filled with concrete is weighed, and then the weight of the concrete in the hopper can be obtained through reducing the self-weight of the hopper carrying device 6 and that of the hopper from the above total weight. The electronic scale may consist of a weighing device and an electronic scale system. When the weight of the concrete in the hopper meets related requirement, the electronic scale system will send a signal to the electric control box (i.e., a control center), which will control the material feeding device to stop feeding of materials. The electronic scale may consist of four weighing modules.

(2) Copper sleeve 102. The copper sleeve 102 is used to fix a guiding shaft 103, in order to prevent the guiding shaft 103 from left or right movement, and provide guiding function as well. There are four sets of copper sleeves in total.

(3) Guiding shaft 103. The weighting mechanism 1 has four identical guiding shafts 103, for providing guiding and limiting functions when the hopper is raised or lowered by a hydraulic cylinder.

(4) Hydraulic cylinder 104. The hydraulic cylinder is mainly used for lifting the hopper. Specifically, the hydraulic cylinder can lift the hopper carrying device together with the hopper carried thereby.

(5) Ascending in-position sensor 105. When the hopper is lifted, the ascending in-position sensor 105 can detect a position sensing sheet, indicating the hopper is in place in ascent. At this time, this sensor will send a signal to a PLC in the electric control box of the automatic cleaning system. Then, the PLC will issue a command to switch off a solenoid valve associated with the hydraulic cylinder 104, thereby stopping the hydraulic cylinder 104.

(6) Position sensing sheet 106. The position sensing sheet, which may be made of iron, is fixed to a lower end of one of the guiding shafts, and thus can move up and down along with said guiding shaft. In this manner, the position sensing sheet 106 and the ascending in-position sensor 105 can cooperate to control the hydraulic cylinder.

(7) Descending in-position sensor 107. When the hopper is lowered, the descending in-position sensor 107 can detect the position sensing sheet, indicating the hopper is in place in descent. At this time, this sensor will send a signal to a PLC in the electric control box of the automatic cleaning system. Then, the PLC will issue a command to switch off the solenoid valve associated with the hydraulic cylinder 104, thereby stopping the hydraulic cylinder 104.

(8) Main body support frame 108. The main body support frame 108 functions as a support for other components of the weighing mechanism 1; that is, all the other components are mounted on the main body support frame 108.

Figure 4 schematically shows the structure of the lifting platform mechanism 2 according to the embodiment of the present invention. The lifting platform mechanism 2 is mainly used as an interface tool between the carrier vehicle and the automatic cleaning system. The lifting platform mechanism 2 can be used for taking the hopper away from the carrier vehicle when no hopper is in the second station, or lifting the hopper to the carrier vehicle when it is in the second station.

The lifting platform mechanism 2 mainly includes the following components.

(1) Lifting device 201. The lifting device 201 may be a linkage mechanism, consisting of square-through support rods, pulleys, bearings or the like. The lifting device can be deformed along a vertical direction to change its height. The lifting device is driven by a hydraulic cylinder 203 to move up and down, for picking and receiving the hopper.

(2) Connector 202. The connector 202 is used to connect the hydraulic cylinder 203 with the lifting device 201.

(3) Hydraulic cylinder 203. The hydraulic cylinder 203 is used to drive the lifting device to move up and down through the connector 202.

(4) Descending sensor 204. When the lifting device is lowered to its designated position, the descending sensor will output a signal for stopping the hydraulic cylinder.

(5) Ascending sensor 205. When the lifting device is lifted to its designated position, the ascending sensor will output a signal for stopping the hydraulic cylinder.

(6) Support 206. Components, such as the lifting device and the hydraulic cylinder, can be mounted on the support 206.

Figure 5 schematically shows the structure of the blocking mechanism 3 according to the embodiment of the present invention. The blocking mechanism 3 mainly functions to stopping and positioning the main planetary drive mechanism 4. Therefore, a more stable manner for accurate connection between the automatic cleaning system and the carrier vehicle can be realized when the hopper is discharged from the carrier vehicle.

