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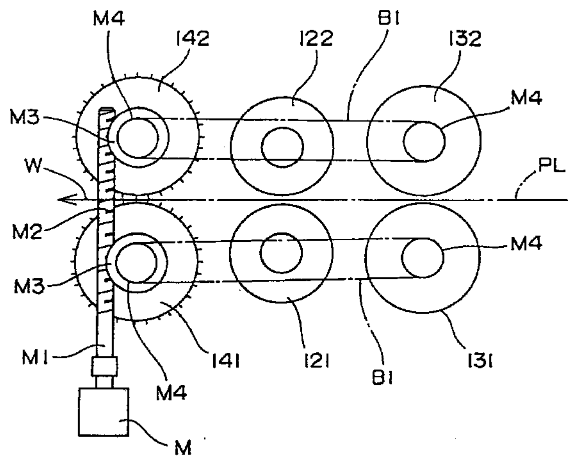
(54) Wire feeding mechanism and use thereof in a wire feeding unit of a wire cutting apparatus

(57) In a wire feeding mechanism, a pair of encoder rollers (121, 122) are disposed between a pair of first feed rollers (141, 142) and a pair of second feed rollers (131, 132). The outer diameter of the first feed rollers (141, 142) is set larger than that of the second feed rollers (131, 132) so as to apply a tensile force to the wire between the first feed rollers (141, 142) and the second feed rollers (131, 132).

A wire W can be precisely fed by a predetermined length since it is not loosened between the first feed rollers (141, 142) and the second feed rollers (131, 132).

FIG. 1



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Description

The present invention relates to a wire feeding mechanism for feeing a wire along a specified pass line when the wire is cut to a specified length in a process of manufacturing a wiring harness and also to the use thereof in a wire feeding unit of a wire cutting apparatus for producing wire materials having a specified length.

A wiring harness to be mounted in an automotive vehicle or the like includes a multitude of final wires cut to a variety of lengths. These wires are bound so that the wiring harness looks like branches shape as a whole. Here, the final wires refer to wires (wire materials) cut to specified lengths and having necessary terminal fittings mounted at their ends.

Accordingly, the manufacturing of the wiring harness includes a multitude of steps: a wire cutting step of measuring the length of the wire and cutting the wire to a predetermined length, a peeling step of peeling an insulation coating from the ends of the cut wires, a terminal mounting step of connecting terminal fittings with the cores of the wires exposed by peeling, and a binding step of binding the respective wires. In the case that connectors are mounted at the ends of the wires, there is also provided a terminal inserting step of inserting the connected terminal fittings into the housings of the connectors.

Next, a prior art of the present invention is briefly described. FIGS. 3(a) to 3(c) schematically show a prior art wire cutting step. With reference to FIG. 3(a), a cutting apparatus 1 for automatically and successively measuring and cutting a wire W is adopted in the wire cutting step. The cutting apparatus 1 includes a wire feeding unit 6 for feeding the wire W while measuring the length of the wire W fed therefrom and a wire guiding unit 7 for curving the fed wire W in U-shape. Identified by C1 is a cutter for cutting the fed wire W, and by C2 and C3 are clamps for gripping the opposite ends of the cut wire W.

The wire W fed from the wire feeding unit 6 is first curved in U-shape by the wire guiding unit 7. The leading end of the wire W is gripped by the clamp C2 (see FIG. 3(b)), and then a portion 7b of the wire guiding unit 7 moves away from the wire feeding unit 6 as shown in FIG. 3(c). Subsequently, the wire W is fed by a predetermined length. The thus fed wire W is cut by the cutter C1, and the end of the cut wire W is gripped by the clamp C3. In this way, the wire feeding and cutting operation is completed, and the produced wire materials are transferred to a location of the succeeding step.

The wire feeding unit 6 includes two pairs of feed rollers 6a, and a pair of encoder rollers 6b disposed behind the feeder rollers 6a, i.e. upstream therefrom with respect to a wire feeding direction. Identified by 6c are rollers for detecting a seam of the wire W. The rollers 6c are not directly used for the feeding operation.

In the wire feeding unit 6, the wire W is held by the two pairs of feed rollers 6a and the pair of encoder rollers 6b. The respective feed rollers 6a are driven in directions indicated by arrows by drive motors (not shown), thereby feeding the wire W toward the wire guiding unit 7. On the other hand, the respective encoder rollers 6b are rotatable about their center axes. As the wire W is fed, the encoder rollers 6b holding it therebetween rotates. Accordingly, a feed amount of the wire W can be measured by counting pulses generated as the encoder rollers 6b rotate. In other words, the wire W can be fed only by a predetermined length and, as a result, the wire W can be cut to the predetermined length.

However, in the wire feeding unit 6, even if the rotation of the feed rollers 6a is stopped after the wire W is fed by the predetermined length, the wire W upstream from the feed rollers 6a moves in the wire feeding direction due to an inertial force. As a result, the wire W may be loosened between the feed rollers 6a and the encoder rollers 6b. If the next measuring operation is performed while the wire W is left loosened, a loosened portion of the wire W is not measured as a feed amount. Accordingly, the wire W cannot be cut to the predetermined length. (If a specified control is executed to correct the number of pulses counted during the next measuring operation by the number of pulses counted for the loosened portion of the wire W, the loosened portion can be measured as the feed amount during the next measuring operation. However, such a control is very difficult and is not easily realizable in consideration of a production cost.) Further, since the loosening of the wire W is not constant in each measuring operation, if the feeding and cutting operation is continuously performed, there may be a variation in the length of the cut wires W.

It is thus an object of the present invention to provide a wire feeding mechanism and a use thereof in a wire feeding unit of a wire cutting apparatus, which allow to precisely feed a wire by a predetermined length, in particular for precisely cutting a wire to a predetermined length and producing wire materials.

