

AUTOMATIC BATTERY EXCHANGING SYSTEM FOR
AN AUTOMATIC GUIDED VEHICLE

The present invention relates to an automatic battery exchanging system, and particularly but not exclusively to an automatic battery exchanging system for an automatic guided vehicle having a battery as the driving power source in an article carrying system.

Usually, conveyance and carrying are fully automatically carried out by automatic guided vehicles in automated factories. These automatic guided vehicles have a battery as the driving power source and all operations are carried out under the instructions of a host computer.

Therefore, problems have arisen in that when the battery is discharged to below final discharge voltage, i.e. to an excessive discharge state, the automatic guided vehicle comes to a halt and accordingly operation is interrupted.

In order to solve these problems caused by the excessive discharge of a battery, although a recharging device for a battery has been developed, a satisfactory effect cannot be expected for automated factories because not only does it not have relevance between them but also there is no automatic exchange.

Recently, in order to solve the aforementioned various problems, a device has been developed which checks the discharged state upon the battery being discharged and which

is capable of automatically exchanging the battery, and also an automatic battery exchanging system using a robot and turning rack has been proposed.

This system still requires considerable research to overcome its problems particularly the problems that not only is its structure complicated because it uses robot and turning rack but also that it has no probable economical applications in view of the installation and its cost.

The present invention has been devised in consideration of the above-mentioned various problems, and it is an object of the present invention to provide an automatic battery exchanging system for an automatic guided vehicle capable of automatically exchanging the battery but having a simple structure.

According to one aspect of the present invention, there is provided a computer-controlled automatic battery exchanging system for exchanging a discharged battery of an automatic guided vehicle with a charged battery, which automatic battery charging system comprises:

first means for unloading the discharged battery from the automated guided vehicle and loading the charged battery in the automatic guided vehicle, said first means comprising engaging means for engaging a portion of the battery and an operating element mounted to cause the engaging means to be moved reciprocally in a plane so as to load and unload the battery, and means for raising and lowering said operating element so as to change the plane of movement of the engaging means so as to cause it to engage or disengage said portion of the battery;

second means, associated with said first means for charging the discharged battery;

third means for transferring the charged battery to said first means for loading in the automatic guided vehicle; and

a control unit for controlling the execution of said first means, said second means, and said third means.

According to another aspect of the present invention, there is provided a method of controlling an automatic battery exchanging system comprising the steps of:

detecting the presence or absence of a battery at the inlet of a recharging station;

unloading the battery from an automatic guided vehicle;

conveying the battery to a lifting means at a lower position of the charging station;

raising a lifting plate with the battery thereon to a raised position to align the battery with raised charging station conveyors;

driving the charging station conveyors to move horizontally, and checking for the presence or absence of the battery on the charging station conveyors;

lifting a charging socket into contact with a jack of the battery and charging the battery;

lowering a further plate with the battery thereon to a lower position of the charging station; and

removing the battery from the further plate and loading the charged battery in the automatic guided vehicle.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a schematic diagram for showing an applying condition of the present invention;

Figure 2 is a structural diagram for showing in entirety a preferred embodiment of an automatic battery exchanging system of the present invention;

