

AUTOMATIC METAL WIRE BENDING MACHINE AND AUTOMATIC BENDING METHOD THEREOF

Technical Field

The present invention relates to a metal processing technology, in particular to an automatic metal wire bending machine and an automatic bending method thereof.

Background

In the prior art, the lifting lug product formed by bending a metal wire is finally formed by adopting a fixed-length straight metal wire after several bending. The lifting lug product is originally produced manually by simple tooling such as bending vices. With the increase of the yield, the production process needs more manpower, and is low in the degree of automation and low in production efficiency. Moreover, the quality of the products produced is unstable. The prior art has the defects of time and labor consumption, high working strength, low production efficiency, quality instability, inability to achieve automatic production by cycles, etc. in production of the lifting lug by manual bending. There is an urgent need for an automatic metal wire bending machine that can realize automatic bending and forming according to a certain production cycle, so as to load and position the fixed-length straight metal wire according to the cycle, bend and form the metal wire according to the cycle to leave an assembly line, and meet an interface of a subsequent automatic device. That is, the lifting lug product leaves the assembly line according to the cycle, and the subsequent device can automatically grasp and enter the next procedure for production according to the cycle.

Summary

A technical problem to be solved in the present invention is to provide an automatic metal wire bending machine and an automatic bending method thereof with respect to the above defects in the prior art.

To achieve the above purpose, the present invention provides an automatic metal wire bending machine, comprising:

a stepping handling mechanism, comprising a main rack, a lifting mechanism and a translation mechanism, wherein the lifting mechanism is installed on the main rack and moves up and down along the main rack; the translation mechanism is connected with the lifting mechanism; the translation mechanism is horizontally switched among a first station, a second station, a third station, a fourth station and a moving-out station arranged sequentially respectively relative to the main rack; and the translation mechanism is provided with first handling claws relative to the first station, the second station and the third station respectively, and provided with a second handling claw relative to the fourth station;

a first bending mechanism, arranged on the first station and used for symmetrically bending a fixed-length straight metal wire into a U-shaped metal wire;

a second bending mechanism, arranged on the second station and used for symmetrically bending the ends of the U-shaped metal wire handled to the second station by the stepping handling mechanism into outwards-facing structures;

a third bending mechanism, arranged on the third station and used for symmetrically inwards bending and forming the U-shaped metal wire handled to the third station by the stepping handling mechanism and having the ends with the outwards-facing structures; and

a fourth bending mechanism, arranged on the fourth station and used for bending and forming the inwards-bent U-shaped metal wire handled to the fourth station by the stepping handling mechanism into a finished lifting lug.

In the above automatic metal wire bending machine, wherein the lifting mechanism comprises a lifting frame, a lifting cylinder, a lifting guide rail, a lifting slider and a lifting limiting element; the lifting guide rail is installed on the main rack; the lifting frame is connected with the lifting guide rail through the lifting slider; the lifting cylinder is installed at the bottom of the main rack and connected with the lifting frame to drive the lifting frame to move up and down relative to the main frame; and the lifting limiting element is installed on the main rack correspondingly to the bottom end of the lifting guide rail to ensure that the lowering height of the lifting frame is adapted to the height of a grasping position of a workpiece.

In the above automatic metal wire bending machine, wherein the translation mechanism comprises: a translation cylinder, a translation crossbeam, a translation guide rail, a traversing slider, a translation stopper and a translation limiting element; the translation crossbeam is installed on the translation guide rail; the translation guide rail is connected with the traversing slider; the traversing slider is installed on a front panel of the lifting frame; the translation cylinder is connected with the translation crossbeam and drives the translation crossbeam to move back and forth horizontally; the translation stopper is installed at the lower end of the translation crossbeam and matched with the translation limiting element to ensure the stepping distance of translation; and the front side of the translation crossbeam is provided with the first handling claws corresponding to the first station, the second station and the third station respectively, and provided with the second handling claw corresponding to the fourth station.

In the above automatic metal wire bending machine, wherein the first bending mechanism comprises:

a frame platform, arranged at the first station, wherein a platform surface of the frame platform is provided with a guide groove;

an elevating mechanism, comprising an elevating beam, an elevating cylinder and a guide port, wherein the guide port is installed on one side of the guide groove; the elevating beam is located below the platform surface of the frame platform and arranged opposite to the guide

groove; and the elevating cylinder is installed on the frame platform and connected with the elevating beam;

a first positioning mechanism, comprising a forming positioning block, dynamic forming blocks and a bending pressing plate, wherein the forming positioning block is installed on the platform surface of the frame platform and located on one side of the guide groove; a first groove is arranged correspondingly to the forming positioning block; the bending pressing plate is installed on the platform surface of the frame platform through a pressing plate sliding rail and located on the other side of the guide groove; the dynamic forming blocks are symmetrically arranged correspondingly to the forming positioning block and hinged with the bending pressing plate; and the dynamic forming blocks have forming surfaces adapted with the forming positioning block; and

a first forming mechanism, comprising a first bending pressing cylinder and a pressure swing arm, wherein the first bending pressing cylinder is installed on the frame platform and connected with the pressure swing arm; and the pressure swing arm is connected with the bending pressing plate through the pressing plate crossbeam.

In the above automatic metal wire bending machine, wherein the bending pressing plate is also provided with an elastic driving element, comprising a forming elastic pressing block, a spring adjusting rod and a spring; the spring adjusting rod is installed on the bending pressing plate; the front end of the forming elastic pressing block is abutted against the rear end of the dynamic forming block; and both ends of the spring are abutted against the spring adjusting rod and the rear end of the forming elastic pressing block respectively.

