

AUTOMATIC CONVEYANCE AND DETECTION APPARATUS OF METAL MEMBER AND OPERATION METHOD THEREOF

Technical Field

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The present invention relates to the technical field of equipment for automatic conveyance and automatic detection, and in particular, to an apparatus for automatic conveyance and detection of metal member, and an operation method thereof.

10 Technical Background

Currently, an iron rake machine is provided with an automatic conveyance apparatus, which can automatically convey a metal member, such as an iron bar, of the same specification from a starting point to a designated iron bar carrier. The metal member is intended to be connected with a corresponding member through screws or the like, so that there are strict requirements on the size of the metal member *per se* and the position and size of an opening formed in the metal member. If there is excessive deviation on the size or position, the metal member cannot be engaged and connected with said corresponding member.

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In current automatic conveyance apparatus, the size of the metal member, the position and size of the opening, or the like should be detected during conveyance. After detection, a metal member with large deviation will be taken away, while that with acceptable deviation is allowed to be delivered to the designated location. This detection is usually performed manually, which would not only negatively influence on automation of the apparatus and operation efficiency thereof, but also cause disengagement and disconnection when the metal member is assembled with the corresponding member if the detection is not accurate enough. Therefore, the speed and accuracy of assembly are both deteriorated.

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Summary of the Invention

The present invention aims to provide an apparatus for automatic conveyance

and detection of metal member, whereby high degree of automation and accurate detection can be achieved, and an operation method thereof.

According to a first aspect, the present invention provides an automatic
5 conveyance and detection apparatus of metal member, comprising a conveying device for conveying a metal member, a detecting device for detecting the metal member, a movable metal member picking-and-placing device for picking up and placing down the metal member, and an electric control box. The conveying device includes a conveyor belt, and a conveyor belt motor for driving the conveyor belt in operation.
10 The electric control box is provided therein with a PLC, wherein the conveying device, the detecting device, and the metal member picking-and-placing device are connected to the electric control box respectively and controlled by the PLC. The detecting device includes at least one camera, which is arranged above the conveyor belt, for taking images of the metal member. The metal member picking-and-placing device
15 includes a platform arranged above the conveyor belt, an electromagnet arranged on the platform, a platform moving mechanism for driving the platform to move along a forward or backward direction, a lateral moving mechanism for driving the electromagnet to move along a rightward or leftward direction, a vertical moving mechanism for driving the electromagnet to move along an upward or downward
20 direction, and a direction correcting mechanism for driving the electromagnet to rotate horizontally.

In an embodiment, the platform moving mechanism includes: two first sliding rails and two first racks respectively arranged along the forward or backward direction,
25 a platform moving motor fixed on the platform, two synchronous wheels, wherein one is above the other and are driven by a motor shaft of the platform moving motor, and a first gear that is rotatable coaxially with a lower synchronous wheel. The platform is slidably connected with the first sliding rails, and the first racks are in engagement with the first gear. The platform moving motor drives the synchronous wheels and the
30 first gear into rotation, so that the platform is driven to slide along the first sliding rails through the first racks.

In an embodiment, the lateral moving mechanism includes at least one second

slide rail arranged on the platform laterally, a sliding support slidably connected to the second slide rail, a lateral moving motor fixed to a first side of the platform, a driving wheel configured to be driven into rotation by a motor shaft of the lateral moving motor, a driven wheel fixed to a second side of the platform, and a synchronous belt
5 wound around the driving wheel and the driven wheel, with both ends thereof being fixedly connected to the sliding support. The electromagnet is arranged at the sliding support, and the lateral moving motor drives the synchronous belt to move through the driving wheel and the driven wheel, so that the synchronous belt drives the sliding support and the electromagnet to slide along the second slide rail along the rightward
10 or leftward direction. The vertical moving mechanism includes a vertical moving motor fixed to the sliding support, a second gear configured to be driven into rotation through the vertical moving motor, and a second rack arranged vertically, wherein the second gear is in engagement with the second rack, the electromagnet move vertically in a manner synchronous with the second rack, and the vertical moving motor drives
15 the second gear into rotation, so as to enable the electromagnet and the second rack move vertically.