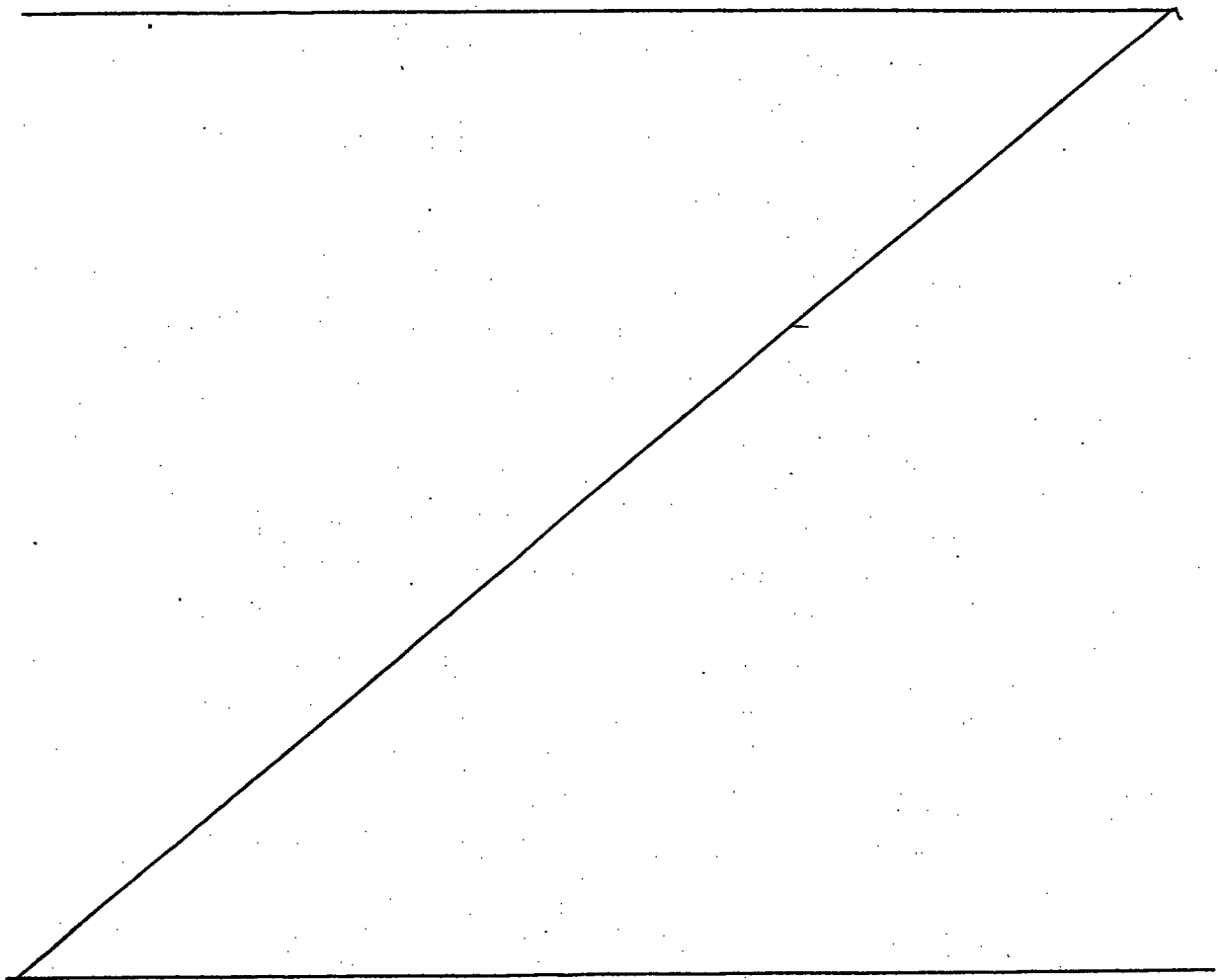


Figure 3 is a fragmentary perspective view for showing a battery exchanging portion of the system;

Figure 4 is a plan view of an automatic guided vehicle used for realizing the present invention;

Figure 5 is a schematic diagram for illustrating the raising and lowering operation of a charging socket in the case of battery charging by this invention; and

Figure 6 is a flow chart for showing states of an operational sequence of the present invention.

Throughout the drawings, like reference numerals and symbols are used for designating like or equivalent parts or portions, for simplicity of illustration and explanation.

Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings.

Figure 1 is a schematic diagram for illustrating an applying condition of a preferred embodiment of the present invention, in which an automatic guided vehicle 1 travels along a predetermined route 3 according to the instructions of a host computer 2. The automatic guided vehicle 1 is usually provided with a battery discharging state detecting circuit (not shown). While it is travelling along the route 3, when the battery 4 of automatic guided vehicle 1 is over discharged, its state is detected by said battery discharging state detecting circuit, which sends a signal to the host computer 2. When the signal representing the state of battery over discharging is transmitted to the host computer 2, the host computer 2 causes the automatic guided vehicle 1 to leave from the route 3, and to be forwarded to a battery recharging

station 5, and when the automatic guided vehicle 1 reaches the battery recharging station 5, a signal representing it is transmitted to a control unit 6, so that the battery recharging station 5 is rendered to operate.