In the above automatic metal wire bending machine, wherein the second bending mechanism comprises:

an installing substrate, arranged on the second station;

a second positioning mechanism, comprising a positioning block, bending fixing blocks, bending moving blocks and a middle limiting block, wherein the positioning block is arranged on the installing substrate; the middle limiting block is arranged correspondingly to the positioning block; the bending fixing blocks are symmetrically arranged on both sides of the middle limiting block; the bending moving blocks are symmetrically arranged at one end of the middle limiting block correspondingly to the bending fixing blocks; and the bending moving blocks and the bending fixing blocks are provided with mutually adapted processing surfaces respectively; the installing substrate is provided with a second groove corresponding to the positioning block; and

a second forming mechanism, comprising a second bending pressing cylinder, a second bending sliding plate, a second bending guide rail, a second moving bending base slider, a second bending sliding plate guide rail and second bending connecting rods; the second bending pressing cylinder is connected with the second bending sliding plate; the second bending sliding plate is installed on a bottom surface of the installing substrate through the second bending sliding plate guide rail; one end of the second bending connecting rods arranged symmetrically is hinged with

the second bending sliding plate respectively; the other end of the second bending connecting rods is connected with the second moving bending base slider respectively; the second moving bending base slider is installed on the bottom surface of the installing substrate through the second bending guide rail; the second bending base slider is connected with the bending moving blocks respectively and drives the bending moving blocks to move synchronously towards or away from each other.

In the above automatic metal wire bending machine, wherein the third bending mechanism comprises:

a substrate, arranged on the third station;

a third positioning mechanism, installed on the substrate and comprising a positioning element, bending fixing elements, bending moving elements and a middle limiting element, wherein the positioning element is arranged on the substrate; the middle limiting element is arranged correspondingly to the positioning element; the bending fixing elements are symmetrically arranged on both sides of the middle limiting element; the bending moving elements are symmetrically arranged at both sides of the middle limiting element correspondingly to the bending fixing elements; and the bending moving elements and the middle limiting element are provided with mutually adapted processing surfaces respectively; the substrate is provided with a third groove corresponding to the positioning element; and

a third forming mechanism, comprising a third bending pressing cylinder, a third bending sliding plate, a third bending slider, a third bending swing rod and third bending connecting rods, wherein the third bending pressing cylinder is connected with the third bending sliding plate; the third bending sliding plate is installed on a bottom surface of the substrate through a third bending sliding plate guide rail; the third bending slider is installed on the substrate through a third bending slider guide rail; one end of the third bending connecting rods arranged symmetrically is hinged with the third bending sliding plate respectively; the other end of the third bending connecting rods is connected with one end of the third bending swing rod respectively; the other end of the third bending swing rod is connected with the third bending slider; and the third bending slider is connected with the bending moving elements and drives the bending moving elements to move synchronously towards or away from each other.

In the above automatic metal wire bending machine, wherein the fourth bending mechanism comprises:

a vertical frame, arranged on the fourth station and comprising a base and a vertical column;

a fourth positioning mechanism, arranged on an upper surface of the base and comprising an end bending block and a fixing block, wherein the fixing block is provided with a fourth groove;

an upper forming mechanism, comprising an upper bending pressing cylinder, an upper bending sliding plate and an upper bending slider, wherein the upper bending pressing cylinder is installed on the vertical column; the upper bending sliding plate is installed on the vertical column through an upper bending sliding plate guide rail; the upper bending slider is installed on the upper

bending sliding plate through an upper bending slider guide rail; and the bottom of the upper bending sliding plate is provided with an end bending pressing block; and

a lower forming mechanism, arranged on an inclined surface of the base correspondingly to the fourth positioning mechanism and comprising a lower bending pressing cylinder and a lower bending slider, wherein the lower bending pressing cylinder is connected with the lower bending slider, and the lower bending slider is installed on the base through the lower bending slider guide rail.

In the above automatic metal wire bending machine, wherein the upper forming mechanism also comprises an elastic adjusting mechanism which comprises an adjusting screw sleeve positioning block, an upper limiting screw rod and an upper bending spring; the upper limiting screw rod is installed in the adjusting screw sleeve positioning block through an upper spring adjusting screw sleeve and is connected with the top of the upper bending slider; and both ends of the upper bending spring are abutted against a top surface of the upper bending slider and the bottom end of the upper spring adjusting screw sleeve respectively.

To better achieve the above purpose, the present invention further provides an automatic metal wire bending method, comprising the following steps:

S100: positioning the fixed-length straight metal wire on the first station of the automatic metal wire bending machine, and bending the straight metal wire symmetrically into a U-shaped metal wire by the first bending mechanism;

S200: handling the U-shaped metal wire to the second station by the stepping handling mechanism, and bending the ends of the U-shaped metal wire symmetrically into outwards-facing structures by the second bending mechanism;

S300: handling the U-shaped metal wire having the ends with the outwards-facing structures to the third station by the stepping handling mechanism, and inwards bending and forming the U-shaped metal wire symmetrically by the third bending mechanism;

S400: handling the inwards-bent U-shaped metal wire to the fourth station by the stepping handling mechanism, and bending and forming the U-shaped metal wire into a finished lifting lug by the fourth bending mechanism; and

S500: handling the finished lifting lug by the stepping handling mechanism for leaving an assembly line.

The present invention has the following technical effects:

The present invention can automatically realize the bending production of a metal lifting lug. The automatic bending machine realizes the massing of the structural mechanism, has simple and compact overall structure and is convenient for operation, repair and maintenance. The automatic bending machine can realize automatic bending of metal wires with standard diameter, and can realize automatic bending of metal wires such as aluminum, copper, iron and other metal materials, and composite wires.

The present invention is described below in detail in combination with drawings and specific embodiments, but the present invention is not limited.

Description of Drawings

Figs. 1A and 1B are structural schematic diagrams of an embodiment of the present invention;

Fig. 2 is a process diagram of an automatic bending technology of an embodiment of the present invention;

Fig. 3 is a structural schematic diagram of a first bending mechanism of an embodiment of the present invention;

Fig. 4 is a sectional view of Fig. 3;

Figs. 5A and 5B are schematic diagrams of a working process of a first bending mechanism;

Fig. 6A is a structural schematic diagram of a second bending mechanism of an embodiment of the present invention;

Fig. 6B is another structural schematic diagram of Fig. 6A;

Figs. 7A and 7B are schematic diagrams of a working process of a second bending mechanism;

Fig. 8A is a structural schematic diagram of a third bending mechanism of an embodiment of the present invention;

Fig. 8B is another structural schematic diagram of Fig. 8A;

Figs. 9A and 9B are schematic diagrams of a working process of a third bending mechanism;

Fig. 10 is a structural schematic diagram of a fourth bending mechanism of an embodiment of the present invention;

Fig. 11 is a sectional view of Fig. 10;

Fig. 12 is a processing sectional view of another station of Fig. 10;

Fig. 13A is a structural schematic diagram of a stepping handling mechanism of an embodiment of the present invention;

Fig. 13B is a top view of Fig. 13A.

