CRIMPING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a crimping apparatus for connecting terminals by crimping to electrical wires.

2. Description of the Related Art

Crimping apparatuses that connect terminals to electrical wires include a fully automatic type crimping apparatus which automatically performs the work of setting terminals and electrical wires in the crimping apparatus and the work of connecting terminals that are set in the crimping apparatus to electrical wires by crimping. Since such a fully automatic type crimping apparatus automatically performs the work ranging from setting terminals and electrical wires in the crimping apparatus to the work of crimping the terminals, there is no burden on the worker performing the crimping work, and the time required to complete all of the work is short. Accordingly, such a crimping apparatus is suitable for use in cases where terminals to which electrical wires have been crimped are mass-produced.

However, when such full-automation of the work ranging from setting terminals and electrical wires in a crimping apparatus to the work of crimping the terminals is attempted, the following drawbacks arise: namely, the overall apparatus becomes large, and the price is increased, so that it becomes difficult to use such an apparatus. Furthermore, fully automatic type crimping apparatuses require special means or a mechanism for reliably setting terminals to the crimping apparatus, so that the mechanism becomes complex.

Therefore, so-called semi-automatic type crimping apparatuses have been developed which manually perform the work of setting terminals and

electrical wires in the crimping apparatuses and which automatically perform the work of connecting the terminals that are set in the crimping apparatuses to the electrical wires by crimping. One example of a conventional semi-automatic type crimping apparatus is shown in Fig. 11 (see Japanese Utility Model Application Kokoku No. S63-35506).

This crimping apparatus 101 shown in Fig. 11 comprises, in a case 110, a motor 111, a speed reduction gear 112 by means of a planetary gear mechanism linked to the output shaft of the motor 111, and a helical gear 114 that is supported by the drive shaft 113 of the speed reduction gear 112. This helical gear 114 is devised so that a driven gear 115 meshes with this helical gear 114 and is rotated in the clockwise direction. A cam part 116 is provided on the driven gear 115. Furthermore, a pair of toggle links 119, 119 are supported by a pin 118 in a pivotable manner, and a roller 117 that contacts the cam part 116 is supported by the pin 118 in a pivotable manner. Moreover, the two tip end portions of the toggle links 119, 119 are supported in a pivotable manner by pins 120 at the rear ends of clasps 121, 121. These clasps 121, 121 are held between joint couplings 123, 123 that are disposed on both sides (both sides in a direction perpendicular to the plane of the page in Fig. 11) of these clasps 121, 121, and are respectively supported by pins 122 in a pivotable manner with respect to the joint couplings 123, 123. Crimping blades 121a, 121a are respectively provided on the portions of the clasps 121, 121 that face each other. A spring member 127 that constantly drives the crimping blades 121a, 121a in the closing direction is provided between the clasps 121, 121. Furthermore, one end of each of the joint couplings 123, 123 is attached to the case 110 by an attachment pin 124, and the other end of each of the joint couplings 123, 123 is attached to the case 110 by a nut 125 and a bolt 126.

Moreover, a lever 128 that pivots with a locking pin 129 as a fulcrum is provided on the case 110. In order to cause an electrical wire and a terminal to be held between the crimping blades 121a, 121a of the clasps 121, 121 beforehand as a preparation prior to crimping, this lever

128 is used to open the crimping blades 121a, 121a by forcibly pulling this lever 128 with the fingers.

A method for crimping an electrical wire to a terminal using this crimping apparatus 101 will now be described. First, one of the clasps 121, 121 is forcibly pulled down by causing the lever 128 to rotate in the counterclockwise direction with the fingers, thus opening the clasps 121, 121 via the toggle links 119, 119.

Next, a terminal is held between the opened crimping blades 121a, 121a, and an electrical wire is set in a specified position. As a result, the preparation prior to crimping is completed.

Then, when the motor 111 is actuated by operating the switch, the speed of the rotation of the output shaft of the motor 111 is reduced by the speed reduction gear 112, and this decelerated rotation of the drive shaft 113 of the speed reduction gear 112 is transmitted to the helical gear 114, so that the helical gear 114 is rotated in a direction perpendicular to the plane of the page. As a result, the driven gear 115 is rotated in the counterclockwise direction with respect to the plane of the page; along with this, the cam part 116 is also rotated in the counterclockwise direction. Then, the roller 117 advances, and accompanying this, the toggle links 119, 119 also advance while opening, so that the clasps 121, 121 are rotated in the mutually closing direction with the pins 122 as the center of rotation. Consequently, the crimping blades 121a, 121a sandwich the terminal with pressure, so that the terminal is connected by crimping to the electrical wire. Furthermore, in order to remove the terminal to which the electrical wire has been crimped from the crimping blades 121a, 121a, the motor 111 is further actuated so that the roller 117 is retracted to the original position, after which the lever 128 is rotated in the counterclockwise direction by the fingers to forcibly pull down one of the clasps 121, 121, and the clasps 121, 121 are simply opened via the toggle links 119, 119.

However, the following problems have been encountered in this crimping apparatus 101 shown in Fig. 11:

Specifically, it is necessary to sharply reduce the speed of the rotation of the output shaft of the motor 111 by means of the speed reduction gear 112, which not only makes the mechanism of the speed reduction gear 112 complex, but also makes it necessary to convert the rotational direction of the helical gear 114, which rotates in a direction perpendicular to the plane of the page in Fig. 11, into the rotational direction of the driven gear 115, which rotates in the counterclockwise direction with respect to the plane of the page. Therefore, the problem is that the mechanism for converting the rotation for this purpose becomes complicated.