The battery recharging station 5, as shown in Figures 2 and 3, is provided with an actuator in the form of a rodless cylinder 8 at a bracket 7. The rodless cylinder 8 is formed with a coupling device in the form of a hook 9. This hook 9 moves to front and back by the operation of rodless cylinder 8. The bracket 7 provided with the rodless cylinder 8 is fixed to a raising and lowering plate 11 which may be raised and lowered by an air pressure cylinder 10, to form a battery mounting and releasing means E. Conveyors 12 having a driving means SM as a driving power source are provided on both sides of the rodless cylinder 8 and a further raising and lowering plate 20. Another conveyor 13 driven by a driving means M is provided in a longitudinal direction of the conveyor 12 extending therefrom, and a still further conveyor 14 is provided also by extending subsequently therefrom and keeping the same level horizontally with this conveyor 13, so that a horizontal battery conveyance means T is constituted. This further conveyor 14 of the horizontal battery conveyance means T is driven by a driving means M1, and this driving means M1 is fixedly mounted to a raising and lowering plate 15. The raising and lowering plate 15 is coupled to a ball screw 16 which is driven by a driving means M2, and thereby constituting a raising and lowering means S. Therefore, when the ball screw 16 is turned by driving of driving means M2, the raising and lowering plate 15 is raised or lowered upwards or downwards, and accordingly the conveyor 14 is also raised or lowered together therewith. The ball screw 16 is mounted vertically to a supporting frame 17.

On the other hand, the battery mounting and releasing means E

is provided with a supporting frame 18, and a ball screw 19 which is mounted vertically and can be turned by a driving means M3, and this ball screw 19 is provided with the raising and lowering plate 20, which is mounted for moving stably upwardly and downwardly of a supporting bar 27 (Figure 3), in a ball nut coupling manner, and forming a lowering means P.

A battery charging means R is provided in the upper region between the supporting frames 17, 18. The battery charging means R is provided with a number of air pressure cylinders 22 each with a charging socket 21 at the front end and mounted to a fixing plate 23, and a plurality of conveyors 24, 25, 26, driven respectively by driving means M4, M5, M6, of the same number as the number of air pressure cylinders are provided therefor. Though three charging places are shown in the embodiment of the present invention shown in Figure 2, the invention is not restricted to this; as a matter of course it is possible to alter the number according to requirements.

A battery for use with the present invention is shown in Figure 4. As shown in Figure 4, a coupling means H to be coupled with hook 9 of said rodless cylinder 8 is fixedly mounted at the front side of the battery B, and contact terminals L are mounted at the other side and projecting therefrom.

An automatic guided vehicle 1 is provided with jacks for contacting with these terminals L. Usual banana jacks are used for these jacks J.

In Figure 5, the reference numeral 21a represents a wire for supplying the electric power, 21b is non-conductive material, and numeral 28 in Figure 1 represents a withdrawal conveyor.

The operation of a preferred embodiment of the present invention having the above described construction will now be described. When the automatic guided vehicle 1 reaches the battery mounting and releasing means E of the battery recharging station 5, its signal is transmitted to the control unit 6 and the battery recharging station 5 is rendered to operate, of which a detailed description will be explained with reference to Figure 6 hereinafter.

The control unit 6, at the initial state of system standby state (step 101) has a sensor b4 to detect whether or not a battery B is loaded on the conveyor 26 (step 102). If it is not, the driving means M4, M5, M6 is caused to drive (step 103), and b4 detects again whether or not a battery B is loaded on the conveyor 26 (step 104). If it is, the driving means M4, M5, M6 is caused to stop (step 105), and the unit 6 is returned to the system standby state. When a battery B is loaded on the conveyor 26 at step 102, a sensor b3 detects whether or not a battery B is located on the conveyor 25 at step 106. If it is not, the driving means M4, M5 is caused to drive at step 107, and then sensor b3 detects whether or not a battery B is loaded on the conveyor 25 at step 108. If it is, the unit is returned to system standby state at a state that the operation of the driving means M4, M5 is rendered to stop at step 109.

On the other hand, when a battery B is loaded on the conveyor 25, sensor b1 detects whether or not the automatic guided vehicle 1 has reached the battery mounting and releasing means E at step 110, and when it is, the unit executes the battery releasing operation as follows at step 111. That is to say, after moving the hook 9 forward by operating the rodless cylinder 8, then raising the raising and lowering plate 11 by operating the air pressure cylinder 10. In this state the hook 9 is located on the coupling means H of the battery B

mounted to the automatic guided vehicle 10; when the air pressure cylinder 10 is driven and the raising and lowering plate 11 is raised, the hook 9 is hooked to the coupling means H.

When the hook 9 is moved backward by operating the rodless cylinder 8 at this state, the battery B becomes drawn out. When a ball caster or the like is provided at the bottom of the case containing the battery B, a smooth operation can be carried out. The battery B drawn out by the hook 9 is laid on the conveyor 12 mounted on both sides of the rodless cylinder 8.