In the figures, reference signs are as follows:

1 first bending mechanism

11 frame platform

12 first positioning mechanism

121 dynamic forming block

- 122 forming positioning block
- 123 bending pressing plate
 - 1231 pressing plate sliding rail
 - 1232 pressing plate crossbeam
- 124 spring pressing sheet
- 13 elevating mechanism
 - 131 guide port
 - 132 elevating beam
 - 133 elevating cylinder
- 14 first forming mechanism
 - 141 first bending pressing cylinder
 - 142 pressure swing arm
 - 143 swing arm middle shaft
 - 144 pressure-bearing slider
 - 145 cylinder rod pin shaft
 - 146 limiting bolt
 - 147 spring
 - 148 spring adjusting rod
 - 149 forming elastic pressing block
- 15 first groove
- 2 second bending mechanism
 - 21 installing substrate
 - 22 second positioning mechanism
 - 221 positioning block
 - 222 bending fixing block
 - 223 bending moving block
 - 224 middle limiting block
 - 23 second forming mechanism
 - 231 second bending pressing cylinder
 - 232 second bending sliding plate
 - 233 second bending guide rail
 - 234 second moving bending base slider
 - 235 second base slider pin shaft
 - 236 second bending sliding plate guide rail
 - 237 second bending connecting rod
 - 238 second limiting screw rod

- 24 second groove
- 3 third bending mechanism
 - 31 substrate
 - 32 third positioning mechanism
 - 321 positioning element
 - 322 bending fixing element
 - 323 bending moving element
 - 324 middle limiting element
 - 33 third forming mechanism
 - 331 third bending pressing cylinder
 - 332 third bending sliding plate
 - 3321 third bending sliding plate guide rail
 - 333 third bending slider
 - 3331 third bending slider guide rail
 - 3332 third bending slider transfer block
 - 334 third limiting screw rod
 - 335 third bending connecting rod
 - 3351 third connecting pin shaft
 - 336 third bending swing rod
 - 3361 third fixing rotating shaft
 - 3362 third bending slider pin shaft
 - 337 third alignment limiting slider
 - 34 third groove
- 4 fourth bending mechanism
 - 41 vertical frame
 - 42 fourth positioning mechanism
 - 421 end bending block
 - 422 fixing block
 - 43 upper forming mechanism
 - 431 upper bending pressing cylinder
 - 432 upper bending sliding plate
 - 4321 upper bending sliding plate guide rail
 - 433 upper bending slider
 - 4331 upper bending slider guide rail
 - 434 end bending pressing block
 - 435 upper limiting screw rod

- 436 upper spring adjusting screw sleeve
 - 437 adjusting screw sleeve positioning block
 - 438 upper bending spring
- 44 lower forming mechanism
 - 441 lower bending pressing cylinder
 - 442 lower bending slider
 - 443 lower bending slider guide rail
- 45 fourth groove
- 5 stepping handling mechanism
 - 51 main rack
 - 52 lifting mechanism
 - 521 lifting guide rail
 - 522 lifting slider
 - 523 lifting frame
 - 524 lifting limiting element
 - 525 lifting cylinder
 - 53 translation mechanism
 - 531 translation crossbeam
 - 532 translation stopper
 - 533 translation limiting element
 - 534 translation cylinder
 - 535 translation guide rail
 - 536 traversing slider
 - 54 first handling claw
 - 55 second handling claw
- 6 metal wire
- 7 lifting lug
- A first station
- B second station
- C third station
- D fourth station
- E moving-out station

Detailed Description

The structural principle and the working principle of the present invention are described below in detail in combination with the drawings.

By referring to Fig. 1A and Fig. 1B, Figs. 1A and 1B are structural schematic diagrams of different operating states of an embodiment of the present invention. The automatic metal wire bending machine of the present invention is used for achieving automatic production of a product of a metal lifting lug 7. The automatic metal wire bending machine comprises: a stepping handling mechanism 5, comprising a main rack 51, a lifting mechanism 52 and a translation mechanism 53, wherein the lifting mechanism 52 is installed on the main rack 51 and moves up and down along the main rack 51; the translation mechanism 53 is connected with the lifting mechanism 52; the translation mechanism 53 is horizontally switched among a first station A, a second station B, a third station C, a fourth station D and a moving-out station E arranged sequentially respectively relative to the main rack 51; and the translation mechanism 53 is provided with first handling claws 54 relative to the first station A, the second station B and the third station C respectively, and provided with a second handling claw 55 relative to the fourth station D; a first bending mechanism 1, arranged on the first station A and used for symmetrically bending a fixed-length straight metal wire into a U-shaped metal wire 6; a second bending mechanism 2, arranged on the second station B and used for symmetrically bending the ends of the U-shaped metal wire 6 handled to the second station B by the stepping handling mechanism 5 into outwards-facing structures; a third bending mechanism 3, arranged on the third station C and used for symmetrically inwards bending and forming the U-shaped metal wire 6 handled to the third station C by the stepping handling mechanism 5 and having the ends with the outwards-facing structures; and a fourth bending mechanism 4, arranged on the fourth station D and used for bending and forming the inwards-bent U-shaped metal wire 6 handled to the fourth station D by the stepping handling mechanism 5 into a finished lifting lug 7.