This object is solved according to the invention by a wire feeding mechanism according to claim 1 and by the use thereof in a wire feeding unit of a wire cutting apparatus according to claim 9. Preferred embodiments of the invention are subject of the dependent claims.

According to the invention, there is provided a wire feeding mechanism for feeding a wire along a specified pass line, in particular from an upstream side to a downstream side, comprising a first pair of feed rollers ; a second pair of feed rollers which are arranged upstream from (and in particular at a specified distance from) the first pair of feed rollers, the feed rollers of each pair being opposed to each other on opposite sides of the pass line for feeding the wire on the pass line while tightly holding and guiding the wire.

According to a preferred embodiment of the invention, the wire feeding mechanism further comprises measuring means disposed in the first or second pair of feed rollers or between them for measuring a moving amount of the wire moving on the pass line.

In this construction, the wire can be fed from the upstream side to the downstream side along the pass line while tightly holding the wire by the first and second feed rollers. Since the first feed rollers are arranged at the downstream side of the pass line and the second feed rollers are arranged at the upstream side thereof, the wire can be fed in a section between the first and second feed rollers without being loosened. Further, the moving amount of the wire can be measured by the measuring means. Since the measuring means is provided in or at the section where the wire is not loosened, the moving amount of the wire can be precisely measured.

Thus, while the wire is fed along the pass line, the moving amount of the wire moving between the pairs of first and second feed rollers can be precisely measured by preventing the wire from being loosened between these roller pairs. Accordingly, the wire can be precisely fed by the predetermined length.

Preferably, the wire feeding mechanism further comprises tensile force applying means for applying a tensile force to the wire being fed between the pairs of first and second feed rollers in the above wire feeding mechanism.

This construction operates in the same fashion as the above wire feeding mechanism . In addition, since a tensile force is applied to the wire passing the section between the first and second feed rollers, the wire is not loosened in this section. Accordingly, the moving amount of the wire can be more precisely measured by the measuring apparatus.

Thus, since a tensile force can be applied to the wire between the pairs of first and second rollers while the wire is being fed along the pass line, the loosening of the wire between the roller pairs can be securely prevented. Accordingly, the moving amount of the wire moving between the roller pairs can be more precisely measured and, as a result, the wire can be more precisely fed by the predetermined length.

Further preferably, the wire feeding mechanism further comprises a differential means for rotating the first and second feed rollers such that the peripheral velocity of the first feed rollers is higher than that of the second feed rollers in the above wire feeding mechanism .

This construction operates in the same fashion as the above wire feeding mechanism . Particularly, since the peripheral velocity of the first feed rollers is higher than that of the second feed rollers, the wire being fed is constantly pulled by the first feed rollers, thereby applying a tensile force to the wire passing the section between the first and second feed rollers. Accordingly, the wire passing this section is not loosened. Further, the tensile force applying means has no complicated mechanism because it acts only to differ the peripheral velocities of the first and second rollers.

Thus, the tensile force can be easily applied to the wire by differing the peripheral velocities of the first and second feed rollers, thereby preventing the wire from being loosened. Accordingly, the construction of the corresponding mechanism can be simplified.

Preferably, the differential means comprises pulleys and/or gears being rotationally connected or fixed to the first and second feed rollers, wherein the pulleys and/or gears of the first feed rollers have a larger effective circle diameter or pitch circle diameter than the pulleys and/or gears of the second feed rollers.

Still further preferably, the wire feeding mechanism further provides a means for applying a specified rotational resistance or resistance against turning to the second feed rollers so as to constrain the feed of the wire by the first feed rollers in the above wire feeding mechanism , in particular for applying a predetermined or predeterminable tensile strength to the portion of wire between the first and second feed rollers.

This construction operates in the same fashion as the above wire feeding mechanism . Particularly, since a rotational friction is applied to the second feed rollers, if the wire is fed while being held between the first feed rollers and between the second feed rollers, it needs to be pulled by the first feed rollers. Accordingly, the wire is not loosened between the first and second feed rollers. Further, the tensile force applying means has no complicated mechanism because it acts only to apply a rotational friction to the second feed rollers.

Thus, the tensile force can be easily applied to the wire by applying a rotational resistance or resistance against turning to the second feed rollers, thereby preventing the wire from being loosened. Accordingly, the construction of the corresponding mechanism can be considerably simplified.

Further preferably, a first circumference of the first feed rollers is larger than a second circumference of the second feed rollers, in particular wherein the first and second feed rollers are driven with the same or similar rotational speed. Thus the first feed rollers will feed the wire, when the rotational speed of the first and second feed rollers is approximately equal, with a higher feeding velocity (i.e. length of the wire fed in a predetermined time) than the second feed roller thus causing a tensile force on the wire.

Further preferably, the wire feeding mechanism further comprises a means for causing the pairs of the feed rollers to hold the wire such that a frictional force which acts between the first feed rollers and the wire is larger than a frictional force which acts between the second feed rollers and the wire in the above wire feeding mechanism .

This construction operates in the same fashion as the above wire feeding mechanism . Particularly, since the frictional force between the first feed rollers and the wire is larger than the frictional force between the second feed rollers and the wire, if a slip were to occur between the wire and the feed rollers in the section where a tensile force is applied to the wire, it would always occur between the second feed rollers and the wire. Accordingly, the wire being fed is pulled by the first feed rollers, thereby securely preventing the wire passing between the pairs of feed rollers from being loosened. Further, since the first feed rollers pull the wire downstream therefrom with respect to the wire feeding direction, a wire feeding speed does not decrease.

Thus, even if the wire being fed were to slip, this slip would always occur between the second rollers and the wire. Accordingly, the wire is pulled by the first feed rollers, thereby more securely preventing the loosening of the wire passing between the roller pairs. Thus, the moving amount of the wire can be more precisely measured and, as a result, the wire can be more precisely fed by the predetermined length.