The blocking mechanism 3 mainly includes the following components.

(1) Copper sleeve 301. It is used for guiding and fixing a blocking shaft. Two copper sleeves can be provided.

(2) Blocking shaft 302. The blocking shaft 302 can be pushed out or pulled back by an air cylinder, so as to block the hopper carrying device or allow the hopper carrying device to pass through.

(3) Ascending in-position sensor 303. When the air cylinder pushes up the blocking shaft until the ascending in-position sensor 303 outputs a signal, the PLC in the electric control box will issue a command, based on the signal, to switch off a solenoid valve associated with the air cylinder, thus stopping the air cylinder.

(4) Air cylinder 304. It is used to push out or pull back the blocking shaft.

(5) Descending in-position sensor 305. When the air cylinder pulls back the blocking shaft until the descending in-position sensor 305 outputs a signal, the PLC in the electric control box will issue a command, based on the signal, to switch off the solenoid valve associated with the air cylinder, thus stopping the air cylinder.

(6) Fixing stand 306. It is used to fix the above components.

Figure 6 schematically shows the structure of the hopper opening mechanism 7 according to the embodiment of the present invention. There are two hopper opening mechanisms 7 respectively arranged at the third and the fourth stations, for opening a hopper port to discharge the remaining materials and other elements to be cleaned in the hopper.

The hopper opening mechanism 7 mainly includes the following components.

(1) Spring 701. It is used to buffer an impact force generated when a hook opening cylinder moves forward. There are two springs 701, which are arranged around two push rods respectively.

(2) Linear bearing 702. It is used for guiding and fixing a corresponding push rod. There are two bearings in total, wherein said two push rods are respectively installed in the two bearings, and can slide back and forth in the bearings.

(3) Cylinder advancing sensor 703. It is used to send, when the hook opening cylinder advances to its position, a signal to the PLC of the electric control box to switch off the solenoid valve associated with the hook opening cylinder, thus stopping the cylinder.

(4) Hook opening cylinder 704. Before the hopper port is opened, the hook opening cylinder pushes the push rods, so as to open a hooking device on the hopper through a hook opening push block 714 arranged at front ends of the push rods.

(5) Cylinder retracting sensor 705. When the hook opening cylinder retracts in response to a signal, the cylinder retracting sensor 705 sends a signal to the PLC of the electric control box to switch off the solenoid valve associated with the hook opening cylinder, thus stopping the cylinder.

(6) Hopper opening motor 706. It is used to output power to drive a hopper opening arm to move, in order to open the hopper port and an opening of the wall hopper. The hopper opening motor 705 is switched on or off by a corresponding inverter.

(7) Mounting base plate 707. All the components of the entire hopper opening mechanism 7 are mounted on and fixed to the mounting base plate 707.

(8) Origin sensor 708. When the hopper opening mechanism is not in operation or ready for operation, the hopper opening arm should keep stationary at the origin position.

(9) Hopper closing sensor 709. When the hopper needs to be closed, the hopper opening motor will drive the hopper opening arm to move. When the hopper closing sensor 709 detects the hopper opening arm, the motor will stop.

(10) Hopper opening sensor 710. When the hopper needs to be opened, the hopper opening motor will drive the hopper opening arm to move. When the hopper opening sensor 710 detects the hopper opening arm, the motor will stop.

(11) Hopper opening arm 711. It is used to press or push a linkage mechanism of the hopper, so as to open or close the hopper port.

(12) Coupling 712. It is used to connect an output shaft of the hopper opening motor and the hopper opening arm, so that the motor can output power to the hopper opening arm.

(13) Sliding rail 713. It provides limiting and linear guiding functions when the cylinder 704 drives the push rods to move back and forth. The two linear bearings 702,

together with the two push rods, the hook opening push block or the like arranged thereon, are mounted on a sliding base, which is arranged on the sliding rail 713 and driven by an air cylinder to slide.