In an embodiment, the direction correcting mechanism includes a direction correcting motor, a driving gear driven by the direction correcting motor to rotate
20 horizontally, and a driven gear in engagement with the driving gear. The electromagnet is connected to a rotary shaft of the driven gear, the direction correcting motor drives, through the driving gear, the driven gear to rotate horizontally, which, in turn, drives the electromagnet to rotate horizontally.

25 In an embodiment, the detecting device further includes at least one illuminator, which is arranged above the conveyor belt and used for lighting the camera.

In an embodiment, a guide port, which is gradually tapered along a conveying direction, is provided in a conveying path of the conveyor belt.

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In an embodiment, the detecting device further includes a movable sensing sheet arranged in front of the guide port, and a first sensor in signal communication with the PLC. A gap between the movable sensing sheet and the conveyor belt just allows the

metal member of standard size to pass therethrough, and a signal is sent to the PLC through the first sensor when the metal member comes into touch with the movable sensing sheet.

5 In an embodiment, a workpiece sensor for sensing the metal member is arranged under a downstream end of the conveyor belt, the workpiece sensor being in signal communication with the PLC.

10 In an embodiment, the apparatus further includes a metal member pushing device arranged above an upstream end of the conveyor belt. The metal member pushing device comprises a base frame for receiving a metal member loading box, a pushing cylinder for pushing the metal member in the metal member loading box out, a locking cylinder for adjusting a distance between a front edge and a rear edge of the base frame, a lateral moving cylinder for driving the base frame to move along the
15 rightward or leftward direction, and a plurality of cylinder sensors for sensing movement states of the pushing cylinder, the locking cylinder and the lateral moving cylinder, respectively. The pushing cylinder, the locking cylinder and the lateral moving cylinder are all connected with the electric control box, and each of the cylinder sensors is in signal communication with the PLC.

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According to a second aspect, the present invention provides a method of operating the automatic conveyance and detection apparatus of metal member as mentioned above, comprising steps of:

25 conveying, through the conveyor belt under a command from the PLC, the metal member forward;

30 activating, after the conveyor belt is controlled by the PLC to stop, the camera of the detecting device, in order to determine, based on images taken and through a vision system, whether position and size of an opening of the metal member are deviated or qualified, or whether the metal member is guided away from its direction, and conveying, through the conveyor belt controlled by the PLC, the metal member to a waste box arranged at a downstream end of the conveyor belt, if the metal member is not qualified, while activating the metal member picking-and-placing device to move the platform from its original position to a position above the metal member, if

qualified;

moving, through the vertical moving mechanism of the metal member picking-and-placing device controlled by the PLC, the electromagnet downward and energizing the electromagnet concurrently, and then moving the electromagnet upward when the electromagnet contacts and attracts the metal member;

prompting, through the PLC according to a signal from the camera, whether it is necessary to activate the direction correcting mechanism to adjust a direction of the metal member, after the metal member is picked up;

activating the platform moving mechanism of the metal member picking-and-placing device, so that the metal member is carried by the platform moving mechanism to a designated position above the metal member carrier before stopped;

sending, through the PLC based on a signal indicating the platform moving mechanism is stopped and a signal from the metal member carrier indicating whether there is the metal member thereon, an instruction to activate the lateral moving mechanism, so that the electromagnet with the metal member move along the rightward or leftward direction to a position where the metal member is required; and

de-energizing, through the PLC based on a signal indicating the vertical moving mechanism drives the electromagnet downward to a designated low position, the electromagnet, placing the metal member on the metal member carrier, and then moving, through the vertical moving mechanism, the electromagnet upward.

Compared with the prior arts, the automatic conveyance and detection apparatus of metal member according to the present invention has the following advantages. The detecting device of the apparatus includes a camera, so that detection can be performed with a vision system. In this manner, automation and accuracy of detection of the apparatus can be both increased, and unqualified metal member having large deviation on the position and size of the opening can be rapidly removed. Accordingly, the subsequent connection of the metal member with a corresponding member is smooth and accurate, and the apparatus is convenient in operation, maintenance, and repair.

Brief Description of the Drawings

Figure 1 is a perspective view of an automatic conveyance and detection apparatus of metal member according to the present invention, in an assembled state.

5 Figure 2 is a side view of the automatic conveyance and detection apparatus of metal member according to the present invention, in the assembled state.