Further preferably, the measuring means comprises a pair of encoding rollers which are opposed to each other on opposite sides of the pass line, and which may be in particular the first or second pair of feed rollers.

According to the invention there is provided a use of a wire feeding mechanism according to the invention in a wire feeding unit of a wire cutting apparatus, wherein the wire cutting apparatus comprises: the wire feeding unit for feeding a wire along a specified pass line, and a cutting unit for cutting the wire fed by a predetermined length by the wire feeding mechanism to produce a wire material for forming a wiring harness.

According to a preferred embodiment of the invention, the wire cutting apparatus further comprises a wire guiding unit for guiding and bending the wire fed by the wire feeding unit.

Preferably, the wire cutting apparatus further comprises a wire feeding stopper means arranged on the pass line forcibly stopping the feeding of the wire upon receiving a stopping signal.

According to a further aspect of the invention, there is provided a wire cutting apparatus comprising a wire feeding unit for withdrawing a long wire stocked in advance and feeding it along a specified pass line, and a cutting unit for cutting the wire fed by a predetermined length by the wire feeding unit to produce a wire material forming a wiring harness, wherein the wire feeding unit comprises the above wire feeding mechanism .

In this construction, the long wire stocked in advance is fed by the predetermined length by the wire feeding unit. The fed wire is cut into a wire material by the cutting unit. Since the wire feeding unit comprises the above wire feeding mechanism, it operates in the same fashion as the above wire feeding mechanism.

Thus, the wire fed by the wire feeding unit can be precisely cut to the predetermined length. Therefore, the wire material having the predetermined length can be precisely produced.

These and other objects, features and advantages of the present invention will become more apparent upon a reading of the following detailed description and accompanying drawings in which:

FIG. 1 is a schematic diagram of a wire feeding mechanism adopted by a wire feeding unit,

FIG. 2 is a plan view showing the construction of a wire cutting apparatus according to one embodiment of the invention, and

FIG. 3 is a diagram showing a schematic construction of a prior art wire cutting apparatus.

With reference to FIG. 2, the wire cutting apparatus A is used to produce wire materials as elements of a wiring harness by measuring and cutting a wire to a predetermined length. The apparatus A includes a wire feeding unit 10 for withdrawing a long wire stocked in advance in an unillustrated place and feeding it along a pass line PL, a wire guiding unit 20 provided contiguously with the wire feeding unit 10 for guiding the wire W being fed so that the wire W is curved substantially in U-shaped, a clamping unit 30 for gripping the wire W, and a cutting unit 40 for cutting the wire W. In other words, the apparatus A is capable of producing wire materials of a predetermined length by feeding the wire W while curving it substantially in U-shaped and, after the wire is fed by the predetermined length, cutting the wire while gripping it. Hereafter, the respective units are described.

<u>(1) Wire Feeding Unit</u>

Hereafter, the wire feeding unit 10 is described in detail with reference to FIGS. 1 and 2.

The wire feeding unit 10 withdraws the wire W from an unillustrated reel station and feeds it to the wire guiding unit 20 along the pass line PL. The wire feeding unit 10 feeds the wire W by a predetermined length in cooperation with the wire guiding unit 20.

(1) The wire feeding mechanism includes a pair of first feed rollers 141, 142, a pair of encoder rollers 121, 122 and a pair of second feed rollers 131, 132 which are arranged in this order along the pass line PL from a downstream side (upper side in FIG. 2).

(2) The first and second feed rollers 141, 142 and 131, 132 are driven by a motor M (shown only in FIG. 1) as a source of driving force to feed the wire W along the pass line PL while holding it between the corresponding pairs. A tensile force is applied to the wire W being fed in a section between the first rollers 141, 142 and the second rollers 131, 132.

The respective pairs of feed rollers 141, 142 and 131, 132 are arranged on the opposite sides of the pass line PL. In the words, the wire W is fed along the pass line PL while being held between the first feed rollers 141 and 142 and between the second feed rollers 131 and 132. The encoder rollers 121, 122 are adapted to measure a moving amount of the wire W moving along the pass line PL, and are arranged between the first feed rollers 141, 142 and the second feed rollers 131, 132, respectively. The encoder rollers 121, 122 are also arranged on the opposite sides of the pass line PL and are capable of holding the wire W therebetween. By holding or gripping the wire W therebetween, the encoder rollers 121, 122 are rotated by the wire W being fed. The moving amount of the wire W can be measured by counting pulses generated as the encoder rollers

121, 122 rotate by means of an unillustrated counter.

In this embodiment, a tensile force is applied to the wire W between the first feed rollers 141, 142 and the second feed rollers 131, 132 by a construction to be described later. This prevents the wire W from being loosened between the pairs of feed rollers, thereby enabling the encoder rollers 121, 122 to precisely measure a feed amount of the wire W. Next, a mechanism for applying a tensile force to the wire W is described.

First, the first feed rollers 141, 142 are driven by the motor M. Specifically, the motor M is a coupled with a drive shaft M1 having a thread M2 formed on its outer surface. Each of the feed rollers 141, 142 is formed with a gear M3 (shown only in FIG. 1). The gear M3 is formed with an unillustrated thread spirally engageable with the thread M2 of the drive shaft M1. The threads M2 of the gears M3 are spirally engaged with the thread M2 of the drive shaft M1. These may be constructed by, e.g. a worm mechanism. Further, pulleys M4 are mounted on the feed rollers 141, 142. Timing belts B1 are fitted on the pulleys M4 so that the feed rollers 131, 132 rotate together with the feed rollers 141, 142.