(14) Hook opening push block 714. It is used to, in cooperation with the springs, the linear bearings, the hook opening cylinder or the like, push a hook member of the hopper open.

Figure 7 schematically shows the structure of the cleaning mechanism 8 according to the embodiment of the present invention. The cleaning mechanism 8 is arranged at the fourth station, and mainly functions to cover the top of the hopper and spray high pressure water, so as to flush the concrete in the hopper out of the hopper.

The cleaning mechanism 8 mainly includes the following components.

(1) Lifting cylinder 801. It is used to drive a nozzle and a hopper cover to move up and down.

(2) Guiding shaft 802. The guiding shaft 802 can provide guiding function when the lifting cylinder 801 drives the cleaning members (including the nozzle and the hopper cover) to move up and down.

(3) Water pipe joint 803. The water pipe joint 803 is connected to a water pipe, for delivering a water flow to the nozzle.

(4) Hopper cover 804. Waterproof cotton can be provided under the hopper cover 804. When the hopper reaches the fourth station for cleaning, the lifting cylinder 801 drives the hopper cover to press down, so that the waterproof cotton will closely press against the hopper port. In this manner, water can be prevented from overflowing when cleaning the hopper.

(5) Nozzle 805. The nozzle is used to spray a high pressure water flow, for cleaning the inside of the hopper.

(6) Ascending in-position sensor 807. It is used to detect whether the lifting cylinder 801 has ascended to its designated position. When the ascending in-position sensor 807 outputs a signal, the PLC in the electric control box will send an instruction to activate the hopper opening mechanism located at the present station.

(7) Descending in-position sensor 808. It is used to detect whether the lifting cylinder 801 has lowered to its designated position. When the descending in-position sensor 808 outputs a signal, the PLC in the electric control box will, based on the signal, send an instruction to activate a boost pump, for cleaning the hopper.

Figure 8 schematically shows the structure of the integral support and rail mechanism 5 according to the embodiment of the present invention. The integral support and rail mechanism 5 is a main load-bearing mechanism of the entire system, and mainly includes the following components.

(1) Support member 501. It is formed by assembling arc-shaped I-steel profiles, I-steel profiles, cylindrical members or the like together. The support member 501 includes a central cylinder, a peripheral round rail, and several connecting elements for connecting the central cylinder and the peripheral round rail. The central cylinder has a bottom supported on the ground, and supporting legs are provided under the peripheral round rail to support the same. By means of the support member 501 having the round rail, the main planetary driving mechanism 4 and the hopper carrying device 6 can perform a circular motion on the round rail, with the central cylinder as the center.

(2) Gear 502. It is arranged at the top of the central cylinder of the support member 501. The gear 502 is a driving gear, and can be driven by a hydraulic motor 503 to rotate. In this manner, it can drive a driven wheel on the main planetary driving mechanism 4 to rotate, and then drive the hopper carrying device 6 to move in a circle.

(3) Hydraulic motor 503. The hydraulic motor 503 is mounted on the support member 501, for supplying power to drive the gear 502 to rotate, thereby driving the main planetary drive mechanism 4 to move. The hydraulic motor 503 can be activated

or deactivated by switching on or off a corresponding solenoid valve of a hydraulic station.

(4) Encoder 504. The encoder 504 is mounted at the center of an encoder fixing bracket, which is fixed on an upper surface of the central cylinder of the support member 501. The center of the encoder is coincident with that of the central cylinder of the support member 501. A connector is fixed on an output shaft of the encoder, and both ends of the connector are fixed on a driven wheel 405. When the hydraulic motor 503 drives the hopper carrying device 6 to rotate through the gear 502 or the like, the shaft of the encoder 504 will also rotate, so that a pulse signal will be sent to the electric control box, for providing the position of the hopper carrying device 6.