Furthermore, when opening the clasps 121, 121, it is necessary to forcibly pull down one of the clasps 121, 121 by rotating the lever 128 in the counterclockwise direction with the fingers, and to open the clasps 121, 121 via the toggle links 119, 119. However, the clasps 121, 121 cannot easily be opened by hand because of the construction of the apparatus.

SUMMARY OF THE INVENTION

Accordingly, the present invention was devised in light of the problems described above; it is an object of the present invention to provide a semi-automatic type crimping apparatus which can semi-automatically perform the work of setting terminals and electrical wires and the work of connecting terminals by crimping to electrical wires with a simple mechanism, and in which the crimper that crimps terminals to electrical wires can easily be opened manually.

In order to solve the problems described above, the crimping apparatus of Claim 1 comprises: a rotating drive shaft which has an eccentric shaft part; a cam link which is provided so as to be freely raised and lowered, and which has a cam hole that allows the movement of the

eccentric shaft part along the inner wall, with this cam hole comprising a first hole in which the eccentric shaft part is positioned when a terminal is connected by crimping to an electrical wire, and a second hole in which the eccentric shaft part is positioned when the terminal is set on an anvil, with these first and second holes having different communicating lengths from each other in the direction of width; a slider which is supported in a pivotable manner with respect to the cam link, and which is raised and lowered as the cam link is raised and lowered; a crimper which is supported in a pivotable manner with respect to the slider, which is opened and closed with respect to the anvil as the slider is raised and lowered, and which connects the terminal by crimping to the electrical wire; a slider operating spring which constantly drives the slider upward; a cam link operating spring which constantly drives the cam link downward with a force weaker than that of the slider operating spring, and which causes the eccentric shaft part to be constantly positioned on the side of the first hole of the cam hole; and a manual lever which lowers the cam link, and which causes the eccentric shaft part to temporarily move to the side of the second hole of the cam hole.

Furthermore, the crimping apparatus of Claim 2 is the invention according to Claim 1, further comprising an adjustment mechanism which adjusts the crimping height of the crimper by adjusting the height of the anvil in the vertical direction with an increase or decrease in the thickness of a shim plate.

Moreover, the crimping apparatus of Claim 3 is the invention according to Claim 1 or 2, wherein the first hole is formed from a plurality of holes having different communicating lengths from each other in the direction of width.

The crimping apparatus of Claim 1 comprises: a rotating drive shaft which has an eccentric shaft part; a cam link which is provided so as to be freely raised and lowered, and which has a cam hole that allows the movement of the eccentric shaft part along the inner wall, with this cam hole comprising a first hole in which the eccentric shaft part is positioned

when a terminal is connected by crimping to an electrical wire, and a second hole in which the eccentric shaft part is positioned when the terminal is set on an anvil, with these first and second holes having different communicating lengths from each other in the direction of width; a slider which is supported in a pivotable manner with respect to the cam link, and which is raised and lowered as the cam link is raised and lowered; a crimper which is supported in a pivotable manner with respect to the slider, which is opened and closed with respect to the anvil as the slider is raised and lowered, and which connects the terminal by crimping to the electrical wire; a slider operating spring which constantly drives the slider upward; and a cam link operating spring which constantly drives the cam link downward with a force weaker than that of the slider operating spring, and which causes the eccentric shaft part to be constantly positioned on the side of the first hole of the cam hole. Accordingly, it is possible to semi-automatically perform the work of setting terminals and electrical wires and the work of connecting terminals by crimping to electrical wires with a simple construction without requiring any control means such as an expensive servo mechanism. Furthermore, since a manual lever is provided which lowers the cam link, and which causes the eccentric shaft part to temporarily move to the side of the second hole of the cam hole, it is possible to lower the slider by lowering the cam link by means of the manual lever and causing the eccentric shaft part to temporarily move to the side of the second hole of the cam hole, thus opening the crimper with respect to the anvil. Consequently, the crimper that crimps terminals to electrical wires can easily be opened manually. When the manual lever is lowered, since it is only necessary to resist the force of the slider operating spring, the crimper can be opened even by hand. Moreover, since the crimper can be opened quickly in one operation, the efficiency of the crimping work is dramatically increased compared to a mechanism in which the crimper is opened electrically. In addition, the cam link operating spring is provided which constantly drives the cam link downward with a force weaker than that of the slider operating spring, and which causes the eccentric shaft part to be constantly positioned on the side of the first hole of the cam hole. Therefore, the slider is raised if no other force is

applied to the slider since the driving force of the slider operating spring is stronger than the driving force of the cam link operating spring. As a result, the crimper is closed with respect to the anvil, and the terminal to be crimped can be held by the difference in force between the driving force of the slider operating spring and the driving force of the cam link operating spring. Accordingly, the positioning of the terminal to be crimped can easily be performed.

Moreover, the crimping apparatus of Claim 2 is the invention according to Claim 1, wherein an adjustment mechanism is provided which adjusts the crimping height of the crimper by adjusting the height of the anvil in the vertical direction with an increase or decrease in the thickness of a shim plate. Accordingly, it is possible to adjust the crimping height of the crimper with a construction that is simpler than a construction in which the crimping height of the crimper is automatically adjusted.