By referring to Fig. 2, Fig. 2 is a process diagram of an automatic bending technology of an embodiment of the present invention. An automatic bending method for the metal wire 6 in the present invention comprises the following steps:

step S100: positioning the fixed-length straight metal wire on the first station A of the automatic metal wire bending machine, and bending the straight metal wire symmetrically into a U-shaped metal wire 6 by the first bending mechanism 1;

step S200: handling the U-shaped metal wire 6 to the second station B by the stepping handling mechanism 5, and bending the ends of the U-shaped metal wire 6 symmetrically into outwards-facing structures by the second bending mechanism 2;

step S300: handling the U-shaped metal wire 6 having the ends with the outwards-facing structures to the third station C by the stepping handling mechanism 5, and inwards bending and forming the U-shaped metal wire 6 symmetrically by the third bending mechanism 3;

step S400: handling the inwards-bent U-shaped metal wire 6 to the fourth station D by the stepping handling mechanism 5, and bending and forming the U-shaped metal wire 6 into a finished lifting lug 7 by the fourth bending mechanism 4; and

step S500: handling the finished lifting lug 7 by the stepping handling mechanism 5 for leaving an assembly line.

By referring to Fig. 3-Fig. 5B, Fig. 3 is a structural schematic diagram of a first bending mechanism 1 of an embodiment of the present invention; Fig. 4 is a sectional view of Fig. 3; and Figs. 5A and 5B are schematic diagrams of a working process of the first bending mechanism 1. In the present embodiment, the first bending mechanism 1 comprises: a frame platform 11, arranged at the first station A, wherein a platform surface of the frame platform 11 is provided with a guide groove; an elevating mechanism 13, comprising an elevating beam 132, an elevating cylinder 133 and a guide port 131, wherein the guide port 131 is installed on one side of the guide groove; the elevating beam 132 is located below the platform surface of the frame platform 11 and arranged opposite to the guide groove; and the elevating cylinder 133 is installed on the frame platform 11 and connected with the elevating beam 132; a first positioning mechanism 12, comprising a forming positioning block 122, dynamic forming blocks 121 and a bending pressing plate 123, wherein the forming positioning block 122 is installed on the platform surface of the frame platform 11 and located on one side of the guide groove; a first groove 15 is arranged correspondingly to the forming positioning block 122 on the frame platform 11 for reserving a space for grasping and placement of the claws; the bending pressing plate 123 is installed on the platform surface of the frame platform 11 through a pressing plate sliding rail 1231 and located on the other side of the guide groove; the dynamic forming blocks 121 are symmetrically arranged correspondingly to the forming positioning block 122 and hinged with the bending pressing plate 123; and the dynamic forming blocks 121 have forming surfaces adapted with the forming positioning block 122; and a first forming mechanism 14, comprising a first bending pressing cylinder 141 and a pressure swing arm 142, wherein the first bending pressing cylinder 141 is installed on the frame platform 11 and connected with the pressure swing arm 142; and the pressure swing arm 142 is connected with the bending pressing plate 123 through the pressing plate crossbeam 1232.

Wherein the bending pressing plate 123 is also provided with an elastic driving element, comprising a forming elastic pressing block 149, a spring adjusting rod 148 and a spring 147; the spring adjusting rod 148 is installed on the bending pressing plate 123; the front end of the forming elastic pressing block 149 is abutted against the rear end of the dynamic forming block 121; and both ends of the spring 147 are abutted against the spring adjusting rod 148 and the rear end of the forming elastic pressing block 149 respectively. A limiting bolt 146 is also arranged correspondingly to the pressure swing arm 142 below the frame platform 11.

A fixed-length conveying device conveys the fixed-length cut and straightened metal wire 6 through a guide port 131 to a position above the elevating beam 132. The elevating beam 132 is flush with the upper surface of the frame platform 11 through the elevation of the elevating

cylinder 133. Spring pressing sheets 124 at both ends have small elasticity to press the metal wire 6 to keep stable and immovable. A cylinder rod of the first bending pressing cylinder 141 extends. A cylinder rod pin shaft 145 drives the pressure swing arm 142 to swing along a swing arm middle shaft 143. An internal surface of a pressure-bearing slider 144 above the pressure swing arm 142 pushes a pressing plate crossbeam 1232, and drives the bending pressing plate 123 to move forward along a pressing plate sliding rail 1231. The front ends of the two dynamic forming blocks 121 arranged symmetrically firstly come into contact with the fixed-length straight metal wire. The straight metal wire begins to be bent under the reaction force of the forming positioning block 122. Finally, the inner arc surfaces of the two dynamic forming blocks 121 completely wrap the outer arc surface of the forming positioning block 122, and the fixed-length straight metal wire is symmetrically bent into a U-shaped metal wire 6.

Under the action of the spring 147, the front end of the forming elastic pressing block 149 is always abutted against the rear end surfaces of the two dynamic forming blocks 121 to prevent the reverse deformation of the bottom of the U-shaped metal wire 6 bent symmetrically in the bending process, so as to ensure the quality of the bending formation. The elasticity of the spring 147 can be adjusted by a spring adjusting rod 148. After the elevating cylinder 133 and the first bending pressing cylinder 141 return to the original positions, the first handling claws 54 on the stepping handling mechanism 5 can take away a workpiece of the symmetrically bent U-shaped metal wire 6 from a first groove 15 to the second bending mechanism 2 for further bending.

By referring to Figs. 6A-7B, Fig. 6A is a structural schematic diagram of the second bending mechanism 2 of an embodiment of the present invention; Fig. 6B is another structural schematic diagram of Fig. 6A; and Figs. 7A and 7B are schematic diagrams of a working process of the second bending mechanism 2. The second bending mechanism 2 comprises: an installing substrate 21, arranged on the second station B; a second positioning mechanism 22, comprising a positioning block 221, bending fixing blocks 222, bending moving blocks 223 and a middle limiting block 224, wherein the positioning block 221 is arranged on the installing substrate 21; the middle limiting block 224 is arranged correspondingly to the positioning block 221; the bending fixing blocks 222 are symmetrically arranged on both sides of the middle limiting block 224; the bending moving blocks 223 are symmetrically arranged at one end of the middle limiting block 224 correspondingly to the bending fixing blocks 222; and the bending moving blocks 223 and the bending fixing blocks 222 are provided with mutually adapted processing surfaces respectively; the installing substrate 21 is provided with a second groove 24 corresponding to the positioning block 221 for reserving a space for grasping and placement of the claws; and a second forming mechanism 23, comprising a second bending pressing cylinder 231, a second bending sliding plate 232, a second bending guide rail 233, a second moving bending base slider 234, a second bending sliding plate guide rail 236 and second bending connecting rods 237; the second bending pressing cylinder 231 is connected with the second bending sliding plate 232; the second bending sliding plate 232 is installed on a bottom surface of the installing substrate 21 through the second bending sliding plate guide rail 236; one end of the second bending connecting rods 237 arranged symmetrically is hinged with the second bending sliding plate 232 respectively; the other

end of the second bending connecting rods 237 is connected with the second moving bending base slider 234 respectively; the second moving bending base slider 234 is installed on the bottom surface of the installing substrate 21 through the second bending guide rail 233; and the second bending base slider is connected with the bending moving blocks 223 respectively and drives the bending moving blocks 223 to move synchronously towards or away from each other.