Fig. 9 schematically shows the structure of the main planetary drive mechanism 4 and the hopper carrying device 6 according to an embodiment of the present invention. The main planetary drive mechanism 4 is mounted on the integral support and rail mechanism 5, and can be rotated thereon. The hopper carrying device 6, which is used to carry the hopper, is arranged on the main planetary drive mechanism 4, for circulating the hopper to different stations in turn.

The main planetary drive mechanism 4 includes the following components.

(1) Integral bracket 401. The integral bracket 401 is mainly formed by welding I-beam elements according to design requirements, for providing load-bearing and connecting functions. The integral bracket 401 has four ends, which correspond to the four stations, respectively.

(2) Moving wheel 404. Two moving wheels 404 may be provided on a bottom surface of each end of the integral bracket 401, so that there are a total of eight moving wheels 404 in the main planetary driving mechanism 4. The moving wheels 404 run on the round rail of the integral support and rail mechanism 5, mainly for reducing resistance generated during rotation of the whole mechanism, and facilitating startup of the mechanism.

(3) Driven wheel 405. The driven wheel is arranged at the center of the integral

bracket 401. The driven wheel is in engagement with the gear 502. The hydraulic motor 503 drives the gear 502, which is used as a driving wheel, to output power, thus driving the driven wheel 405 into rotation. The driven wheel 405 is fixed with the integral bracket 401 together, thereby driving the integral bracket 401 to rotate, and finally realizing the rotation of the main planetary drive mechanism 4 as a whole.

(4) Cushioning rubber column 406. A number of cushioning rubber columns 406 can be arranged at appropriate positions of the integral bracket 401, for cooperating with the blocking shaft 302 of the blocking mechanism 3. Specifically, a total of 4 cushioning rubber columns can be provided. Each time when the main planetary drive mechanism 4 drives the hopper carrying device 6 to reach the second station, the cushioning rubber column 406 will press the blocking shaft 302 due to the inertia of motion, thus providing cushioning effect. Moreover, a positioning block can be further provided below. As long as the position of the positioning block is correctly adjusted, together with the use of the blocking shaft, the automatic cleaning system can be positioned precisely, and the problem of inaccurate position of the hopper on the carrier vehicle can be addressed.

There are a total of four hopper carrying devices 6, which are respectively arranged on four ends of the integral bracket 401 of the main planetary drive mechanism 4. Each of the hopper carrying devices 6 may include the following components.

(1) Liftable platform 601. The liftable platform, on which the hopper is placed, is detachably mounted at the end of the integral bracket 401. The liftable platform can move up and down within a required range by a power mechanism, in order achieve required effect.

(2) Limit block assembly 602. The liftable platform 602 is provided with a plurality of limit block assemblies 602, for positioning the hopper placed thereon. The limit block assemblies 602 are used for restricting the hopper placed on the hopper carrying device not to move, thus not only enabling smooth pick-and-place of the hopper each time, but also providing safety protection. There are a total of 16 limit block assemblies, four of which are mounted on one single lifting platform 601. Each

limit block assembly consists of four ladder-shaped metal blocks, each having an inwardly-inclined surface, thus forming a groove with a relatively large upper end and a relatively small lower end. In this manner, the feet of the hopper can be smoothly received and thus restricted in the grooves formed by the limit block assemblies, so that the hopper can be prevented from movement.

In some embodiments, the operation process of the automatic cleaning system according to the present invention includes the following steps.

S01. Initially, there will be an empty hopper on each of the first, third and fourth stations of the automatic cleaning system.

S02. When the operator at the control center presses a material feeding button, the following operations will be performed.