When this state is detected by a limit switch LM1 at step 112, after lowering the raising and lowering plate 11 by operating the air pressure cylinder, the operation of the air pressure cylinder 10 is stopped and the driving means SM is driven at step 113.

When the conveyor 12 is operated by the driving means SM and the moving of the battery B switches the limit switch LM2 to ON at step 114, after driving the driving means M, the driving means SM is stopped, and thereby the conveyor 13 is caused to operate at step 115.

When the battery B moving along the conveyor 13 switches the limit switch LM3 to ON at step 116, after turning the driving means M1 to ON in normal direction, the driving means M is stopped and the battery B is moved via the conveyor 14 at step 117.

When the movement of the battery B is confirmed by the limit switch LM4 at step 118, the operation of the driving means M1 is stopped at step 119, the unit checks whether or not to do the recharge of the battery B on the conveyor 14 at step 120.

When it is impossible then the driving means M1, M0 is driven at once at step 121, the battery B is withdrawn by the conveyor 14 and the withdrawal conveyor 28, and this condition is detected by the limit switch LM0 at step 122, then the operation of the driving means M1, M0, is stopped and the system returned to the system standby state at step 123.

When it is confirmed that recharging is possible, the driving means M3 is driven to rotate in normal direction so that the raising and lowering plate 20 is moved upwardly by the ball screw 19 while empty at step 124, when the limit switch LM7 detects that the raising and lowering plate 20 is completely moved to an end at step 125, the operation of the driving means M3 is stopped so as to make preparation to withdraw the battery B charged completely at step 126.

The driving means M2 is driven in normal direction the raising and lowering plate 15 is raised, so that the battery B is lifted up together with a state that said battery B is loaded on the conveyor 14 as it is at step 127.

When the conveyor 14 is raised and its horizontal position becomes matched to that of the conveyor 24, this is detected by the limit switch LM5 at step 128. According to this, the operation of the driving means M2 is stopped and subsequently the driving means M1 rotates in reverse direction, so that the conveyor 14 is moved reversely at step 129.

When the battery B is moved backwards in response to the reverse movement of the conveyor 14 and the limit switch LM6 is connected at step 130, after making the driving means M4, M5, M6 operate at once and making the conveyors 24, 25, 26 to move subsequently, the operation of the driving means M1 is stopped so stopping the reverse rotation of the conveyor 14 at step 131.

At this moment, the conveyors 24, 25, 26 are moved until the batteries B in charging are detected by the sensor b4 at step 132, the driving of the driving means M4, M5, M6 is stopped causing the movement of the conveyors 24, 25, 26 to be stopped at step 133.

On the other hand, when the operation of the driving means M1 is terminated, making the conveyor 14 move downwards by driving the driving means M2 with reverse rotation at step 134, when the state that the conveyor 14 being moved downwards so as to be at the same horizontal level as the conveyor 13 is detected by the limit switch LM4 at step 135, the driving means M2 is made to stop at step 136.

When the battery B is located on the conveyor 26, the charging socket 21 is raised by driving the air pressure cylinder 22 at step 137. The unit confirms whether or not the charging socket 21 is lifted up and contacted to the contacting terminal L of the battery B at step 138, and if it is, the operation of the air pressure cylinder 22 is stopped at step 139. This state is the state of charging the battery B, of which the method is the same as the usual charging method, at step 140.

The unit confirms whether or not the charging of the battery B is completed at step 141, and, if it is completed, the charging socket 21 is lowered by driving the air pressure cylinder 22 at step 142, completion of the lowering is confirmed at step 143, and the operation of the air pressure cylinder 22 is stopped at step 144. In the case that there are a number of batteries B to be charged so that the batteries B are charged at the conveyors 24, 25, the method is carried out by a method as just described.

When the charging is completed on the conveyor 26 and the air pressure cylinder 22 is lowered, the driving means M6 is caused

to operate with normal rotation, and the driving means SM is caused to operate with reverse rotation, to cause the battery B on the conveyor 26 to be transferred to the conveyor 12 at step 145. When the battery B is completely transferred to the conveyor 12 and switches the limit switch ON at step 146, the operation of the driving means SM is stopped and the driving means M3 is driven to rotate with reverse rotation at step 147.