In addition, the crimping apparatus of Claim 3 is the invention according to Claim 1 or 2, wherein the first hole is formed from a plurality of holes having different communicating lengths from each other in the direction of width. Accordingly, when the electrical wire is crimped to the terminal, the eccentric shaft part is continuously positioned in the plurality of holes, so that the work of crimping the terminal to the electrical wire can be performed in a plurality of operations. Consequently, it is possible to use a motor with a small output.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing a state in which the crimper is in the home position in one example of the crimping apparatus of the present invention;

Fig. 2 is a front view of the crimping apparatus in the state shown in Fig. 1;

Fig. 3 is a perspective view showing a state in which the crimper is manually opened with respect to the anvil in one example of the crimping apparatus of the present invention;

Fig. 4 is a front view of the crimping apparatus in the state shown in Fig. 3;

Fig. 5 is a perspective view showing a state in which the crimper is slightly more closed than in Fig. 4 only by the force of the slider operating spring and cam link operating spring (i.e., a state in which a terminal (not shown in the figure) is set on the anvil, and the crimper is holding the terminal with the force of the slider operating spring and cam link operating spring) in one example of the crimping apparatus of the present invention;

Fig. 6 is a front view of the crimping apparatus in the state shown in Fig. 5;

Fig. 7 is a perspective view showing a state in which the terminal is connected by crimping to an electrical wire by means of the rotation of the eccentric shaft part in one example of the crimping apparatus of the present invention (the electrical wire and terminal are not shown in Fig. 7);

Fig. 8 is a front view of the crimping apparatus in the state shown in Fig. 7;

Fig. 9 is a model view showing in model form a state in which the covering crimping barrel of the terminal is pressed by the crimping part of the covering crimper;

Fig. 10 is a front view of a modified example of the cam link;

Fig. 11 is a schematic structural diagram of a conventional example of a crimping apparatus.

BEST MODE FOR CARRYING OUT THE INVENTION

Next, an embodiment of the present invention will be described with reference to the figures. Fig. 1 is a perspective view showing a state in which the crimper is in the home position in one example of the crimping apparatus of the present invention. Fig. 2 is a front view of the crimping apparatus in the state shown in Fig. 1. Fig. 3 is a perspective view

showing a state in which the crimper is manually opened with respect to the anvil in one example of the crimping apparatus of the present invention. Fig. 4 is a front view of the crimping apparatus in the state shown in Fig. 3. Fig. 5 is a perspective view showing a state in which the crimper is slightly more closed than in Fig. 4 only by the force of the slider operating spring and cam link operating spring (i.e., a state in which a terminal (not shown in the figure) is set on the anvil, and the crimper is holding the terminal with the force of the slider operating spring and cam link operating spring) in one example of the crimping apparatus of the present invention. Fig. 6 is a front view of the crimping apparatus in the state shown in Fig. 5. Fig. 7 is a perspective view showing a state in which the terminal is connected by crimping to an electrical wire by means of the rotation of the eccentric shaft part in one example of the crimping apparatus of the present invention (the electrical wire and terminal are not shown in Fig. 7). Fig. 8 is a front view of the crimping apparatus in the state shown in Fig. 7.

In the crimping apparatus 1 shown in Fig. 1, a housing 11 is installed in an upright orientation on the rear end (toward the back in Fig. 1) of a base stand part 10 that has a plurality of leg parts 10a, and a supporting part 11a is installed in an upright orientation on the base stand part 10 on the front side of the housing 11. The supporting part 11a comprises a supporting wall part 11b that extends upward with respect to the base stand part 10 and a seat part 11c that extends forward from the lower end of the supporting wall part 11b.

Furthermore, a motor 12 and a speed reduction gear 13 that is linked to the output shaft of this motor 12 are provided on the housing 11. The speed reduction gear 13 can also be omitted in cases where the force required for crimping (torque) is small, for example, in cases where the crimping apparatus is used only for compact terminals. An eccentric shaft part 13b that is offset with respect to the center of the rotating drive shaft 13a is formed to protrude forward from the rotating drive shaft 13a of the speed reduction gear 13. The rotating drive shaft 13a is provided so that this rotating drive shaft 13a passes through the supporting wall

part 11b. In cases where the speed reduction gear 13 is omitted, the rotating drive shaft 13a is linked to the output shaft of the motor 12.

Moreover, a cam link 14 is provided on the front side of the supporting wall part 11b so that this cam link 14 can be freely raised and lowered. The cam link 14 has a cam hole 14a formed therein to allow the movement of the eccentric shaft part 13b of the rotating drive shaft 13a along the inner wall of this cam hole 14a. The cam hole 14a is formed with an asymmetric V shape or heart shape consisting of a first hole 14b and a second hole 14c that is longer than the first hole 14b, with these first and second holes communicating with each other in the direction of width. These holes are devised so that the eccentric shaft part 13b is positioned in the first hole 14b when a terminal is connected by crimping to an electrical wire, and so that the eccentric shaft part 13b is positioned in the second hole 14c when the terminal is set on an anvil 19. Furthermore, it is necessary that the width of the upper edge portion of the first hole 14b have a dimension which is 0.7 to 0.8 times the diameter of the eccentric shaft part 13b in order to cause the eccentric shaft part 13b to catch in this hole without slipping during the crimping operation. Moreover, with regard to the length dimension of the first hole 14b, this dimension is set so that the rotational diameter d (see Fig. 10) of the eccentric shaft part 13b is greater than the dimension created by adding the amount of spring-back to the distance D_1 that is formed by the vertex at the upper edge portion of the first hole 14b and the center of the eccentric shaft part 13b when the eccentric shaft part 13b is positioned at the lower vertex of the heart shape where the first hole 14b and the second hole 14c of the cam hole 14a in the cam link 14 cross as shown in Fig. 2. As a result, the crimping work can be reliably performed.