After the workpiece bent by the first bending mechanism 1 is grasped by the first handling claw 54 to the second bending mechanism 2, the workpiece is positioned at the positioning block 221, and the second bending pressing cylinder 231 starts to move. The cylinder rod extends, and drives the second bending sliding plate 232 to move along the second bending sliding plate guide rail 236. The pin shaft at the front end of the second bending sliding plate 232 is connected with two symmetrical second bending connecting rods 237. The second bending connecting rods 237 are connected with the second moving bending base slider 234 through a second base slider pin shaft 235, so as to drive the second moving bending base slider 234 to move to both sides along the second bending guide rail 233. Second bending moving blocks 223 are installed on the other side of the second moving bending base slider. The two second bending moving blocks 223 move symmetrically to both sides, and the end of the workpiece that is symmetrically bent into the U-shaped metal wire 6 begins to be bent. Due to the limiting action of the two symmetrical bending fixing blocks 222 and the anti-deformation action of the metal wire 6 of the middle limiting block 224, the inclined end surfaces of the two symmetrical bending moving blocks 223 and the bending fixing blocks 222 are finally pressed in place, and the workpiece is bent into outwards-facing structures with symmetrical ends. A second limiting screw rod 238 plays a role of movement limiting. Then, the second bending pressing cylinder 231 drives the mechanism back to the original position. The first handling claw 54 grasps away the workpiece in the second groove 24, and places the workpiece in the third bending mechanism 3 for the next bending step.

By referring to Figs. 8A-9B, Fig. 8A is a structural schematic diagram of the third bending mechanism 3 of an embodiment of the present invention; Fig. 8B is another structural schematic diagram of Fig. 8A; and Figs. 9A and 9B are schematic diagrams of a working process of the third bending mechanism 3. The third bending mechanism 3 in the present embodiment comprises: a substrate 31, arranged on the third station C; a third positioning mechanism 32, installed on the substrate 31 and comprising a positioning element 321, bending fixing elements 322, bending moving elements 323 and a middle limiting element 324, wherein the positioning element 321 is arranged on the substrate 31; the middle limiting element 324 is arranged correspondingly to the positioning element 321; the bending fixing elements 322 are symmetrically arranged on both sides of the middle limiting element 324; the bending moving elements 323 are symmetrically arranged at both sides of the middle limiting element 324 correspondingly to the bending fixing elements 322; and the bending moving elements 323 and the middle limiting element 324 are provided with mutually adapted processing surfaces respectively; the substrate 31 is provided with a third groove 34 corresponding to the positioning element 321 for reserving a space for grasping and placement of the claws; and a third forming mechanism 33, comprising a third bending pressing cylinder 331, a third bending sliding plate 332, a third bending slider 333, a third bending

swing rod 336 and third bending connecting rods 335, wherein the third bending pressing cylinder 331 is connected with the third bending sliding plate 332; the third bending sliding plate 332 is installed on a bottom surface of the substrate 31 through a third bending sliding plate guide rail 3321; the third bending slider 333 is installed on the substrate 31 through a third bending slider guide rail 3331; one end of the third bending connecting rods 335 arranged symmetrically is hinged with the third bending sliding plate 332 respectively; the other end of the third bending connecting rods 335 is connected with one end of the third bending swing rod 336 respectively; the other end of the third bending swing rod 336 is connected with the third bending slider 333; and the third bending slider 333 is connected with the bending moving elements 323 and drives the bending moving elements 323 to move synchronously towards or away from each other. A third alignment limiting slider 337 is also arranged correspondingly to the third bending sliding plate 332.

After the workpiece bent by the second bending mechanism 2 is grasped by the first handling claw 54 to the third bending mechanism 3, the workpiece is positioned at the positioning element 321, and the third bending pressing cylinder 331 starts to move. The cylinder rod extends, and drives the third bending sliding plate 332 to move along the third bending sliding plate guide rail 3321. The pin shaft at the front end of the third bending sliding plate 332 is connected with two symmetrical third bending connecting rods 335. The third bending connecting rods 335 are connected with the third bending swing rod 336 through a third connecting pin shaft 3351. The third bending swing rod 336 swings along a third fixing rotating shaft 3361. The third bending swing rod 336 drives a third bending slider transfer block 3332 to move. The third bending slider transfer block 3332 is connected with a third bending slider 333 through a third bending slider pin shaft 3362, so as to drive the third bending slider 333 to move towards each other along the third bending slider guide rail 3331. Bending moving elements 323 are installed on the other side of the third bending slider 333. The two bending moving elements 323 move symmetrically towards each other. The workpiece begins to be bent. Due to the anti-deformation action of the metal wire 6 of the two symmetrical bending fixing elements 322, and the limiting action of the middle limiting element 324, the inclined end surfaces of the bending moving elements 323 and the middle limiting element 324 are finally pressed in place, and the workpiece is symmetrically and inwards bent and formed. A third limiting screw rod 334 plays a role of movement limiting. Then, the third bending pressing cylinder 331 drives the mechanism back to the original position. The first handling claw 54 grasps away the workpiece in the third groove 34, and places the workpiece in the fourth bending mechanism 4 for the next bending step.