Since at this moment the conveyor 12 is located at the raising and lowering plate 20 of the lowering means P which is raised up to top end by coupling of the nut with the ball screw, it corresponds to the state that the raising and lowering plate 20 begins to move downwardly according to the ball screw 19 being reversely rotated by the driving means M3. When the raising and lowering plate 20 is completely moved downwards, and turns the limit switch ON at step 148, the operation of the driving means M3 is stopped at step 149.

After lowering the battery B, the air pressure cylinder 10 is driven and the raising and lowering plate 11 is raised at step 150, and then a duration (3 seconds) is awaited so that the raising and lowering plate 11 is completely raised at step 151.

When the raising and lowering plate 11 is completely raised, and the hook 9 is hooked to the coupling means H of the battery B, the rodless cylinder 8 is driven and the hook 9 is caused to push the battery B at step 152, and the unit waits during mounting (5 seconds) of the battery B to the automatic guided vehicle 1 at step 153.

When the battery B is mounted to the automatic guided vehicle 1, the rodless cylinder 8 is caused to stop and to move back at step 154, driving the air pressure cylinder 10 so as to lower the raising and lowering plate 11 at step 155.

Then the connecting terminals L of the battery B are inserted into the jack J, so that the battery exchange is achieved.

Thus, an automatic battery exchanging system as described above detects automatically the over discharged condition of the battery and charges and exchanges it, so that the various conventional problems are solved, and, also, there is the advantage that the structure is simplified, and accordingly the manufacturing cost is decreased.



CLAIMS:

1. A computer-controlled automatic battery exchanging system for exchanging a discharged battery of an automatic guided vehicle with a charged battery, which automatic battery charging system comprises:

first means for unloading the discharged battery from the automatic guided vehicle and loading the charged battery in the automatic guided vehicle, said first means comprising engaging means for engaging a portion of the battery and an operating element mounted to cause the engaging means to be moved reciprocally in a plane so as to load and unload the battery, and means for raising and lowering said operating element so as to change the plane of movement of the engaging means so as to cause it to engage or disengage said portion of the battery;

second means, associated with said first means for charging the discharged battery;

third means for transferring the charged battery to said first means for loading in the automatic guided vehicle; and

a control unit for controlling the execution of said first means, said second means, and said third means.

2. A computer-controlled automatic battery exchanging system as claimed in claim 1, in which said engaging means comprises a hook and said operating element comprises a rodless cylinder, said hook being mounted to and movable with said rodless cylinder.



3. A computer-controlled automatic battery exchanging system as claimed in claim 1 or 2, further comprising fourth means for determining whether the discharged battery can be recharged.

4. A computer-controlled automatic battery exchanging system as claimed in any one of claims 1 to 3, wherein said third means comprises a threaded rod turned by the rotation of a driving means and a plate coupled to said threaded rod.

5. A computer-controlled automatic battery exchanging system as claimed in any preceding claim, wherein the raising and lowering means comprises an air pressure cylinder.

6. A method of controlling an automatic battery exchanging system comprising the steps of:

detecting the presence or absence of a battery at the inlet of a recharging station;

unloading the battery from an automatic guided vehicle;

conveying the battery to a lifting means at a lower position of the charging station;

raising a lifting plate with the battery thereon to a raised position to align the battery with raised charging station conveyors;

driving the charging station conveyors to move horizontally, and checking for the presence or absence of the battery on the charging station conveyors;

lifting a charging socket into contact with a jack of the battery and charging the battery;



lowering a further plate with the battery thereon to a lower position of the charging station; and

removing the battery from the further plate and loading the charged battery in the automatic guided vehicle.

7. An automatic battery exchange system having a control unit for performing automatic battery exchange by means of the following steps:

detecting the presence or absence of a battery at the inlet of a recharging station;

unloading the battery from an automatic guided vehicle;

conveying the battery to a lifting means at a lower position of the charging station;

raising a lifting plate with the battery thereon to a raised position to align the battery with raised charging station conveyors;

driving the charging station conveyors to move horizontally, and checking for the presence or absence of the battery on the charging station conveyors;

lifting a charging socket into contact with a jack of the battery and charging the battery;

lowering a further plate with the battery thereon to a lower position of the charging station; and

removing the battery from the further plate and loading the charged battery in the automatic guided vehicle.



8. A computer-controlled automatic battery exchanging system, substantially as herein described with reference to and as shown in the accompanying drawings.

9. A method as claimed in claim 6, substantially as herein described with reference to the accompanying drawings.

10. An automatic battery exchange system as claimed in claim 7, substantially as herein described with reference to the accompanying drawings.