Furthermore, at the lower end portion of the cam link 14, a slider 15 is supported by a supporting shaft 16 so that this slider 15 can pivot with respect to the cam link 14 (conversely speaking, so that the cam link 14 can pivot with respect to the slider 15). The slider 15 is installed so that this slider 15 can be raised and lowered along the vertical direction of the

front surface of the supporting wall part 11b, thus moving up and down as the cam link 14 is raised and lowered.

In addition, a crimper 18 is supported by a supporting shaft 17a in a pivotable manner in a groove 15a formed in the central portion of the lower end of the slider 15. The crimper 18 comprises a core wire crimper 18a for crimping the core wire of an electrical wire, and a covering crimper 18b for crimping the covering of the electrical wire. The core wire crimper 18a and covering crimper 18b are each provided with a crimping part 18c (only the crimping part of the core wire crimper 18a is shown in the figures). Furthermore, a crimping height adjusting block 23 is disposed beneath the slider 15 so that this crimping height adjusting block 23 can move up and down with respect to the supporting wall part 11b, and the anvil 19 that faces the crimper 18 is supported by a supporting shaft 17b in a pivotable manner on this crimping height adjusting block 23. The anvil 19 comprises a core wire crimping anvil 19a that faces the core wire crimper 18a and a covering crimping anvil 19b that faces the covering crimper 18b. The core wire crimping anvil 19a and covering crimping anvil 19b are each provided with a crimping part 19c (only the crimping part of the core wire crimping anvil 19a is shown in the figures). A link plate 20 is disposed on the outside of the core wire crimper 18a of the crimper 18 and the core wire crimping anvil 19a of the anvil 19, and another link plate 20 is disposed on the outside of the covering crimper 18b of the crimper 18 and the covering crimping anvil 19b of the anvil 19. The core wire crimper 18a is shaft-supported by a supporting shaft 21 in a pivotable manner with respect to the first link plate 20, and the core wire crimping anvil 19a is shaft-supported by a supporting shaft 22 in a pivotable manner with respect to the first link plate 20. Furthermore, the covering crimper 18b is shaft-supported by the supporting shaft 21 (not shown in the figures) in a pivotable manner with respect to the second link plate 20, and the covering crimping anvil 19b is shaft-supported by the supporting shaft 22 (not shown in the figures) in a pivotable manner with respect to the second link plate 20. Moreover, when the slider 15 is raised and lowered, the core wire crimper 18a pivots about the supporting shaft 21 as this slider 15 moves upward and

downward, and the covering crimper 18b pivots about the supporting shaft 21, so that the core wire crimper 18a and covering crimper 18b that constitute the crimper 18 respectively open and close with respect to the core wire crimping anvil 19a and covering crimping anvil 19b that constitute the anvil 19.

Furthermore, one end of a slider operating spring 28 is locked to the upper end of the slider 15, and the other end of the slider operating spring 28 is locked to the supporting wall part 11b of the supporting part 11a, so that this slider operating spring 28 constantly drives the slider 15 upward. Moreover, one end of a cam link operating spring 29 is locked to a locking projection 14d that is formed to protrude from the right edge portion of the lower end of the cam link 14, and the other end of the cam link operating spring 29 is locked to the side wall part of the slider 15, so that this cam link operating spring 29 constantly drives the cam link 14 downward, thus causing the eccentric shaft part 13b to be constantly positioned on the side of the first hole 14b of the cam hole 14a. The driving force of the cam link operating spring 29 is weaker than the driving force of the slider operating spring 28.

Moreover, a manual lever 27 for lowering the cam link 14 to cause the eccentric shaft part 13b to temporarily move to the side of the second hole 14c of the cam hole 14a is provided on the left edge portion of the cam link 14.

In addition, an adjustment mechanism 32 for adjusting the crimping height of the crimper 18 is provided beneath the anvil 19. Here, the "crimping height" refers to the actual amount of pressing that is represented by combining the stroke of the crimper 18 being closed by means of the motor 12 and the flexing of the crimper 18 or the like, and this actual amount of pressing is determined by the adjustment mechanism 32. This adjustment mechanism 32 is constructed from the aforementioned crimping height adjusting block 23 which is disposed so as to be raised and lowered with respect to the supporting wall part 11b on the front surface of the supporting wall part 11b, and on which the

anvil 19 is supported in a pivotable manner by the supporting shaft 17b, an adjustment screw 24 which is provided to be movable in the vertical direction with respect to the seat part 11c of the supporting part 11a, and which supports the crimping height adjusting block 23 from below, a block fastening spring 25 which is provided between the crimping height adjusting block 23 and the seat part 11c and around the outer circumference of the shaft part of the adjustment screw 24, and a shim plate 26 which is installed between the head part of the adjustment screw 24 and the seat part 11c. The adjustment of the crimping height of the crimper 18 is accomplished by raising or lowering the crimping height adjusting block 23 with an increase or decrease in the thickness of the shim plate 26, thus adjusting the height of the anvil 19 in the vertical direction. Specifically, in cases where the crimping height of the crimper 18 is desired to be increased, the height of the anvil 19 in the vertical direction is increased by increasing the thickness of the shim plate 26, lowering the crimping height adjusting block 23, and causing the anvil 19 to pivot about the supporting shaft 21 so that the crimping parts 19c are raised. Furthermore, in cases where the crimping height of the crimper 18 is desired to be decreased, the height of the anvil 19 in the vertical direction is lowered by decreasing the thickness of the shim plate 26, raising the crimping height adjusting block 23, and causing the anvil 19 to pivot about the supporting shaft 21 so that the crimping parts 19c are lowered.