S03. The electric control box (i.e., the controller) of the automatic cleaning system outputs a signal, so that the hydraulic station is activated to lift the hydraulic cylinder 104 of the first station. At this time, the hydraulic cylinder 104 pushes the liftable platform 601 of the first station to leave the integral bracket 401, and concurrently, the weighing mechanism 1 of the same station will measure the weight of the liftable platform and the hopper. Then, the material feeding device is turned on. When concrete falls into the hopper, the weighing mechanism will return the weight in real time. If a specified weight is reached, the material feeding device will be turned off immediately. Subsequently, the controller of the automatic cleaning system outputs a signal again, so that the hydraulic station controls the hydraulic cylinder to descend, until the descending in-position sensor 107 is in place. At this time, the liftable platform 601 has returned to the integral bracket 401, waiting for the next operation.

S04. When the material feeding operation is performed in the first station, a carrier vehicle with the hopper to be cleaned has already moved to a position above the second station. When the carrier vehicle stops at its designated position, the electric control box of the automatic cleaning system outputs a signal, so that the hydraulic station activates the hydraulic cylinder 203 of the second station to lift the

liftable platform 601 of the same station, until the sensor is in place. After reaching a specified height, the feet of the hopper will be in contact with a table plate of the liftable platform. If the hopper is slightly displaced, the limit block assemblies 602 will function at this time, so that the slopes of the limit blocks will touch the feet of the hopper, thereby correcting the position of the hopper on the liftable platform. When the liftable platform with the hopper reaches the position where the highest sensor is located, the controller of the automatic cleaning system will send a signal to the carrier vehicle, for opening the hopper locking device. After that, the carrier vehicle will send a signal to the automatic cleaning system, so that the electric control box of the system outputs a signal, enabling that the hydraulic station activates the hydraulic cylinder 203 to lower, until the sensor 204 is in place. At the same time, the liftable platform will return to the integral bracket 401. When the above actions are completed, the carrier vehicle will leave the second station.

S05. After the above actions are completed, the sensor 902 of the second station will check whether there is a hopper on the liftable platform 601 of the same station and whether the position of the hopper is correct. When a positive signal is received, the system will control the air cylinder 304 to retract the block shaft 302, until the descending in-position sensor 305 is triggered. After that, the PLC will command the hydraulic motor to drive the main planetary drive mechanism 4 to rotate, so that the hopper carrying device 6 will carry the empty hopper to turn away from the carrier vehicle. At the same time, the encoder 504 will immediately return rotation information to the controller. When a specified position is reached, the controller will activate the cylinder 304 again to lift the block shaft, until the ascending in-position sensor 303 is triggered. At this time, the main planetary drive mechanism 4 continues to rotate, until the cushioning rubber columns on the hopper carrying device come into touch with the blocking shaft 302.

S06. At this time, the hopper on the main planetary drive mechanism 4 has just changed its position. That is, the hopper that was previously filled with materials at the first station has now just moved to a position under the carrier vehicle at the second station, thus triggering the sensor 902. Then, the electric control box will control the hydraulic cylinder 203 of the second station to lift the lifting device, causing the liftable platform 601 and the hopper to lift together, until the sensor 205 is

triggered. After that, the automatic cleaning system will send a signal to the carrier vehicle, so that a pin mechanism of the carrier vehicle will be pinned and a corresponding signal will be fed back to the cleaning system. Accordingly, the system will activate the hydraulic cylinder 203 to lower the lifting device, until the sensor 204 is triggered. Accordingly, a signal was sent to the carrier vehicle, which will leave the cleaning system at that time.

S07. If the first station, when being loaded with the hopper, receives a material feeding instruction, the materials will be fed as described in S03.