On the other hand, pulleys M4 are also mounted on the second feed rollers 131, 132. The timing belts B1 are fitted so as to connect the feed rollers 141 and 131 and to connect the feed rollers 142 and 132. The so-called pitch circle diameter (PCD) of the pulleys M4 is substantially the same and, accordingly, the respective feed rollers 141, 142 and 131, 132 are rotated at substantially the same speed. Chains or the like may be used in place of the timing belts B1.

The outer diameter of the first feed rollers 141, 142 is set larger than that of the second feed rollers 131, 132 (in this embodiment, the outer diameter of the feed rollers 141, 142 is 63.66 mm and that of the feed rollers 131, 132 is 63 mm). Accordingly, when the motor M is driven, the peripheral velocity of the feed rollers 141, 142, i.e. the velocity thereof at their peripheries, is higher than that of the feed rollers 131, 132. More specifically, the wire W being fed is constantly pulled by the first feed rollers 141, 142, thereby applying a tensile force to the wire W between the first feed rollers 141, 142 and the second feed rollers 131, 132.

Further, in this embodiment, a coefficient of friction between the first feed rollers 141 and 142 is set larger than a coefficient of friction between the second feed rollers 131 and 132. Specifically, diamond coating is applied to the peripheral surfaces of the feed rollers 141, 142. Further, the first and second feed rollers 141, 142 and 131, 132 are made movable by a sliding mechanism incorporating cylinders to be described later. In other words, each pair of feed rollers are movable between a position where they are close to each other and another position where they are away from each other, and hold the wire W therebetween by moving closer to each other. The first rollers 141, 142 and the second rollers 131, 132 hold the wire W with the same holding force, in particular a relative force applied between pairs of rollers is approximately the same.

Accordingly, a frictional force which acts between the first feed rollers 141, 142 and the wire W is larger than a frictional force which acts between the second feed rollers 131, 132 and the wire W. If the wire W being fed were to slip, it would always occur between the second feed rollers 131, 132 and the wire W. More specifically, the wire W being fed is pulled by the first feed rollers 141, 142, with the result that a tensile force is constantly applied to the wire W between the first feed rollers 141, 142 and the second feed rollers 131, 132. Further, since the slip of the wire W always occurs between the second feed rollers 131, 132 and the wire, the feeding speed of the wire W does not decrease due to the slip thereof.

In this embodiment, there is also provided a nozzle 15 for guiding the leading end of the wire W being fed by the first and second feed rollers 141, 142 and 131, 132 to the wire guiding unit 20. The construction of the nozzle 15 is described in detail later. Identified by 111, 112 are rollers for detecting a seam of the wire W. The rollers 111, 112 are not directly used to feed the wire W by a predetermined length.

Next, the sliding mechanism is described. This mechanism is adapted to slide the first feed rollers 141, 142, the second feed rollers 131, 132 and the encoder rollers 121, 122 with respect to each other in the lateral direction of FIG. 2. Specifically, the sliding mechanism causes each pair of rollers to slide between a feeding position where the rollers are moved closer to each other to hold the wire W and a standby position where they are apart from each other and do not feed the wire W.

More specifically, the first feed roller 141 and the encoder roller 121 are integrally slid while the first feed roller 142 and the encoder 122 are integrally slid. Further, the second feed roller 131 and the seam detection roller 111 are integrally slid while the second feed roller 132 and the seam detection roller 112 are integrally slid.

The feed roller 141 and the encoder 121 are rotatably mounted on a support member 71, and the feed roller 142 and the encoder roller 122 are rotatably mounted on a support member 72. On the other hand, the feed roller 131 and the seam detection roller 111 are rotatably mounted on a support member 61, and the feed roller 132 and the seam detection roller 112 are rotatably mounted on a support member 62.

The support member 71 is coupled with a cylinder CYL2. Specifically, a cylinder rod is coupled with the back surface of a bent portion of the support member 71 and a cylinder tube is secured to a fixed frame. Though unillustrated, the support member 72 is similarly coupled with a cylinder. On the other hand, the support member 61 is coupled with a cylinder CYL1 such that a cylinder rod is coupled with the back surface of a bent portion of the support member 61, and a cylinder tube is secured to a fixed frame. Though unillustrated, the support member 62 is similarly coupled with a cylinder.

As the cylinder rods of the cylinders CYL2, CYL1 expand, the feed rollers 141, 142, the feed rollers 131, 132 and the encoder rollers 121, 122 are slid to their feeding positions, thereby holding the wire W therebetween. In this state, the motor M is driven to rotate the feed rollers 141, 142 and 131, 132 via the timing belts B1 so as to feed the wire W along the pass line PL. The encoder rollers 121, 122 are rotated by the wire W being fed, thereby measuring the moving amount of the wire W, i.e. the fed length of the wire W. On the other hand, as the cylinder rods of the cylinders CYL2, CYL1 contract, the feed rollers 141, 142, the feed rollers 131, 132 and the encoder rollers 121, 122 are slid to their standby positions, thereby moving away from the wire W.

Guide tubes 71a, 61a are mounted on the back surfaces of the bent portions of the support members 71, 61, respectively. The fixed frames of the support members 71, 61 are provided with guide pins P2, P1 in positions corresponding to the guide tubes 71a, 61a, respectively. Though unillustrated, the support members 72, 62 are similarly constructed. The guide pins P2, P1 project in a direction approximately normal to the pass line PL. Accordingly, as the cylinders CYL2, CYL1 expand or contract, the rollers 141, 142, 131, 132, 121, and 122 are slid while the guide tubes 71a, 61a are guided by the guide pins P2, P1. This ensures a smooth sliding movement of the respective rollers.