10 Figure 3 schematically shows a part of the automatic conveyance and detection apparatus of metal member according to the present invention under a camera, viewed from an angle.

15 Figure 4 schematically shows a part of the automatic conveyance and detection apparatus of metal member according to the present invention under the camera, viewed from another angle.

 Figure 5 schematically shows the structure of the camera and an illuminator according to the present invention.

20 Figure 6 is an exploded view showing the components connected to a platform.

 Figure 7 is an assembly view of the components connected to the platform, viewed from a rear side.

25 Figure 8 is an assembly view of the components connected to the platform, viewed from a front side.

 Figure 9 is an enlarged view of a platform moving mechanism.

Detailed Description of the Embodiments

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 In the following, embodiments of the present invention will be further illustrated with reference to the accompany drawings.

Referring to Figures 1 to 4, the automatic conveyance and detection apparatus of metal member according to the present invention mainly includes a conveying device for conveying a metal member 10, a detecting device for detecting the metal member 10, a movable metal member picking-and-placing device for picking up and placing
5 down the metal member 10, a metal member pushing device for pushing out the metal member 10 to an upstream end of the conveying device, and an electric control box with a PLC (Programmable Logic Controller) arranged therein. The conveying device, the detecting device, the metal member picking-and-placing device and the metal member pushing device are all mounted on a mounting frame 30, and connected to the
10 electric control box respectively and thus controlled by the PLC.

As shown in Figure 2, the conveying device includes a conveyor belt 11, and a conveyor belt motor 12 that can drive the conveyor belt 11 in operation. Preferably, the conveying device further includes an adjustable roller 13, the position of which
15 can be adjusted along a vertical direction, so as to adjust tightness of the conveyor belt 11.

Preferably, in the conveying path of the conveyor belt 11 there is also arranged with a guide port 4, which is of a horn shape that gradually narrows along the
20 conveying direction. This guide port 4 can be used to guide the metal member 10 being conveyed with a designated orientation to a designated position.

As shown in Figures 2, 4 and 5, in this embodiment, the detecting device includes: two cameras 21 for taking images of the metal member 10, two illuminators
25 22 for lighting the cameras 21, a movable sensing sheet 23 arranged in front of the guide port 4, and a first sensor 24 in signal communication with the PLC. The cameras 21 and the illuminators 22 are arranged at respective positions above a middle part of the conveyor belt 11 through the mounting frame 30. The images captured by the cameras 21 can be processed by the PLC using a vision system, so
30 that it can be determined whether the position and size of the opening of the metal member 10 are deviated or qualified, and whether the metal member is guided away from its direction. The movable sensing sheet 23 may be movably arranged above the conveyor belt 11, and a gap formed between the movable sensing sheet 23 and the

conveyor belt 11 just allows a metal member 10 of standard size to pass therethrough. If the metal member 10 passing over the movable sensing sheet 23 is excessively thick or deformed heavily, it will come into touch with the movable sensing sheet 23, which will accordingly send a signal to the PLC through the first sensor 24.

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In addition, a workpiece sensor 5 for sensing the metal member 10 is arranged under a downstream end of the conveyor belt 11. The workpiece sensor 5 is in signal communication with the PLC. When the metal member 10 arrives at the position of the workpiece sensor 5, the workpiece sensor 5 will send a signal to the PLC.

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The metal member picking-and-placing device includes: a platform 31 arranged above the conveyor belt 11, an electromagnet 32 arranged on the platform 31, a platform moving mechanism for driving the platform 31 to move along a forward or backward direction, a lateral moving mechanism for driving the electromagnet 32 to move along a rightward or leftward direction, a vertical moving mechanism for driving the electromagnet 32 to move along an upward or downward direction, and a direction correcting mechanism for driving the electromagnet 32 to rotate horizontally.