By referring to Figs. 10-12, Fig. 10 is a structural schematic diagram of a fourth bending mechanism 4 of an embodiment of the present invention; Fig. 11 is a sectional view of Fig. 10; and Fig. 12 is a processing sectional view of another station of Fig. 10. The fourth bending mechanism 4 in the present embodiment comprises: a vertical frame 41, arranged on the fourth station D and comprising a base and a vertical column; a fourth positioning mechanism 42, arranged on an upper surface of the base and comprising an end bending block 421 and a fixing block 422, wherein the fixing block 422 is provided with a fourth groove 45 for reserving a space for grasping and

placement of the claws; an upper forming mechanism 43 , comprising an upper bending pressing cylinder 431, an upper bending sliding plate 432 and an upper bending slider 433, wherein the upper bending pressing cylinder 431 is installed on the vertical column; the upper bending sliding plate 432 is installed on the vertical column through an upper bending sliding plate guide rail 4321; the upper bending slider 433 is installed on the upper bending sliding plate 432 through an upper bending slider guide rail 4331; and the bottom of the upper bending sliding plate 432 is provided with an end bending pressing block 434; and a lower forming mechanism 44, arranged on an inclined surface of the base correspondingly to the fourth positioning mechanism 42 and comprising a lower bending pressing cylinder 441 and a lower bending slider 442, wherein the lower bending pressing cylinder 441 is connected with the lower bending slider 442, and the lower bending slider 442 is installed on the base through the lower bending slider guide rail 443.

Wherein the upper forming mechanism 43 also comprises an elastic adjusting mechanism which comprises an adjusting screw sleeve positioning block 437, an upper limiting screw rod 435 and an upper bending spring 438; the upper limiting screw rod 435 is installed in the adjusting screw sleeve positioning block 437 through an upper spring adjusting screw sleeve 436 and is connected with the top of the upper bending slider 433; and both ends of the upper bending spring 438 are abutted against a top surface of the upper bending slider 433 and the bottom end of the upper spring adjusting screw sleeve 436 respectively.

After the workpiece bent by the third bending mechanism 3 is grasped by the first handling claw 54 to the fourth bending mechanism 4, the claw moves to the fourth groove 45 and places the workpiece in place. The upper bending pressing cylinder 431 starts to move. The cylinder rod extends, and drives the upper bending sliding plate 432 to move downward along the upper bending sliding plate guide rail 4321. The upper bending slider 433 firstly comes into contact with the workpiece. The upper bending sliding plate 432 continues to move down, and the upper bending spring 438 contracts to play a role of pressure on the upper bending slider 433. The pressure of the upper bending spring 438 can also be adjusted by the upper spring adjusting screw sleeve 436, and the upper limiting screw rod 435 plays a role of guide limiting on the upper bending spring 438. The end bending pressing block 434 begins to come into contact with the workpiece through the continuing downward movement of the upper bending sliding plate 432 and completes the end bending under the joint clamping of the end bending block 421 and the bending fixing block 222. The lower bending pressing cylinder 441 starts to move. The lower bending slider 442 moves obliquely upwards along a lower bending slider guide rail 443. The lower bending slider 442 comes into contact with the workpiece, and then acts jointly with the upper bending slider 433 to complete the vertical bending of the front end of the workpiece. The upper bending pressing cylinder 431 and the lower bending pressing cylinder 441 return back to the original positions. The second handling claw 55 grasps away the workpiece in the fourth groove 45, and moves out from the bending machine for leaving an assembly line.

By referring to Figs. 13A and 13B, Fig. 13A is a structural schematic diagram of a stepping handling mechanism 5 of an embodiment of the present invention; and Fig. 13B is a top view of Fig. 13A. The lifting mechanism 52 in the present embodiment comprises a lifting frame 523, a

lifting cylinder 525, a lifting guide rail 521, a lifting slider 522 and a lifting limiting element 524; the lifting guide rail 521 is installed on the main rack 51; the lifting frame 523 is connected with the lifting guide rail 521 through the lifting slider 522; the lifting cylinder 525 is installed at the bottom of the main rack 51 and connected with the lifting frame 523 to drive the lifting frame 523 to move up and down relative to the main frame; and the lifting limiting element 524 is installed on the main rack 51 correspondingly to the bottom end of the lifting guide rail 521 to ensure that the lowering height of the lifting frame 523 is adapted to the height of a grasping position of the workpiece. Wherein the translation mechanism 53 comprises: a translation cylinder 534, a translation crossbeam 531, a translation guide rail 535, a traversing slider 536, a translation stopper 532 and a translation limiting element 533; the translation crossbeam 531 is installed on the translation guide rail 535; the translation guide rail 535 is connected with the traversing slider 536; the traversing slider 536 is installed on a front panel of the lifting frame 523; the translation cylinder 534 is connected with the translation crossbeam 531 and drives the translation crossbeam 531 to move back and forth horizontally; the translation stopper 532 is installed at the lower end of the translation crossbeam 531 and matched with the translation limiting element 533 to ensure the stepping distance of translation; and the front side of the translation crossbeam 531 is provided with the first handling claws 54 corresponding to the first station A, the second station B and the third station C respectively, and provided with the second handling claw 55 corresponding to the fourth station D.

The stepping handling mechanism 5 is used for handling the bent workpiece from the first to the fourth station D, realizing the stepping transportation of the workpiece, and finally realizing the automatic bending and handling of the whole machine. The lifting cylinder 525 is installed below the main rack 51, which can jack up the lifting frame 523 to realize rising and falling. Two lifting limiting elements 524 can ensure that the falling height meets the grasping position height of the claw for the workpiece. The lifting guide rail 521 and the lifting slider 522 ensure the stability of the lifting path.

A front panel of the lifting frame 523 is provided with a traversing slider 536, and the translation guide rail 535 is matched with the traversing slider and assembled. The translation crossbeam 531 is installed on the translation guide rail 535. The expansion and contraction of a rod of the translation cylinder 534 can realize the round-trip horizontal movement of the translation crossbeam 531. The translation stopper 532 is installed at the lower end of the crossbeam, and comes into contact with the translation limiting elements 533 at both ends in place in the round-trip movement to ensure the stepping distance of the translation. The front end of the translation crossbeam 531 is provided with four groups of handling claws respectively which correspond to four bending mechanisms one by one.