Oblong holes 71b, 72b extending in a direction normal to the pass line PL are formed on roller supports of the support members 71, 72, respectively. Stopper pins P3, P4 are inserted into the holes 71b, 72b, respectively. This arrangement enables a precise positioning of the support members 71, 72 when they are slid. Accordingly, the wire W can be nipped by the feed rollers 141, 142 in a precise position, enabling a satisfactory feed of the wire W. Alternatively, the rollers 141, 131 and 121 may be mounted on a single support member and slid by a single cylinder. Further, the respective pairs of feed rollers 141, 142 and 131, 132 may be moved closer to each other along a horizontal or vertical plane including the pass line PL to hold the wire W.

Next, the construction of the nozzle 15 is described.

The nozzle 15 includes a main body 150, a stopper arm 152 for opening and closing a nozzle hole of the main body 150, a cylinder CYL3 for moving the stopper arm 152, a link plate 153 provided between the cylinder CYL3 and the stopper arm 152, and a spring 154 for biasing the link plate 153 in a specified direction. The main body 150, the stopper arm 152, the link plate 153 and the spring 154 are mounted on a beam 151. The beam 151 is so disposed as to project from the pass line PL, and acts as a so-called bracket. The link plate 153 is rotatably mounted on the beam 151 by a pin 153a. One end of the link plate 153 is rotatably connected with the stopper arm 152 via a pin 152a.

A guide hole 15a is formed in the outer surface of the main body 150. By being guided by the guide hole 15a, the stopper arm 152 enters the main body 150 along a radial direction of the nozzle 15. In other words, the stopper arm 152 closes the nozzle hole by entering the main body 150, while opening the nozzle hole by moving out of the main body 150.

A cylinder tube of the cylinder CYL3 is mounted on the fixed frame and the leading end of a cylinder rod thereof is directed to the other end of the link plate 153. The spring 154 biases the other end of the link plate 153 toward the cylinder rod of the cylinder CYL3. In this way, the link plate 153 is constantly biased so as to be rotatable counterclockwise in FIG. 2. Therefore, the stopper arm 152 is constantly biased in such a direction as to close the nozzle hole.

When the wire W is to be fed by the predetermined length, the cylinder CYL3 is expanded to press the other end of the link plate 153, which then rotates clockwise against the biasing force of the spring 154. As a result, the stopper arm 152 is so moved as to open the nozzle hole, thereby permitting the wire W to be fed. On the other hand, when the cylinder CYL3 is contracted after the wire W is fed by the predetermined length, the link plate 153 is rotated counterclockwise by the biasing force of the spring 154. As a result, the stopper arm 152 enters the main body 150, thereby forcibly stopping the feed of the wire W by pressing the wire W against the inner wall of the main body 150.

<u>(2) Wire Guiding Unit</u>

The wire guiding unit 20 is adapted to curve the wire W fed by the wire W substantially in U-shape before the wire W is cut. The wire guiding unit 20 includes a fixed guide block 21, a movable guiding block 22, and a pair of guide bars 231, 232 for guiding the blocks 21, 22 in such directions that they are moved closer to and away from each other.

The fixed guide block 21 is fixed on the wire feeding unit 10 and has a substantially semicircular convex surface 211. Each of the guiding bars 231, 232 and a support bar 213 disposed between the arms 231, 232 has one end thereof mounted on the fixed guide block 21. The other ends of the guiding bars 231, 232 and the support bar 213 are mounted on an unillustrated fixed frame. The movable guide block 22 has a substantially semicircular concave surface 221 which defines a substantially semicircular wire guide path R1 with the convex surface 211 when the movable guide block 22 is moved closer to the fixed guide block 21.

The wire W fed by the wire feeding unit 10 is inserted into the wire guide path R1. The inserted wire W is guided along the wire guide path R1, thereby being curved in U-shape. When the wire W is curved in U-shape, the movable guide block 22 is moved away from the fixed guide block 21 (to a position indicated by phantom line in FIG. 2). The wire W is further fed until its feed amount reaches the predetermined length.

<u>(3) Clamping Unit</u>

The clamping unit 30 is disposed between the wire feeding unit 10 and the wire guiding unit 20, and includes first and second clamps 31 and 32. The first clamp 31 introduces the wire W fed from the wire feeding unit 10 into an entrance of the wire guiding path R1 and grips the wire W in a position near its portion to be cut by the cutting unit 40. The second clamp 32 grips the leading end of the wire W coming out of the wire guide path R1 after being curved in U-shape by the wire guide path R1.

The leading end of the first clamp 31 projects more toward the wire feeding unit 10 than that of the second clamp 32, i.e. is located in the vicinity of the nozzle 15 so as to securely grip the wire W fed from the nozzle 15. The first and second clamps 31 and 32 are mounted on an elevator block 33. A cylinder CYL4 is mounted on the lower surface of the first clamp 31 so as to move the first clamp 31 upward and downward. In other words, as the cylinder CYL4 expands and contracts, the first and second clamps 31 and 32 are integrally moved upward and downward.

While the wire W is fed by the predetermined length, the cylinder CYL4 is expanded so as to bring the first and second clamps 31, 32 to positions facing the entrance and exit of the wire guide path R1, respectively. The leading end of the wire W being fed while being curved in U-shape by the wire guiding path R1 is gripped by the second clamp 32. After the wire W is fed by the predetermined length, the wire W is also gripped by the first clamp 31 so that the wire W can be cut to the predetermined length while being securely gripped. After the wire W is cut, the cylinder CYL4 is contracted to lower the clamps 31, 32 gripping the wire W downward.

(4) Cutting Unit

The cutting unit 40 is disposed between the wire feeding unit 10 and the clamping unit 30, and is adapted to cut the wire W having been fed by a predetermined length. The cutting unit 40 includes a pair of cutters 41, 42 and a pair of cylinders CYL5, CYL6 for driving the cutters 41, 42, respectively. The cutters 41, 42 are mounted on a beam of a U-shaped frame 43 straddling over the first clamp 31 via guiding members 44, 45 so as to be opposed to each other, respectively, and are movable along a direction normal to the pass line PL. The cylinders CYL5, CYL6 move the cutters 41, 42, respectively. Rods of the cylinders CYL5, CYL6 are mounted on the back surfaces of the guiding members 44, 45, and tubes thereof are mounted on the beam of the frame 43.