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As shown in Figures 3 and 9, in this embodiment, the platform moving mechanism includes: at least one first sliding rail 331, at least one first rack 332, a platform moving motor 333, two synchronous wheels 334 in which one is above the other, a first gear 335, and a synchronous belt 336. Two first sliding rails 331 and two first racks 332 are arranged on the right and left sides of the conveyor belt 10, respectively, along a front-and-back direction, which is parallel to a lengthwise direction of the conveyor belt 10. In other words, each side of the conveyor belt 10 is provided with a first sliding rail 331 and a first rack 332. The platform 31 is arranged on the two first sliding rails 331 located at the right and left sides, and slidably connected therewith. The platform moving motor 333 is fixed at the right side or the left side of the platform 31. The upper synchronous wheel 334 is mounted on a motor shaft of the platform moving motor 333 to drive the lower synchronous wheel 334 to rotate through the synchronous belt 336, while the lower synchronous wheel 334 is arranged to rotate coaxially with the first gear 335, which is in engagement with the

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first racks 332. When the platform moving motor 333 drives the upper and lower synchronous wheels 334 in rotation, the first gear 335 will also rotate to drive the platform 31, through the first racks 332 engaged therewith, to slide forward or backward along the first slide rails 331, because the first racks 332 are fixed in position.

As shown in Figure 8, in this embodiment, the direction correcting mechanism includes: a direction correcting motor 361, a driving gear driven by the direction correcting motor 361 to rotate horizontally, and a driven gear in engagement with the driving gear, wherein the electromagnet 32 is connected to a rotary shaft of the driven gear. When the direction correcting motor 361 drives the driven gear to rotate horizontally through the driving gear, the driven gear will drive the electromagnet 32 to rotate horizontally.

As shown in Figures 6, 7 and 8, in this embodiment, the lateral moving mechanism includes: two second slide rails 341 that are both arranged on the platform 31 and one is in front of the other, a sliding support 342, a lateral moving motor 343 fixed to a side of the platform 31, a driving wheel 344 that can be driven into rotation by a motor shaft of the lateral moving motor 343, a driven wheel 345 fixed to the other side of the platform 31, and a synchronous belt 346. Said two second sliding rails 341 are arranged laterally, that is, perpendicular to the conveying direction of the conveyor belt 10, and the sliding support 342 is slidably connected to said two second sliding rails 341, so that it can slide rightward or leftward. The synchronous belt 346 is wound around the driving wheel 344 and the driven wheel 345, and both ends of the synchronous belt 346 are fixedly connected to the sliding support 342 through angle steels 347. The electromagnet 32 is arranged at the sliding support 342. When the lateral moving motor 343 is activated, the driving wheel 344 rotates to drive the synchronous belt 346 to move, which, in turn, drives the sliding support 342 and the electromagnet 32 to slide rightward or leftward along the second slide rails 341.

The vertical moving mechanism includes: a vertical moving motor 351 fixed to the sliding support 342, a second gear 352 that can be driven into rotation through the vertical moving motor 351, and a second rack 353 arranged vertically. The direction

correcting motor 361 is fixedly mounted on a vertical plate 354, which is connected with the sliding support 342 and vertically slidable thereon. The second rack 353 is fixed on the rear side of the vertical plate 354, so that the electromagnetic 32 will move along the vertical direction synchronously with the second rack 353, which is in engagement with the second gear 352. When the vertical moving motor 351 drives the second gear 352 into rotation, the second gear 352 will drive the second rack 353 to move vertically upward or downward. Accordingly, the vertical plate 354, the direction correcting motor 361 and the electromagnet 32 will also move vertically upward or downward in a synchronous manner.

Thus, the platform moving mechanism can drive the platform 31 and the electromagnet 32 to move along the forward or backward direction, the direction correcting mechanism can adjust the horizontal angle of the electromagnet 32, the lateral moving mechanism can drive the electromagnet 32 to move along the rightward or leftward direction, and the vertical moving mechanism can drive the electromagnet 32 to moved along the upward or downward direction. Of course, a sensor in signal communication with the PLC is arranged on the electromagnet 32, for sensing the position of the electromagnet 32. With the cooperation of the above-mentioned mechanisms, the metal member 10 can be picked up, moved to a set position, and then placed down.