Incidentally, in Figs. 1 through 8, symbol 30 indicates a driving switch for the motor 12, and 31 indicates a handle that is used when carrying the crimping apparatus 1.

Next, a method for connecting a terminal by crimping to an electrical wire will be described with reference to Figs. 1 through 8.

Before a terminal is crimped to an electrical wire, the crimper 18 is located in the home position shown in Figs. 1 and 2. In this case, the eccentric shaft part 13b of the rotating drive shaft 13a is positioned at the lower vertex portion of the heart shape where the first hole 14b and

second hole 14c of the cam hole 14a in the cam link 14 cross, and the cam link 14 and the slider 15 are raised, so that the crimping parts 18c of the crimper 18 are closed with respect to the crimping parts 19c of the anvil 19. The cam link 14 is bent to a substantial V shape with respect to the slider 15 by the action of the cam operating spring 29.

Furthermore, when the manual lever 27 is lowered from the home position shown in Figs. 1 and 2 while turning this lever in the direction of arrow A by hand, the cam link 14 is lowered in the direction of arrow B in Figs. 3 and 4, and the eccentric shaft part 13b is positioned in the upper portion of the second hole 14c of the cam hole 14a as shown in Figs. 3 and 4. The slider 15 is also lowered in the direction of arrow C as this cam link 14 is lowered. The core wire crimper 18a partly constituting the crimper 18 pivots about the supporting shaft 21 in the direction of arrow D so that the crimping part 18c is raised, and the covering crimper 18b pivots about the supporting shaft 21 in the direction of arrow D so that the crimping part 18c is raised, thus respectively opening the core wire crimper 18a and covering crimper 18b with respect to the core wire crimping anvil 19a and covering crimping anvil 19b that constitute the anvil 19. In this state, the terminal is set by positioning the core wire crimping barrel of the terminal on the crimping part 19c of the core wire crimping anvil 19a and positioning the covering crimping barrel on the crimping part 19c of the covering crimping anvil 19b. Furthermore, the electrical wire is set by positioning the core wire of the electrical wire on the core wire crimping barrel of the terminal and positioning the covering on the covering crimping barrel.

Moreover, when the hand is removed from the manual lever 27, since the driving force of the slider operating spring 28 is stronger than the driving force of the cam link operating spring 29, the slider 15 is raised in the direction of arrow G shown in Figs. 5 and 6, the cam link 14 is raised in the direction of arrow F, and the manual lever 27 is raised in the direction of arrow E. The eccentric shaft part 13b of the rotating drive shaft 13a is positioned in the upper portion of the first hole 14b of the cam hole 14a by the action of the cam link operating spring 29.

Furthermore, as the slider 15 is raised in the direction of arrow G, the core wire crimper 18a partly constituting the crimper 18 pivots about the supporting shaft 21 in the direction of arrow H so that the crimping part 18c is lowered. Moreover, the covering crimper 18b pivots about the supporting shaft 21 in the direction of arrow H so that the crimping part 18c is lowered. As a result, the crimping part 18c of the core wire crimper 18a lightly holds the core wire crimping barrel of the terminal, and the crimping part 18c of the covering crimper 18b lightly holds the covering crimping barrel of the terminal. The holding force of the crimping part 18c of the core wire crimper 18a and of the crimping part 18c of the covering crimper 18b in this case is determined by the difference between the driving force of the slider operating spring 28 and the driving force of the cam link operating spring 29.

Then, when the motor 12 is driven by operating the driving switch 30 in this state, the rotating drive shaft 13a rotates in the clockwise direction, and the eccentric shaft part 13b pushes up the upper edge of the first hole 14b of the cam hole 14a. As a result, the cam link 14 is raised in the direction of arrow I in Figs. 7 and 8. The slider 15 is also raised as the cam link 14 is raised. Consequently, the core wire crimper 18a partly constituting the crimper 18 pivots about the supporting shaft 21 in the direction of arrow K so that the crimping part 18c is further lowered, and the covering crimper 18b pivots about the supporting shaft 21 in the direction of arrow K so that the crimping part 18c is further lowered. As a result, the crimping part 18c of the core wire crimper 18a presses the core wire crimping barrel of the terminal, and the crimping part 18c of the covering crimper 18b presses the covering crimping barrel of the terminal. Thus, the core wire crimping barrel is connected by crimping to the core wire of the electrical wire, and the covering crimping barrel is connected by crimping to the covering.

Moreover, when the driving of the motor 12 is stopped by operating the driving switch 30, and the manual lever 27 is lowered while turning this lever in the direction of arrow L by hand, the crimper 18 is opened to the position shown in Figs. 3 and 4, so that it is possible to remove the

terminal to which the electrical wire has been crimped. In this state, furthermore, the setting of the next electrical wire and terminal becomes possible.

Furthermore, Fig. 9 shows in model form a state in which the covering crimping barrel of the terminal is pressed by the crimping part 18c of the covering crimper 18b.