The lifting frame 523 of the stepping handling mechanism 5 initially stops positioning at the lifting limiting element 524. The first handling claws 54 and the second handling claw 55 above the four bending mechanisms are in the low positions synchronously. The claws are opened. The claws are closed to grab the workpiece according to the completion of automatic bending of each station. The cylinder rod of the lifting cylinder 525 is lifted, and the lifting frame 523 is lifted. The

first handling claws 54 and the second handling claw 55 at the front end of the translation crossbeam 531 lift the workpieces respectively. The translation cylinder 534 moves, and the cylinder rod extends. The translation crossbeam 531 moves horizontally by one station distance to the right side. That is, the workpieces on the first, second, third and fourth stations are moved by one station at the same time, and then the lifting cylinder 525 falls down. The workpieces of the first, second, third and fourth bending mechanisms are placed in the second, third and fourth mechanisms and the moving-out station E respectively. The first handling claws 54 and the second handling claw 55 are released. The cylinder rod of the lifting cylinder 525 is lifted again, and the empty handling claw is lifted. The cylinder rod of the translation cylinder 534 is withdrawn. The translation crossbeam 531 is returned to the original position. The cylinder rod of the lifting cylinder 525 falls again. The first handling claws 54 and the second handling claw 55 are returned to the original positions, so that the stepping handling mechanism 5 completes a stepping handling cycle. The next handling process is carried out according to the above.

The front end of the automatic metal wire bending machine is used in conjunction with a fixed-length conveying device of the metal wire, that is, the fixed-length conveying device conveys the fixed-length cut and straightened metal wire 6 onto the automatic metal wire bending machine for automatic bending; and the rear end can be used in conjunction with an automatic manipulator, that is, after the bent lifting lug 7 is conveyed out and placed by the stepping handling mechanism 5, the manipulator can automatically take away the lifting lug. Through the automatic action, the automatic bending process from the fixed-length straight metal wire to the finished lifting lug 7 is completed, and finally, a qualified product of a metal lifting lug 7 is bent and formed.

The present invention can automatically realize the bending production of the metal lifting lug 7. The automatic bending machine realizes the massing of the structural mechanism, has simple and compact overall structure and is convenient for operation, repair and maintenance. The automatic bending machine can realize automatic bending of metal wires with standard diameter, and can realize automatic bending of metal wires such as aluminum, copper, iron and other metal materials, and composite wires.

Of course, the present invention can also have various other embodiments, and various corresponding variations and modifications can be made by those skilled familiar with the art according to the present invention without departing from the spirit and essence of the present invention, but these corresponding variations and modifications shall belong to the protection scope of appended claims of the present invention.

Claims

1. An automatic metal wire bending machine, comprising:

a stepping handling mechanism, comprising a main rack, a lifting mechanism and a translation mechanism, wherein the lifting mechanism is installed on the main rack and moves up and down along the main rack; the translation mechanism is connected with the lifting mechanism; the translation mechanism is horizontally switched among a first station, a second station, a third station, a fourth station and a moving-out station arranged sequentially respectively relative to the main rack; and the translation mechanism is provided with first handling claws relative to the first station, the second station and the third station respectively, and provided with a second handling claw relative to the fourth station;

a first bending mechanism, arranged on the first station and used for symmetrically bending a fixed-length straight metal wire into a U-shaped metal wire;

a second bending mechanism, arranged on the second station and used for symmetrically bending the ends of the U-shaped metal wire handled to the second station by the stepping handling mechanism into outwards-facing structures;

a third bending mechanism, arranged on the third station and used for symmetrically inwards bending and forming the U-shaped metal wire handled to the third station by the stepping handling mechanism and having the ends with the outwards-facing structures; and

a fourth bending mechanism, arranged on the fourth station and used for bending and forming the inwards-bent U-shaped metal wire handled to the fourth station by the stepping handling mechanism into a finished lifting lug.

2. The automatic metal wire bending machine according to claim 1, wherein the lifting mechanism comprises a lifting frame, a lifting cylinder, a lifting guide rail, a lifting slider and a lifting limiting element; the lifting guide rail is installed on the main rack; the lifting frame is connected with the lifting guide rail through the lifting slider; the lifting cylinder is installed at the bottom of the main rack and connected with the lifting frame to drive the lifting frame to move up and down relative to the main frame; and the lifting limiting element is installed on the main rack correspondingly to the bottom end of the lifting guide rail to ensure that the lowering height of the lifting frame is adapted to the height of a grasping position of a workpiece.

3. The automatic metal wire bending machine according to claim 2, wherein the translation mechanism comprises: a translation cylinder, a translation crossbeam, a translation guide rail, a traversing slider, a translation stopper and a translation limiting element; the translation crossbeam is installed on the translation guide rail; the translation guide rail is connected with the traversing slider; the traversing slider is installed on a front panel of the lifting frame; the translation cylinder is connected with the translation crossbeam and drives the translation crossbeam to move back and forth horizontally; the translation stopper is installed at the lower end of the translation crossbeam and matched with the translation limiting element to ensure the stepping distance of translation; and the front side of the translation crossbeam is provided with the first handling claws

corresponding to the first station, the second station and the third station respectively, and provided with the second handling claw corresponding to the fourth station.

4. The automatic metal wire bending machine according to claim 1, 2 or 3, wherein the first bending mechanism comprises:

- a frame platform, arranged at the first station, wherein a platform surface of the frame platform is provided with a guide groove;

- an elevating mechanism, comprising an elevating beam, an elevating cylinder and a guide port, wherein the guide port is installed on one side of the guide groove; the elevating beam is located below the platform surface of the frame platform and arranged opposite to the guide groove; and the elevating cylinder is installed on the frame platform and connected with the elevating beam;

- a first positioning mechanism, comprising a forming positioning block, dynamic forming blocks and a bending pressing plate, wherein the forming positioning block is installed on the platform surface of the frame platform and located on one side of the guide groove; a first groove is arranged correspondingly to the forming positioning block; the bending pressing plate is installed on the platform surface of the frame platform through a pressing plate sliding rail and located on the other side of the guide groove; the dynamic forming blocks are symmetrically arranged correspondingly to the forming positioning block and hinged with the bending pressing plate; and the dynamic forming blocks have forming surfaces adapted with the forming positioning block; and

- a first forming mechanism, comprising a first bending pressing cylinder and a pressure swing arm, wherein the first bending pressing cylinder is installed on the frame platform and connected with the pressure swing arm; and the pressure swing arm is connected with the bending pressing plate through the pressing plate crossbeam.