As shown in Figure 3 or 4, in this embodiment, the metal member pushing device is arranged at a position above the upstream end of the conveyor belt 11. It includes a base frame 61, a pushing cylinder 62, a locking cylinder 63, a lateral moving cylinder 64, and a plurality of cylinder sensors for sensing movement states of the pushing cylinder 62, the locking cylinder 63 and the lateral moving cylinder 64, respectively. One or more a metal member loading boxes 20, in which the metal member 10 is received, can be placed on the base frame 61. The distance between a front edge and a rear edge of the base frame 61 can be adjusted through the locking cylinder 63. When the distance between the front and rear edges of the base frame is reduced, the metal member loading box 20 will be locked, while when the distance between the front and rear edges of the base frame is increased, the metal member loading box 20 will be loosened for easy replacement thereof. The pushing cylinder

62 is used to push the metal member 10 in the metal member loading box 20 out to the upstream end of the conveyor belt 11, and the lateral moving cylinder 64 is used to drive the base frame 61 to move to the right or to the left. The pushing cylinder 62, the locking cylinder 63 and the lateral moving cylinder 64 are all connected with the electric control box, and each of the cylinder sensors is in signal communication with the PLC.

The whole procedure of the operation method for detecting the metal member and conveying the same from a starting position to a metal member carrier by means of the automatic conveyance and detection apparatus of metal member according to the present invention will be described in the following.

1. When the iron rake machine sends a signal indicating a metal member is required, the electric control box receives the signal to activate the conveyor belt motor 12 and two cameras 21.

2. When the conveyor belt motor 12 is activated, the locking cylinder 63 acts to reduce the distance between the front and rear edges of the base frame 61, so as to lock the metal member loading box 20. After that, the cylinder sensor corresponding to the locking cylinder 63 sends a signal to the PLC in the electric control box, which, in turn, sends a command to activate a solenoid valve corresponding to the lateral moving cylinder 64, which is pulled back accordingly. Then, the cylinder sensor corresponding to the lateral moving cylinder 64 sends a signal to the PLC, which, in turn, sends a command to activate a solenoid valve corresponding to the pushing cylinder 62, so that the pushing cylinder 62 pushes out the metal member 10 in the metal member loading box 20 forward.

3. After the metal member 10 is pushed out, it will fall on the upstream end of the conveyor belt 11, and thus be carried by the conveyor belt 11 to pass through the guide port 4. At this time, if the metal member is excessively thick or severely deformed, the metal member 10 will come in contact with the movable sensing sheet 23 located here, so that the first sensor 24 will send a signal to the PLC in the electric control box. Then, the PLC will block the workpiece sensor 5, so that this unqualified

metal member 10 will be conveyed to a waste box 7 arranged at the downstream end of the conveyor belt 11. If the metal member 10 is qualified, the metal member 10 will be conveyed to a position where the workpiece sensor 5 is located. Accordingly, the PLC will control the metal member 10 to stop when it is detected by the workpiece sensor 5.

4. After the metal member 10 stops, two cameras 21 start to work at the same time, in order to determine, based on images taken and through the vision system, whether the position and size of the opening of the metal member 10 are deviated or qualified, and whether the metal member 10 is guided away from its direction, or the like. If the metal member 10 is not qualified, the PLC will control the conveyor belt 11 to deliver the metal member 10 to the waste box 7. If the position and size of the opening are both qualified, the platform moving motor 333 is activated to move the platform 31 from its original position to a designated position above the metal member 10.

5. When the platform 31 stops in position accurately and stably, a signal is sent to the electric control box, so that the PLC sends an instruction to activate the vertical moving motor 351. Therefore, the second gear 352 on the vertical moving motor 351 rotates to drive the second rack 353 meshed therewith to move downward, thereby driving the electromagnet 32 to move downward for picking up the metal member 10. At the same time, the electromagnet 32 is energized to pick up the metal member 10 when touching the metal member 10.

6. After the metal member 10 is picked up and kept stably, the PLC will prompt, according to the signal provided by two cameras 21, whether it is necessary to activate the direction correcting motor 361 to adjust any angle deviation of the metal member 10.

7. After the above operations are completed, the platform moving motor 333 is activated, so that the platform 31 carrying the metal member 10 will move to the set position above the metal member carrier, and then stop.

8. When the platform moving motor 333 stops in stable, a signal is sent. Based on this signal, together with a signal from the metal member carrier indicating whether there is a metal member on the metal member carrier, the PLC sends an instruction to activate the lateral moving motor 343, so that the electromagnet 32 carrying the metal member 10 can move rightward or leftward to a position where a metal member is required.

9. When the lateral moving motor 343 stops in stable, a signal is sent. Based on which, the PLC activates the vertical moving motor 351 to move the electromagnet 32 downward to the designated position where a metal member is required.