When the covering crimping barrel of a terminal T is pressed by the crimping part 18c of the covering crimper 18b as shown in Fig. 9, the covering crimper 18b is pulled upward by the slider 15 in a supporting shaft attachment part 18d where the supporting shaft 17a is attached, while the covering crimping anvil 19b is pulled downward by the crimping height adjusting block 23 in a supporting shaft attachment part 19d where the supporting shaft 17b is attached. Accordingly, the covering crimper 18b and covering crimping anvil 19b slightly flex upward and downward, respectively, as indicated by the two-dot chain lines in Fig. 9. The crimping is completed when the undersurface of the tip end of the covering crimper 18b contacts the upper surface of the tip end of the covering crimping anvil 19b. The dimension l_2 between the supporting shaft attachment parts 18d and 19d of the covering crimper 18b and covering crimping anvil 19b at the time of completion of crimping is greater than the dimension l_1 between the supporting shaft attachment parts 18d and 19d during no load time, i.e., when no load whatsoever is applied to the covering crimper 18b or covering crimping anvil 19b. The difference between the dimension l_2 and the dimension l_1 varies according to the size and type of the terminal T to be crimped (difference in elastic coefficient or the like). Here, by providing the adjustment mechanism 32 that adjusts the crimping height of the crimper 18 and adjusting the crimping height by means of this adjustment mechanism 32, it is possible to crimp any terminal T without increasing the difference between the dimension l_2 and the dimension l_1. When an attempt is made to crimp every terminal T without installing the adjustment mechanism 32, there are cases in which the difference between the dimension l_2 and the dimension l_1 becomes significantly large, so that

the durability of the covering crimper 18b and covering crimping anvil 19b is shortened. The same is true when the crimping part 18c of the core wire crimper 18a presses the core wire crimping barrel of the terminal T.

The adjustment mechanism 32 that adjusts the crimping height enables the presetting so that the amount of movement of the crimper 18 will be increased by the amount of flexing of the crimper 18 or the like with respect to the no load time, during which absolutely no load is applied. Since it is difficult to change the amount of movement (stroke) of the crimper 18 in an actual apparatus, the crimping height is essentially varied by varying the height of the anvil 19 in the vertical direction, thus avoiding insufficient crimping. In concrete terms, reliable crimping work is made possible by determining in advance the optimal stroke for terminals having various dimensions (i.e., the thickness of the shim plate 26) and selecting shim plates 26 that are color-sorted to correspond to the various dimensions of terminals.

Since the adjustment mechanism 32 is devised to adjust the crimping height of the crimper 18 by adjusting the height of the anvil 19 in the vertical direction with an increase or decrease in the thickness of the shim plate 26, it is possible to adjust the crimping height of the crimper 18 with a simple construction, compared to a construction in which the crimping height of the crimper 18 is automatically adjusted.

Thus, in the present embodiment, the crimping apparatus comprises the rotating drive shaft 13a which has the eccentric shaft part 13b, the cam link 14 which is provided so as to be freely raised and lowered, and which has the cam hole 14a that allows the eccentric shaft part 13b to move along the inner wall, with this cam hole 14a comprising the first hole 14b in which the eccentric shaft part 13b is positioned when the terminal is connected by crimping to an electrical wire, and the second hole 14c in which the eccentric shaft part 13b is positioned when the terminal is set on the anvil 19, with these first and second holes having different communicating lengths from each other in the direction of width, the slider 15 which is supported in a pivotable manner with respect to the

cam link 14, and which is raised and lowered as the cam link 14 is raised and lowered, the crimper 18 which is supported by the slider 15 in a pivotable manner, which is opened and closed with respect to the anvil 19 as the slider 15 is raised and lowered, and which connects the terminal by crimping to the electrical wire, the slider operating spring 28 which constantly drives the slider 15 upward, and the cam link operating spring 29 which constantly drives the cam link 14 downward with a force that is weaker than that of the slider operating spring 28, and which causes the eccentric shaft part 13b to be constantly positioned on the side of the first hole 14b of the cam hole 14a. Accordingly, it is possible to semi-automatically perform the work of setting the terminal and electrical wire and the work of connecting the terminal by crimping to the electrical wire, with a simple mechanism without requiring any control means such as an expensive servo mechanism.

Furthermore, since the manual lever 27 is provided which lowers the cam link 14 to cause the eccentric shaft part 13b to temporarily move to the side of the second hole 14c of the cam hole 14a, the slider 15 can be lowered by lowering the cam link 14 with the manual lever 27 and causing the eccentric shaft part 13b to temporarily move to the side of the second hole 14c of the cam hole 14a, thus opening the crimper 18 with respect to the anvil 19. Accordingly, it is possible to easily open by hand the crimper 18 that crimps the terminal to the electrical wire. Since it is only necessary to resist the force of the slider operating spring 28 when lowering the manual lever 27, the crimper 18 can be opened even by hand. Moreover, since the crimper 18 can be opened quickly in one operation, the efficiency of the crimping work is dramatically increased compared to a mechanism in which the crimper is electrically opened. In addition, there is no need to reverse the rotation of the motor 12 in order to open the crimper 18, so that it is not necessary to use any expensive servomotor or the like.

Furthermore, since the driving force of the slider operating spring 28 is stronger than the driving force of the cam link operating spring 29, the slider 15 is raised if no other force is applied to the slider 15. As a

result, it is possible to close the crimper 18 with respect to the anvil 19 and to hold the terminal to be crimped by means of the difference in force between the driving force of the slider operating spring 28 and the driving force of the cam link operating spring 29. Accordingly, the positioning of the terminal to be crimped can easily be performed.