S08. On the other hand, at the same time, the sensor 903 of the third station is triggered, so that the system activates the hopper opening motor to rotate counterclockwise, and rotate the hopper opening arm through the coupling, until the hopper closing sensor is triggered. The purpose of the above is to push the hopper arm first to reduce the tension of the hopper locking device, then start the hook opening cylinder to push the push rods forward, until the cylinder advancing sensor is triggered. When the push rods are pushed forward, it will drive the spring, the linear bearing and the hook opening push block also. Because the hopper locking device of each hopper has different tightness, the spring can provide buffering effect when the hook opening push block contacts the hopper locking device of the hopper. If the hopper locking device is too tight, the hook opening push block will move back through the linear bearing; at the same time, the spring will be compressed and the push cylinder will push forward, so that the pushing force will increase, until the hopper locking device is pushed open. In case the hopper locking device cannot be pushed open, the spring should be compressed to the maximum, which will not affect the push rods. When the hopper locking device is pushed open, the system activates the hopper opening motor again to rotate clockwise, and rotate the hopper opening arm through the coupling, until the hopper opening sensor is triggered. At this time, the front end of the hopper opening arm just presses down the hopper arm, so that the hopper port is opened by means of leverage effect. If there are excessive materials in the hopper, they will be poured down into a collection container below. At the same time, the cylinder will be retracted, until the cylinder retracting sensor is triggered. Accordingly, the hopper locking device on the hopper will be put down. The system will control the hopper opening time according to setting. When it is the time, the

system will activate the hopper opening motor to rotate counterclockwise, until the origin sensor is triggered. Then, since the hopper opening arm has left the hopper arm, the hopper port will be naturally closed for waiting for the next operation.

S09. When the operator presses the material feeding button again, the system will perform S03 to S07 again.

S10. The hopper previously at the third station will be rotated to the fourth station. When the sensor 904 of the fourth station detects the hopper, the lifting cylinder 801 will put down the hopper cover 804 and the nozzle 805 through the guiding shaft 802. The waterproof cotton under the hopper cover 804 will just press on the hopper, thus providing improved sealing effect to prevent water from splashing. When the descending in-position sensor 808 is triggered, the system activates the high pressure water pump, so as to supply water to the nozzle 805 through the water pipe joint 803. A number of nozzle tips with different angles are installed on the nozzle, so that water can be sprayed to different positions in the hopper. The system will spray clean water according to set time, and then send a signal to control the hopper opening device, in order to discharge waste water in the hopper to a waste water collecting container below for further treatment. The operation of opening the hopper is the same as that associated with the third station, and the hopper is opened at a time point based on the set time. When it is the time, a hopper closing signal is sent to push out the hook opening cylinder, so that the hopper locking device is pushed open in a manner like in the third station. Then, the hopper opening motor rotates counterclockwise to drive the hopper opening arm into rotation through the coupling, until the hopper closing sensor is triggered. At this time, the hook opening cylinder retracts, until the sensor is triggered, so that the hopper locking device will fall down to hook the hopper arm. Finally, the motor starts again to rotate clockwise, returning to the zero position. In this way, the entire cleaning process is completed, and the system is ready for feeding material at the first station.

S11. When the cleaning is completed, all the mechanisms of the fourth station return to their original points. When all the signals are in place, the blocking shaft is retracted, and the solenoid valve associated with the hydraulic motor enables the hydraulic motor to rotate, so that the clean, empty hopper will move to the first station

for next use.

S12. After the above actions are successfully completed, the entire process of the automatic cleaning system is completed.

In the foregoing, the structure and the operation process of the automatic cleaning system according to the present invention have been described in detail by means of specific embodiments.

It can be seen from the above technical solutions that the embodiments of the present invention have the following advantages.

The automatic cleaning system according to the present invention is provided with four stations, including the first station for loading and weighing materials, the second station for supplying and receiving the hopper, the third station for cleaning remaining materials in the hopper, and the fourth station for cleaning the hopper. The central circulation device drives the hopper circulating among the four stations, realizing a fully automatic operation process including receiving the hopper, cleaning the hopper, loading materials into the hopper, and conveying the hopper. In this manner, operation efficiency and safety are both improved significantly.