10. When the electromagnet 32 is lowered to its position, a signal is sent. Based on which, the PLC de-energizes the electromagnet 32, so that the metal member 10 is stably placed on the metal member carrier.

11. After the metal member is placed, the vertical moving motor 351 is activated to lift the electromagnet 32.

12. After the electromagnet 32 is lifted to its position, the PLC judges, based on this signal together with a signal from the metal member carrier indicating whether there is a metal member on the metal member carrier, whether it is necessary to pick up a further metal member. If necessary, the above steps will be repeated automatically. If not, another metal member will be still picked up to the origin position of the platform 31 for ready according to the setting.

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 conveyance and detection apparatus of metal member, comprising a conveying device for conveying a metal member (10), a detecting device
5 for detecting the metal member (10), a movable metal member picking-and-placing device for picking up and placing down the metal member (10), and an electric control box, the conveying device including a conveyor belt (11) and a conveyor belt motor (12) for driving the conveyor belt (11) in operation,

characterized in that the electric control box is provided therein with a PLC,
10 wherein the conveying device, the detecting device, and the metal member picking-and-placing device are connected to the electric control box respectively and controlled by the PLC;

the detecting device includes at least one camera (21), which is arranged above the conveyor belt (11), for taking images of the metal member (10); and

15 the metal member picking-and-placing device includes a platform (31) arranged above the conveyor belt (11), an electromagnet (32) arranged on the platform (31), a platform moving mechanism for driving the platform (31) to move along a forward or backward direction, a lateral moving mechanism for driving the electromagnet (32) to move along a rightward or leftward direction, a vertical moving mechanism for
20 driving the electromagnet (32) to move along an upward or downward direction, and a direction correcting mechanism for driving the electromagnet (32) to rotate horizontally.

2. The automatic conveyance and detection apparatus of metal member
25 according to claim 1, characterized in that the platform moving mechanism includes two first sliding rails (331) and two first racks (332) respectively arranged along the forward or backward direction, a platform moving motor (333) fixed on the platform (31), two synchronous wheels (334), wherein one is above the other and are driven by a motor shaft of the platform moving motor (333), and a first gear (335) that is
30 rotatable coaxially with a lower synchronous wheel (334),

wherein the platform (31) is slidably connected with the first sliding rails (331), and the first racks (332) are in engagement with the first gear (335), and

wherein the platform moving motor (333) drives the synchronous wheels (334)

and the first gear (335) into rotation, so that the platform (31) is driven to slide along the first sliding rails (331) through the first racks (332).

3. The automatic conveyance and detection apparatus of metal member
5 according to claim 1, characterized in that

the lateral moving mechanism includes at least one second slide rail (341) arranged on the platform (31) laterally, a sliding support (342) slidably connected to the second slide rail (341), a lateral moving motor (343) fixed to a first side of the platform (31), a driving wheel (344) configured to be driven into rotation by a motor
10 shaft of the lateral moving motor (343), a driven wheel (345) fixed to a second side of the platform (31), and a synchronous belt (346) wound around the driving wheel (344) and the driven wheel (345), with both ends thereof being fixedly connected to the sliding support (342), wherein the electromagnet (32) is arranged at the sliding support (342), and the lateral moving motor (343) drives the synchronous belt (346) to
15 move through the driving wheel (344) and the driven wheel (345), so that the synchronous belt (346) drives the sliding support (342) and the electromagnet (32) to slide along the second slide rail (341) along the rightward or leftward direction; and

the vertical moving mechanism includes a vertical moving motor (351) fixed to the sliding support (342), a second gear (352) configured to be driven into rotation
20 through the vertical moving motor (351), and a second rack (353) arranged vertically, wherein the second gear (352) is in engagement with the second rack (353), the electromagnet (32) move vertically in a manner synchronous with the second rack (353), and the vertical moving motor (351) drives the second gear (352) into rotation, so as to enable the electromagnet (32) and the second rack (353) move vertically.

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4. The automatic conveyance and detection apparatus of metal member according to claim 3, characterized in that the direction correcting mechanism includes a direction correcting motor (361), a driving gear driven by the direction correcting motor (361) to rotate horizontally, and a driven gear in engagement with
30 the driving gear,

wherein the electromagnet (32) is connected to a rotary shaft of the driven gear, the direction correcting motor (361) drives, through the driving gear, the driven gear to rotate horizontally, which, in turn, drives the electromagnet (32) to rotate

horizontally.