As the respective cylinders CYL5, CYL6 expand, the cutters 41, 42 move closer to each other so as to cut the wire W. In other words, after the wire W is fed by the predetermined length, the cylinders CYL5, CYL6 are expanded. Then, the cutters 41, 42 are moved toward the wire W, and the shearing faces of the cutters 41, 42 cross to cut the wire W to the predetermined length.

It should be appreciated that the wire feeding unit 10 is applicable even if the wire guiding unit 20, the clamping unit 30 and the cutting unit are differently constructed from this embodiment.

Next, the feeding and cutting operation of the wire W by the wire cutting apparatus A is described together with its action and effect.

The long wire W stocked in advance is fed along the pass line PL by the wire feeding unit 10. The wire W being fed is curved in U-shape by the wire guiding unit 20, and its leading end is gripped by the second clamp 32 of the clamping unit 30. Subsequently, the movable guide block 22 of the wire guiding unit 20 slides to open up the wire guide path R1, and the wire W is further fed by the wire feeding unit 10. Since the feed amount of the wire W is measured by the pair of encoder rollers 121, 122, the wire W is precisely fed by the predetermined amount. The wire W fed by the predetermined length is cut by the cutting unit 40, thereby producing a wire material.

Particularly, this embodiment has the following action and effect.

(1) The loosening of the wire W can be prevented by arranging the first feed rollers 141, 142 and the second feed rollers 131, 132 along the pass line PL. Accordingly, the moving amount of the wire W can be precisely measured by the encoder rollers 121, 122.

In this embodiment, since a tensile force is applied to the wire W between the first feed rollers 141, 142 and the second feed rollers 131, 132, the wire W is not loosened in this section. Further, the moving amount of the wire W can be measured by the encoder rollers 121, 122. Since the encoder rollers 121, 122 are arranged in the section where the wire W is not loosened, the moving amount of the wire W can be precisely measured.

More specifically, if the rotation of the feed rollers 141, 142 and 131, 132 is stopped after the wire W is fed thereby at a high speed, the loosening may occur due to an inertial force acting on the wire W. However, in this embodiment, the wire W is constantly fed while being pulled by the first feed rollers 141, 142. This is because the peripheral velocity of the first feed rollers 141, 142 is higher than that of the second feed rollers 131, 132 and, therefore, the feed of the wire W by the first feed rollers 141, 142 is constrained by the second feed rollers 131, 132.

Accordingly, even if the rotation of the respective feed rollers is suddenly stopped after the wire W has been fed by the predetermined length, the loosening of the wire W does not occur between the first feed rollers 141, 142 and the second feed rollers 131, 132. As a result, the moving amount of the wire W can be precisely measured by the encoder rollers 121, 122. Even if the wire W is continuously fed, the wire materials can be precisely produced without causing any variation in the final length thereof. In order to set the peripheral velocity of the first feed rollers 141, 142 higher than that of the second feed rollers 131, 132, the pulleys M4 mounted on the feed rollers 131, 132 may be made larger, i.e. having a bigger outer circumference, than the pulleys M4 mounted on the feed rollers 141, 142.

(2) In this embodiment, in order to apply a tensile force to the wire W, the outer diameter of the first feed rollers 141, 142 is set larger than that of the second feed rollers 131, 132, thereby setting the peripheral velocity of the first feed rollers 141, 142 higher than that of the second feed rollers 131, 132. Since a simple means is adopted to apply the tensile force to the wire W, the wire feeding mechanism needs not have a complicated construction, thereby avoiding a considerable increase in a production cost.

(3) Further, diamond coating applied on the outer surfaces of the feed rollers 141, 142 causes a large frictional force to act between the first feed rollers 141, 142 and the wire W. Accordingly, an occurrence of a slip between the first feed rollers 141, 142 and the wire W during the feed of the wire W can be prevented. As a result, even if the wire W is fed at a high speed, the feeding speed does decrease due to the slip of the wire, thereby enabling a high speed feed of the wire W by the predetermined length.

It should be appreciated that the invention is not limited to the foregoing embodiment. For example, a means for applying a tensile force to the wire W may be such that the second feed rollers 131, 132 are strongly pressed against each other by means of a spring or like biasing member so as to cause a rotational friction to act between the feed rollers 131, 132. Alternatively, a rotational resistance may be given by disposing, e.g. a brake pad between rotatable shafts of the feed rollers 131, 132. In other words, any means can be adopted so long as the second feed rollers 131, 132 constrain the feed of the wire W by the first feed rollers 141, 142. Further, in such cases, the timing belts B1 may be omitted so as not to transmit a rotational force to the second feed rollers 131, 132.

The above modifications demonstrate the same action and effect as the foregoing embodiment. Specifically, since the wire W is always pulled by the first feed rollers 141, 142, it is not loosened between the first feed rollers 141, 142 and the second feed rollers 131, 132. In these modifications as well, since the wire feeding mechanism needs not have a specially complicated construction, a considerable increase in a production cost can be avoided. It should be appreciated that a variety of design changes are possible without departing from the spirit and scope of the invention as defined in the appended claims.

LIST OF REFERENCE NUMERALS

M	Motor
PL	Pass Line
121	Encoder Roller
122	Encoder Roller
131	Feed Roller
132	Feed Roller
141	Feed Roller
142	Feed Roller

Claims

1. A wire feeding mechanism for feeding a wire (W) along a specified pass line (PL), comprising:

   a first pair of feed rollers (141, 142)
   a second pair of feed rollers (131, 132) which are arranged upstream from the pair of first feed rollers (141, 142), the feed rollers (141, 142; 131, 132) of each pair being opposed to each other on opposite sides of the pass line (PL) for feeding the wire (W) on the pass line (PL) while tightly holding and guiding the wire (W).