The system also has the following characteristics. First, the hopper and the carrier vehicle are separate from each other, thus do not affect each other. While the hopper is cleaned, the carrier vehicle can still be in operation, thus improving efficiency of transportation. Second, the four stations can be in operation at the same time, without conflict with each other. Thus, operation time is saved and efficiency is improved. Third, if during use any one of the hoppers is out of order, only said hopper needs to be removed, without affecting other stations. Fourth, the amount of concrete for production can be weighed according to actual needs, so that materials can be accurately supplied with no concrete wasted. Fifth, a special waste tank with filtering function can be further providing under the system. In this manner, waste water after cleaning the hopper can be reused for washing the hopper again after precipitation and impurities removing, thus saving water.

In the above-mentioned embodiments, the description of each embodiment has its own emphasis. For parts that are not described in detail in an embodiment, reference may be made to related descriptions of other embodiments.

It should be understood that the foregoing embodiments are only used to illustrate, rather than restrict, the technical solutions of the present invention. Those of ordinary skills in the art can modify the technical solutions in the foregoing embodiments, or make equivalent replacements on some of the technical features therein. Obviously, these modifications or replacements would not deviate from the spirit and protection scope of the technical solutions of the embodiments of the present invention.

CLAIMS

1. An automatic cleaning system, comprising four stations uniformly distributed along a circumferential direction, and a central circulation device located in the middle of the four stations,

wherein the central circulation device includes: an integral support and rail mechanism (5), a main planetary drive mechanism (4) rotatable on the integral support and rail mechanism (5), and four hopper carrying devices (6) arranged on the main planetary drive mechanism (4), wherein said four hopper carrying devices (6) are used to carry a hopper, and driven by the main planetary drive mechanism (4) to move in cycles, so as to enter the four stations in sequence; and

said four stations include a first station located under a material feeding device and provided with a weighing mechanism (1), a second station provided with a lifting platform mechanism (2), a third station provided with a hopper opening mechanism (7), and a fourth station is provided with a further hopper opening mechanism (7) and a cleaning mechanism (8), in which:

the first station is configured to load, if a cleaned hopper reaches the first station from the fourth station in a current cycle, the hopper with materials, weigh the hopper through the weighing mechanism (1), stop to load the hopper when the hopper reaches its designated weight, and circulate the loaded hopper to the second station in a next cycle;

the second station is configured to: take away a hopper to be cleaned, which is carried by a carrier vehicle, from the carrier vehicle by the lifting platform mechanism (2), if there is no hopper at the second station in the current cycle, and circulate the hopper to be cleaned to the third station then in the next cycle; or, pick up the loaded hopper by the lifting platform mechanism (2) to the carrier vehicle, if the loaded hopper circulated from the first station is in the second station in the current cycle;

the third station is configured to open the hopper to be cleaned through the hopper opening mechanism (7) located at the third station, if the hopper to be cleaned reaches the third station from the second station in the current cycle, for removing remaining materials in the hopper, and circulate the hopper to be cleaned to the fourth station in the next cycle; and

the fourth station is configured to open the hopper to be cleaned through the

further hopper opening mechanism (7) located at the fourth station if the hopper to be cleaned reaches the fourth station from the third station in the current cycle, clean the hopper to be cleaned through a high pressure water stream sprayed from a cleaning mechanism (8), and circulate the cleaned hopper to the first station in the next cycle.

2. The automatic cleaning system according to claim 1, characterized in that

the integral support and rail mechanism (5) includes a support member (501) with a round rail, a gear (502) arranged at a center of the support member (501), a hydraulic motor (503) for driving the gear (502), and an encoder (504);

the main planetary drive mechanism (4) includes an integral bracket (401) with a driven wheel (405) arranged at a center thereof, wherein the integral bracket (401) has four ends corresponding to said four stations, respectively, a bottom surface of each of the ends being provided a moving wheel (404) running on the round rail, and wherein the driven wheel (405) is in engagement with the gear (502) and driven thereby, for realizing rotation of the integral bracket (401); and

four hopper carrying devices (6) are respectively arranged on said four ends of the integral bracket (401), respectively, wherein each hopper carrying device (6) includes a liftable platform (601), which is detachably mounted at a corresponding one of the four ends, and provided with a plurality of limit block assemblies (602) for positioning the hopper placed thereon.