5 5. The automatic conveyance and detection apparatus of metal member according to any one of claims 1 to 4, characterized in that the detecting device further includes at least one illuminator (22), which is arranged above the conveyor belt (11) and used for lighting the camera (21).

10 6. The automatic conveyance and detection apparatus of metal member according to any one of claims 1 to 4, characterized in that a guide port (4), which is gradually tapered along a conveying direction, is provided in a conveying path of the conveyor belt (11).

15 7. The automatic conveyance and detection apparatus of metal member according to claim 6, characterized in that the detecting device further includes a movable sensing sheet (23) arranged in front of the guide port (4), and a first sensor (24) in signal communication with the PLC,

20 wherein a gap between the movable sensing sheet (23) and the conveyor belt (11) just allows the metal member (10) of standard size to pass therethrough, and a signal is sent to the PLC through the first sensor (24) when the metal member (10) comes into touch with the movable sensing sheet (23).

25 8. The automatic conveyance and detection apparatus of metal member according to any one of claims 1 to 4, characterized in that a workpiece sensor (5) for sensing the metal member (10) is arranged under a downstream end of the conveyor belt (11), the workpiece sensor (5) being in signal communication with the PLC.

30 9. The automatic conveyance and detection apparatus of metal member according to any one of claims 1 to 4, characterized in that the apparatus further includes a metal member pushing device arranged above an upstream end of the conveyor belt (11),

 wherein the metal member pushing device comprises a base frame (61) for receiving a metal member loading box (20), a pushing cylinder (62) for pushing the metal member (10) in the metal member loading box (20) out, a locking cylinder (63)

for adjusting a distance between a front edge and a rear edge of the base frame (61), a lateral moving cylinder (64) for driving the base frame (61) to move along the rightward or leftward direction, and a plurality of cylinder sensors for sensing movement states of the pushing cylinder (62), the locking cylinder (63) and the lateral moving cylinder (64), respectively; and

the pushing cylinder (62), the locking cylinder (63) and the lateral moving cylinder (64) are all connected with the electric control box, and each of the cylinder sensors is in signal communication with the PLC.

10. A method of operating the automatic conveyance and detection apparatus of metal member according to any one of claims 1 to 9, comprising steps of:

conveying, through the conveyor belt (11) under a command from the PLC, the metal member (10) forward;

activating, after the conveyor belt (11) is controlled by the PLC to stop, the camera (21) of the detecting device, in order to determine, based on images taken and through a vision system, whether position and size of an opening of the metal member (10) are deviated or qualified, or whether the metal member (10) is guided away from its direction, and conveying, through the conveyor belt (11) controlled by the PLC, the metal member (10) to a waste box (7) arranged at a downstream end of the conveyor belt (11), if the metal member (10) is not qualified, while activating the metal member picking-and-placing device to move the platform (31) from its original position to a position above the metal member (10), if qualified;

moving, through the vertical moving mechanism of the metal member picking-and-placing device controlled by the PLC, the electromagnet (32) downward and energizing the electromagnet (32) concurrently, and then moving the electromagnet (32) upward when the electromagnet (32) contacts and attracts the metal member (10);

prompting, through the PLC according to a signal from the camera (21), whether it is necessary to activate the direction correcting mechanism to adjust a direction of the metal member (10), after the metal member (10) is picked up;

activating the platform moving mechanism of the metal member picking-and-placing device, so that the metal member (10) is carried by the platform moving mechanism to a designated position above the metal member carrier before

stopped;

5 sending, through the PLC based on a signal indicating the platform moving mechanism is stopped and a signal from the metal member carrier indicating whether there is the metal member thereon, an instruction to activate the lateral moving mechanism, so that the electromagnet (32) with the metal member (10) move along the rightward or leftward direction to a position where the metal member (10) is required; and

10 de-energizing, through the PLC based on a signal indicating the vertical moving mechanism drives the electromagnet (32) downward to a designated low position, the electromagnet (32), placing the metal member (10) on the metal member carrier, and then moving, through the vertical moving mechanism, the electromagnet (32) upward.