2. A wire feeding mechanism according to claim 1, further comprising measuring means (121, 122) disposed in the first (141, 142) or second (131, 132) pair of feed rollers or between them for measuring a moving amount (length) of the wire (W) moving on the pass line (PL).

3. A wire feeding mechanism according to claim 1 or 2, further comprising:

   tensile force applying means for applying a tensile force to the wire (W) being fed between the first (141, 142) and second (131, 132) feed rollers.

4. A wire feeding mechanism according to claim 3, wherein the tensile force applying means comprises a differential means (M4, B1) for rotating the first (141, 142) and second (131, 132) feed rollers such that the peripheral velocity of the first feed rollers (141, 142) is higher than that of the second feed rollers (131, 132).

5. A wire feeding mechanism according to claim 4, wherein the differential means (M4, B1) comprises pulleys (M4) and/or gears being rotationally connected or fixed to the first (141, 142) and second (131, 132) feed rollers, wherein the pulleys (M4) and/or gears of the first feed rollers (141, 142) have a larger effective circle diameter or pitch circle diameter (PCD) than the pulleys (M4) and/or gears of the second feed rollers (131, 132).

6. A wire feeding mechanism according to one or more of the preceding claims and claim 3, wherein the tensile force applying means comprises a

means for applying a specified rotational resistance or resistance against turning to the second feed rollers (131, 132) so as to constrain the feed of the wire (W) by the first feed rollers (141, 142), in particular for applying a specified tensile force to the portion of wire (W) between the first and second feed rollers (141, 142; 131, 132).

7. A wire feeding mechanism according to one or more of the preceding claims, wherein the circumference of the first feed rollers (141, 142) is larger than the circumference of the second feed rollers (131, 132), in particular wherein the first and second feed rollers are driven with the same rotational speed.

8. A wire feeding mechanism according to one or more of the preceding claims, wherein the measuring means (121, 122) comprises a pair of encoding rollers (121, 122) which are opposed to each other on opposite sides of the pass line (PL), and which may be the first (141, 142) or second (131, 132) pair of feed rollers or be positioned between them.

9. Use of a wire feeding mechanism according to one or more of the preceding claims in a wire feeding unit (10) of a wire cutting apparatus, wherein the wire cutting apparatus comprises the wire feeding unit (10), and

a cutting unit (40) for cutting the wire (W) fed by a predetermined length by the wire feeding mechanism to produce a wire material for forming a wiring harness.

10. Use of a wire feeding mechanism according to claim 9, wherein the wire cutting apparatus further comprises a wire guiding unit (20) for guiding and bending the wire (W) fed by the wire feeding unit (10).