5. The automatic metal wire bending machine according to claim 4, wherein the bending pressing plate is also provided with an elastic driving element, comprising a forming elastic pressing block, a spring adjusting rod and a spring; the spring adjusting rod is installed on the bending pressing plate; the front end of the forming elastic pressing block is abutted against the rear end of the dynamic forming block; and both ends of the spring are abutted against the spring adjusting rod and the rear end of the forming elastic pressing block respectively.

6. The automatic metal wire bending machine according to claim 1, 2 or 3, wherein the second bending mechanism comprises:

- an installing substrate, arranged on the second station;

- a second positioning mechanism, comprising a positioning block, bending fixing blocks, bending moving blocks and a middle limiting block, wherein the positioning block is arranged on the installing substrate; the middle limiting block is arranged correspondingly to the positioning block; the bending fixing blocks are symmetrically arranged on both sides of the middle limiting block; the bending moving blocks are symmetrically arranged at one end of the middle limiting block correspondingly to the bending fixing blocks; and the bending moving blocks and the bending fixing blocks are

provided with mutually adapted processing surfaces respectively; the installing substrate is provided with a second groove corresponding to the positioning block; and

a second forming mechanism, comprising a second bending pressing cylinder, a second bending sliding plate, a second bending guide rail, a second moving bending base slider, a second bending sliding plate guide rail and second bending connecting rods; the second bending pressing cylinder is connected with the second bending sliding plate; the second bending sliding plate is installed on a bottom surface of the installing substrate through the second bending sliding plate guide rail; one end of the second bending connecting rods arranged symmetrically is hinged with the second bending sliding plate respectively; the other end of the second bending connecting rods is connected with the second moving bending base slider respectively; the second moving bending base slider is installed on the bottom surface of the installing substrate through the second bending guide rail; the second bending base slider is connected with the bending moving blocks respectively and drives the bending moving blocks to move synchronously towards or away from each other.

7. The automatic metal wire bending machine according to claim 1, 2 or 3, wherein the third bending mechanism comprises:

a substrate, arranged on the third station;

a third positioning mechanism, installed on the substrate and comprising a positioning element, bending fixing elements, bending moving elements and a middle limiting element, wherein the positioning element is arranged on the substrate; the middle limiting element is arranged correspondingly to the positioning element; the bending fixing elements are symmetrically arranged on both sides of the middle limiting element; the bending moving elements are symmetrically arranged at both sides of the middle limiting element correspondingly to the bending fixing elements; and the bending moving elements and the middle limiting element are provided with mutually adapted processing surfaces respectively; the substrate is provided with a third groove corresponding to the positioning element; and

a third forming mechanism, comprising a third bending pressing cylinder, a third bending sliding plate, a third bending slider, a third bending swing rod and third bending connecting rods, wherein the third bending pressing cylinder is connected with the third bending sliding plate; the third bending sliding plate is installed on a bottom surface of the substrate through a third bending sliding plate guide rail; the third bending slider is installed on the substrate through a third bending slider guide rail; one end of the third bending connecting rods arranged symmetrically is hinged with the third bending sliding plate respectively; the other end of the third bending connecting rods is connected with one end of the third bending swing rod respectively; the other end of the third bending swing rod is connected with the third bending slider; and the third bending slider is connected with the bending moving elements and drives the bending moving elements to move synchronously towards or away from each other.

8. The automatic metal wire bending machine according to claim 1, 2 or 3, wherein the fourth bending mechanism comprises:

a vertical frame, arranged on the fourth station and comprising a base and a vertical column;

a fourth positioning mechanism, arranged on an upper surface of the base and comprising an end bending block and a fixing block, wherein the fixing block is provided with a fourth groove;

an upper forming mechanism, comprising an upper bending pressing cylinder, an upper bending sliding plate and an upper bending slider, wherein the upper bending pressing cylinder is installed on the vertical column; the upper bending sliding plate is installed on the vertical column through an upper bending sliding plate guide rail; the upper bending slider is installed on the upper bending sliding plate through an upper bending slider guide rail; and the bottom of the upper bending sliding plate is provided with an end bending pressing block; and

a lower forming mechanism, arranged on an inclined surface of the base correspondingly to the fourth positioning mechanism and comprising a lower bending pressing cylinder and a lower bending slider, wherein the lower bending pressing cylinder is connected with the lower bending slider, and the lower bending slider is installed on the base through the lower bending slider guide rail.

9. The automatic metal wire bending machine according to claim 8, wherein the upper forming mechanism also comprises an elastic adjusting mechanism which comprises an adjusting screw sleeve positioning block, an upper limiting screw rod and an upper bending spring; the upper limiting screw rod is installed in the adjusting screw sleeve positioning block through an upper spring adjusting screw sleeve and is connected with the top of the upper bending slider; and both ends of the upper bending spring are abutted against a top surface of the upper bending slider and the bottom end of the upper spring adjusting screw sleeve respectively.

10. An automatic metal wire bending method, comprising the following steps:

S100: positioning the fixed-length straight metal wire on the first station of the automatic metal wire bending machine, and bending the straight metal wire symmetrically into a U-shaped metal wire by the first bending mechanism;

S200: handling the U-shaped metal wire to the second station by the stepping handling mechanism, and bending the ends of the U-shaped metal wire symmetrically into outwards-facing structures by the second bending mechanism;

S300: handling the U-shaped metal wire having the ends with the outwards-facing structures to the third station by the stepping handling mechanism, and inwards bending and forming the U-shaped metal wire symmetrically by the third bending mechanism;

S400: handling the inwards-bent U-shaped metal wire to the fourth station by the stepping handling mechanism, and bending and forming the U-shaped metal wire into a finished lifting lug by the fourth bending mechanism; and

S500: handling the finished lifting lug by the stepping handling mechanism for leaving an assembly line.