3. The automatic cleaning system according to claim 1, characterized in that the weighing mechanism (1) includes an electronic scale (101) and a hydraulic cylinder (104) which is able to lift the electronic scale (101), wherein the hydraulic cylinder (104) is configured to lift, when it is necessary for weighting, the electronic scale (101), the hopper carrying device (6) together with the hopper carried thereby, so that the hopper is weighed by the electronic scale (101).

4. The automatic cleaning system according to claim 3, characterized in that the weighing mechanism (1) further includes a main body support frame (108), on a top of which a plurality of first copper sleeves (102) are arranged, wherein multiple guiding shafts (103) are movably arranged in said first copper sleeves (102) respectively, with the electronic scale (101) being mounted on top ends of the guiding shafts (103); and

a position sensing sheet (106) is arranged at a lower end of at least one of the guiding shafts (103), and the main body support frame (108) is further provided with an ascending in-position sensor (105) and a descending in-position sensor (107) that are both in cooperation with the position sensing sheet (106).

5. The automatic cleaning system according to claim 1, characterized in that the lifting platform mechanism (2) includes a lifting device (201) movable along a vertical direction, a hydraulic cylinder (203) for driving the lifting device (201) to move up and down through a connector (202), and a support (206) for supporting the lifting device (201) and the hydraulic cylinder (203),

wherein the support (206) is further provided with a descending sensor for detecting whether the lifting device (201) descends to a designated position and an ascending sensor for detecting whether the lifting device (201) ascends to a corresponding designated position.

6. The automatic cleaning system according to claim 1, characterized in that the second station is further provided with a blocking mechanism (3) for blocking and positioning the main planetary drive mechanism (4),

wherein the blocking mechanism (3) includes a fixed stand (306), the fixed stand (306) being provided with a second copper sleeve (302), in which a blocking shaft (302) is arranged, an air cylinder (304) for lifting or lowering the blocking shaft (302), and an ascending in-position sensor (303) and a descending in-position sensor (305) both for detecting movement of the blocking shaft (302), which blocks and positions the main planetary drive mechanism (4) when being lifted; and

the main planetary drive mechanism (4) is provided with at least one cushioning rubber column (406) in cooperation with the blocking shaft (302).

7. The automatic cleaning system according to claim 1, characterized in that the hopper opening mechanism (7) comprises a hook opening push block (714) driven by a cylinder (704), for pushing open a hook of the hopper, a hopper opening arm (711) driven by a motor (706), for pressing or pushing a linkage mechanism of the hopper to open or close a hopper port, a sensor for detecting whether the cylinder (704) moves forward or backward, and a sensor for detecting a position of the hopper opening arm (711) when it is moving.

8. The automatic cleaning system according to claim 7, characterized in that the hook opening push block (714) is provided at front ends of two push rods, which are arranged in two linear bearings (702) respectively,

wherein a spring (701) is wound around each push rod between the hook opening push block (714) and a corresponding linear bearing (702), and

said two linear bearings (702) are fixed to a slidable base arranged on a sliding rail (713), so that the slidable base is driven by a cylinder (704) to move on the sliding rail (713), thus driving the hook opening push block (714) to move.

9. The automatic cleaning system according to claim 1, characterized in that the cleaning mechanism (8) includes a hopper cover (804) for covering the hopper port, a nozzle (805) for spraying a high pressure water flow to the hopper, a water pipe joint (803) connected to the nozzle (805), a lifting cylinder (801) for driving the nozzle (805) and the hopper cover (804) to move up and down, and an ascending in-position sensor (807) and a descending in-position sensor (808) both for detecting movement of the lifting cylinder (801).

10. The automatic cleaning system according to claim 1, characterized in that each of said four stations is further provided with a hopper in-position sensor for detecting whether the hopper is in place.