Next, a modified example of the cam link is shown in Fig. 10. Like the cam link 14 shown in Figs. 1 through 8, the cam link 14' shown in Fig. 10 is provided so that this cam link 14' can be freely raised and lowered on the front side of the supporting wall part 11b. As in the cam link 14, the cam link 14' has a cam hole 14a' formed therein to allow the eccentric shaft part 13b of the rotating drive shaft 13a to move along the inner wall of this cam hole 14a'. However, the shape of this cam hole 14a' is different from the shape of the cam hole 14a in the cam link 14 shown in Figs. 1 through 8. Specifically, the cam hole 14a' comprises a first hole in which the eccentric shaft part 13b is positioned when the terminal is connected by crimping to an electrical wire and a second hole 14d' in which the eccentric shaft part 13b is positioned when the terminal is set on the anvil 19, with these first and second holes having different communicating lengths from each other in the direction of width. However, the first hole is formed from two holes 14b' and 14c' having different communicating lengths from each other in the direction of width. The hole 14c' partly constituting the first hole is located in the middle of the hole 14b' and the second hole 14d', the hole 14b' is shorter than the hole 14c', and the second hole 14d' is longer than the hole 14c'. Furthermore, in order to cause the eccentric shaft part 13b to catch in these holes without slipping during the crimping operation, it is necessary that the widths of the upper edge portions of the holes 14b' and 14c' have dimensions which are 0.7 to 0.8 times the diameter of the eccentric shaft part 13b. Moreover, as in the case with the length dimension of the first hole 14b in the cam link 14, the length dimension of the hole 14b' is set so that the rotational diameter d (see Fig. 10) of the eccentric shaft part 13b is greater than the dimension created by adding the amount of spring-back to the distance formed by the vertex at the upper edge portion of the hole 14b' and the center of the eccentric shaft part 13b when the eccentric

shaft part 13b is positioned at the lower vertex of the substantial heart shape where the hole 14b', hole 14c' and second hole 14d' of the cam hole 14a' cross. Furthermore, the length dimension of the hole 14c' is set so that the rotational diameter d of the eccentric shaft part 13b is greater than the dimension created by adding the amount of spring-back to the distance D_2 formed by the vertex at the upper edge portion of the hole 14c' and the lower corner edge portion of the hole 14c' as shown in Fig. 10. As a result, the crimping work can be reliably performed.

A method for connecting a terminal by crimping to an electrical wire using this cam link 14' will be described.

First, when the crimper 18 (see Figs. 1 and 2) is located in the home position, the eccentric shaft part 13b of the rotating drive shaft 13a is positioned at the lower vertex of the substantial heart shape where the hole 14b', hole 14c' and second hole 14d' of the cam hole 14a' in the cam link 14' cross, and the cam link 14' and slider 15 are raised, so that the crimping parts 18c of the crimper 18 are closed with respect to the crimping parts 19c of the anvil 19. The cam link 14' is bent to a substantial V shape with respect to the slider 15 by the action of the cam link operating spring 29.

Furthermore, when the manual lever 27 is lowered from the home position while turning this lever in the direction of arrow A (see Figs. 1 and 2) by hand, the cam link 14' is lowered in the direction of arrow B (see Figs. 3 and 4), and the eccentric shaft part 13b is positioned in the upper portion of the second hole 14d' of the cam hole 14a'. This state is shown in Fig. 10. The slider 15 is also lowered in the direction of arrow C (see Figs. 3 and 4) as the cam link 14' is lowered. The core wire crimper 18a partly constituting the crimper 18 pivots about the supporting shaft 21 in the direction of arrow D (see Figs. 3 and 4) so that the crimping part 18c is raised, and the covering crimper 18b pivots about the supporting shaft 21 in the direction of arrow D (see Figs. 3 and 4) so that the crimping part 18c is raised, thus respectively opening these crimpers 18a and 18b with respect to the core wire crimping anvil 19a and covering

crimping anvil 19b that constitute the anvil 19. In this state, the terminal is set by positioning the core wire crimping barrel of the terminal on the crimping part 19c of the core wire crimping anvil 19a and positioning the covering crimping barrel on the crimping part 19c of the covering crimping anvil 19b. Furthermore, the electrical wire is set by positioning the core wire of the electrical wire on the core wire crimping barrel of the terminal and positioning the covering on the covering crimping barrel.

Then, when the hand is removed from the manual lever 27, since the driving force of the slider operating spring 28 is stronger than the driving force of the cam link operating spring 29, the slider 15 is raised in the direction of arrow G (see Figs. 5 and 6), the cam link 14' is raised in the direction of arrow F (see Figs. 5 and 6), and the manual lever 27 is raised in the direction of arrow E (see Figs. 5 and 6). The eccentric shaft part 13b of the rotating drive shaft 13a is positioned in the upper portion of the hole 14b' of the cam hole 14a'. Furthermore, as the slider 15 is raised in the direction of arrow G, the core wire crimper 18a partly constituting the crimper 18 pivots about the supporting shaft 21 in the direction of arrow H (see Figs. 5 and 6) so that the crimping part 18c is lowered, and the covering crimper 18b pivots about the supporting shaft 21 in the direction of arrow H (see Figs. 5 and 6) so that the crimping part 18c is lowered. As a result, the crimping part 18c of the core wire crimper 18a lightly holds the core wire crimping barrel of the terminal, and the crimping part 18c of the covering crimper 18b lightly holds the covering crimping barrel of the terminal. The holding force of the crimping part 18c of the core wire crimper 18a and of the crimping part 18c of the covering crimper 18b in this case is determined by the difference between the driving force of the slider operating spring 28 and the driving force of the cam link operating spring 29.

Moreover, when the motor 12 is driven by operating the driving switch 30 in this state, the rotating drive shaft 13a rotates in the clockwise direction, and the eccentric shaft part 13b first pushes up the upper edge of the hole 14b' of the cam hole 14a' as a first stage, thus raising the cam link 14' in the direction of arrow I (see Figs. 7 and 8).

As the cam link 14' is raised, the slider 15 is also raised. Consequently, the core wire crimper 18a partly constituting the crimper 18 pivots about the supporting shaft 21 in the direction of arrow K (see Figs. 7 and 8) so that the crimping part 18c is further lowered, and the covering crimper 18b pivots about the supporting shaft 21 in the direction of arrow K (see Figs. 7 and 8) so that the crimping part 18c is further lowered. As a result, the crimping part 18c of the core wire crimper 18a presses the core wire crimping barrel of the terminal, and the crimping part 18c of the covering crimper 18b presses the covering crimping barrel of the terminal. Furthermore, when the driving of the motor 12 is continued, the rotating drive shaft 13a further rotates in the clockwise direction, and the eccentric shaft part 13b continuously moves from the hole 14b' to the hole 14c' of the cam hole 14a' and pushes up the upper edge of the hole 14c' as a second stage. As a result, the cam link 14' is further raised. As the cam link 14' is further raised, the slider 15 is also raised; consequently, the core wire crimper 18a partly constituting the crimper 18 pivots about the supporting shaft 21 so that the crimping part 18c is further lowered, and the covering crimper 18b pivots about the supporting shaft 21 so that the crimping part 18c is further lowered. As a result, the crimping part 18c of the core wire crimper 18a further presses the core wire crimping barrel of the terminal, and the crimping part 18c of the covering crimper 18b further presses the covering crimping barrel of the terminal. Thus, the core wire crimping barrel is connected by crimping to the core wire of the electrical wire, and the covering crimping barrel is connected by crimping to the covering.

Thus, since the first hole of the cam hole 14a' in which the eccentric shaft part 13b is positioned when the terminal is connected by crimping to the electrical wire is formed from two holes 14b' and 14c' having different communicating lengths from each other in the direction of width, the eccentric shaft part 13b is continuously positioned in the two holes 14b' and 14c' when the terminal is crimped to the electrical wire. Therefore, the work of crimping the terminal to the electrical wire can be performed in a few divided stages without changing the amount of

eccentricity of the eccentric shaft. Accordingly, the output of the motor can be reduced.

Furthermore, when the driving of the motor 12 is stopped by operating the driving switch 30, and the manual lever 27 is lowered while turning this lever by hand in the direction of arrow L (see Figs. 7 and 8), the crimper 18 is opened to the position shown in Figs. 3 and 4, so that the terminal to which the electrical wire has been crimped can be removed. Then, the setting of the next terminal becomes possible in this state.

An embodiment of the present invention was described above. However, the present invention is not limited to this embodiment, and various alterations and modifications can be made.

For example, in Fig. 10, the first hole of the cam hole 14a' in which the eccentric shaft part 13b is positioned when the terminal is connected by crimping to the electrical wire is formed from the two holes 14b' and 14c' having different communicating lengths from each other in the direction of width. However, it is not necessary to form this first hole from the two holes 14b' and 14c'; it would also be possible to form this first hole from a larger number of holes.

Furthermore, it is not absolutely necessary for the crimper 18 to be provided with both the core wire crimper 18a and the covering crimper 18b; it would also be possible to omit the covering crimper 18b and to construct the crimper 18 from the core wire crimper 18a alone. Along with this, it would also be possible to construct the anvil 19 from the core wire crimping anvil 19a alone.

Moreover, the rotational direction of the rotating drive shaft 13a is not limited to the clockwise direction; the counterclockwise direction may also be used.

In addition, the manual lever 27 is provided on the left edge portion of the lower end of the cam link 14 in Figs. 1 through 8. However,

depending on the orientation of the attachment of the terminal, it would also be possible to provide this manual lever 27 on the right side of the cam link 14 or in a manner in which this manual lever 27 extends forward from the cam link 14. Furthermore, the positions in which the slider operating spring 28 and cam link operating spring 29 are attached are not limited to the positions shown in Figs. 1 through 8, but can be appropriately modified.

What Is Claimed Is:

1. A crimping apparatus comprising:

a rotating drive shaft which has an eccentric shaft part;

a cam link which is provided so as to be freely raised and lowered, and which has a cam hole that allows the movement of the eccentric shaft part along the inner wall, with this cam hole comprising a first hole in which the eccentric shaft part is positioned when an electrical wire is connected by crimping to a terminal, and a second hole in which the eccentric shaft part is positioned when the terminal is set on an anvil, with these first and second holes having different communicating lengths from each other in the direction of width;

a slider which is supported in a pivotable manner with respect to the cam link, and which is raised and lowered as the cam link is raised and lowered;

a crimper which is supported in a pivotable manner with respect to the slider, which is opened and closed with respect to the anvil as the slider is raised and lowered, and which connects the terminal by crimping to the electrical wire;

a slider operating spring which constantly drives the slider upward;

a cam link operating spring which constantly drives the cam link downward with a force weaker than that of the slider operating spring, and which causes the eccentric shaft part to be constantly positioned on the side of the first hole of the cam hole; and

a manual lever which lowers the cam link, and which causes the eccentric shaft part to temporarily move to the side of the second hole of the cam hole.

2. The crimping apparatus according to Claim 1, further comprising an adjustment mechanism which adjusts the crimping height of the crimper by adjusting the height of the anvil in the vertical direction with an increase or decrease in the thickness of a shim plate.

3. The crimping apparatus according to Claim 1 or 2, wherein the first hole is formed from a plurality of holes having different communicating lengths from each other in the direction of width.

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