FIG. 1

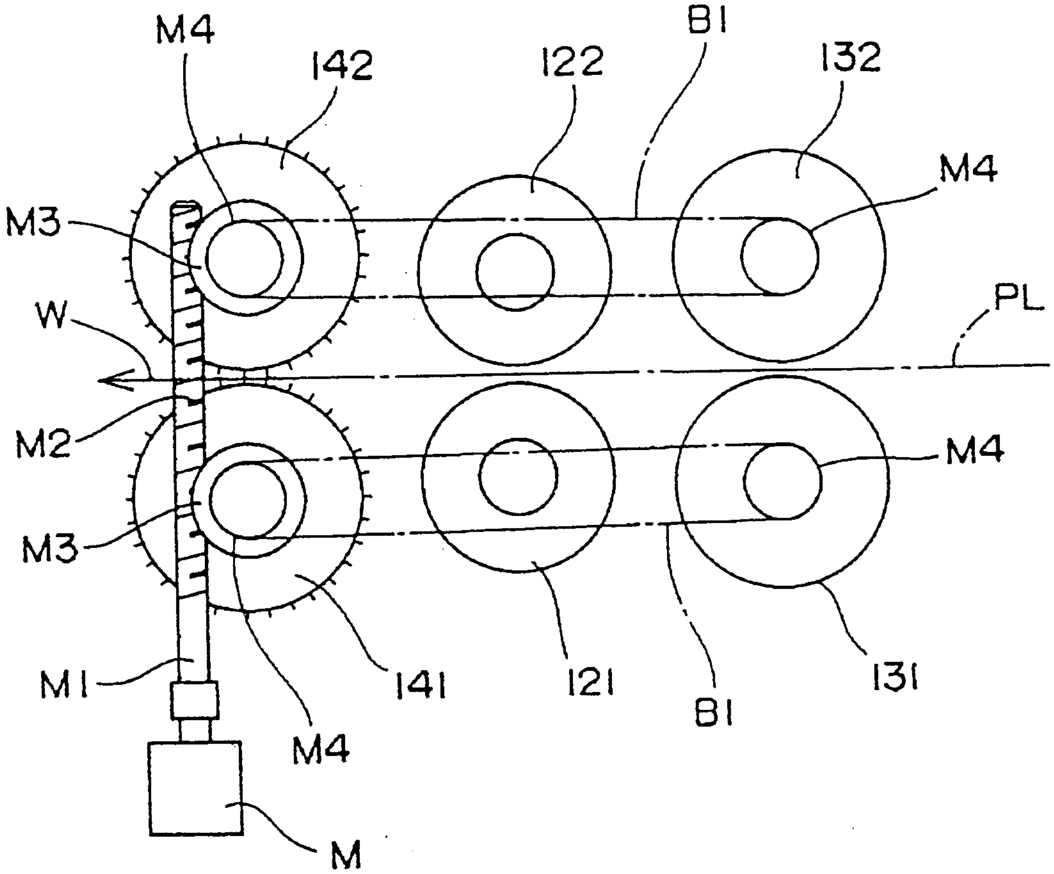


FIG. 2

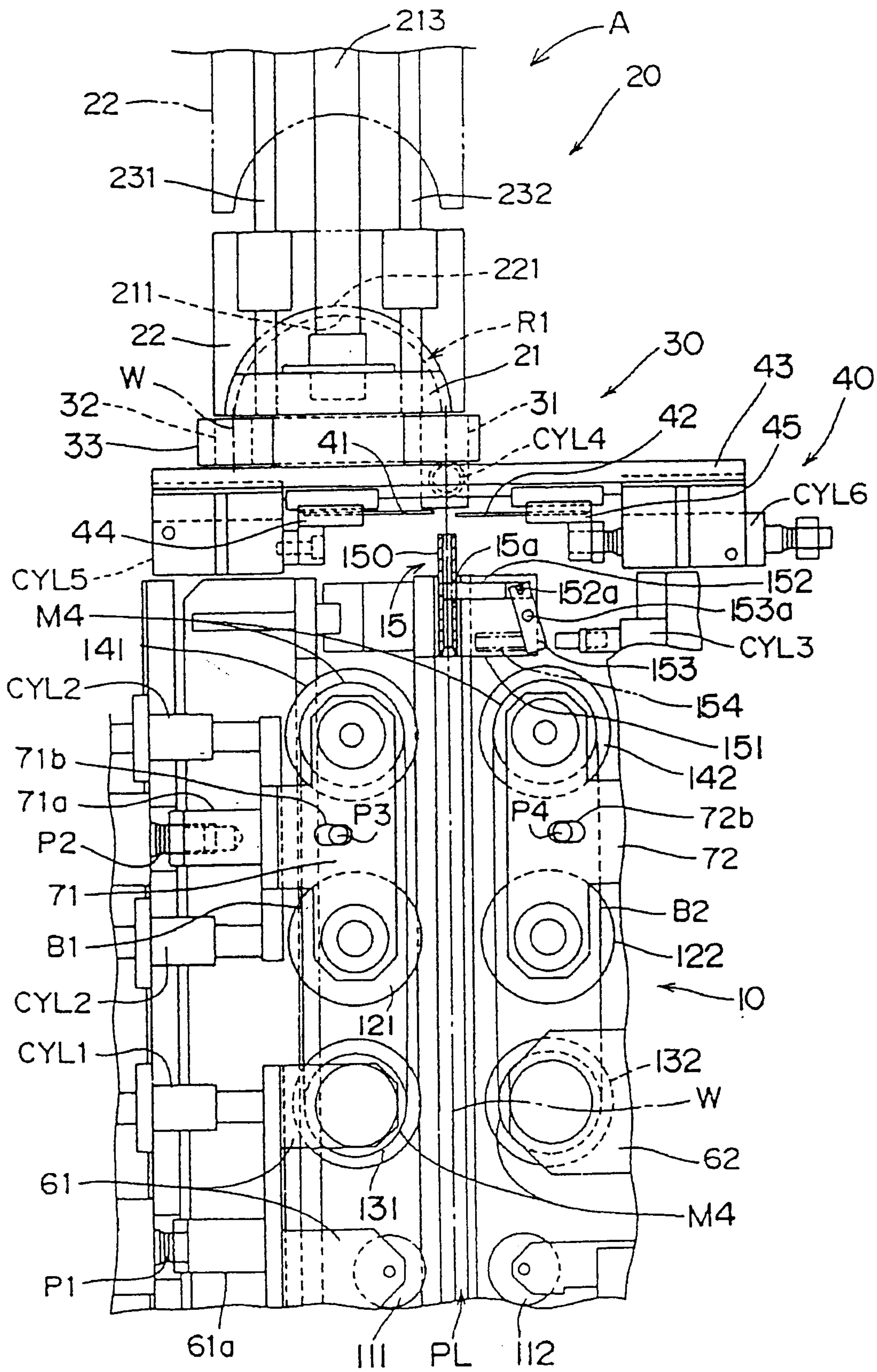
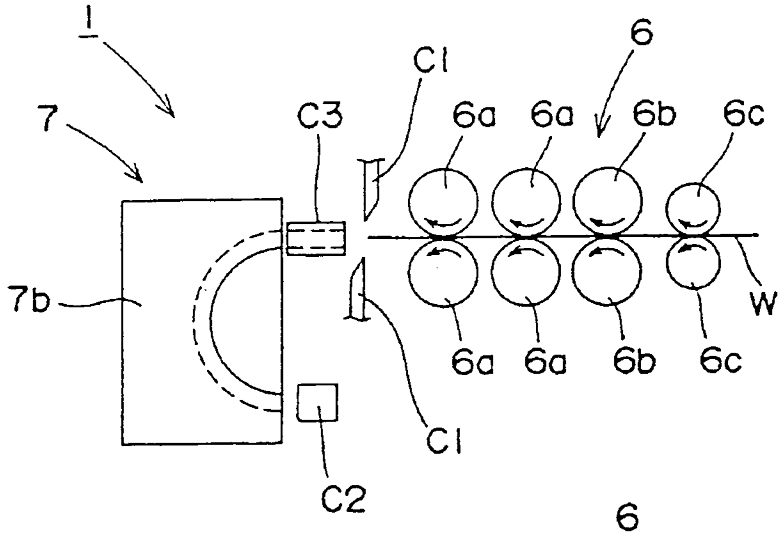

213
A
20
22
231
232
221
211
R1
22
21
30
43
40
W
31
32
33
41
CYL4
42
45
CYL6
44
CYL5
150
15a
152
152a
M4
15
153a
141
CYL3
153
CYL2
154
151
71b
142
71a
P3
P4
72b
P2
72
71
B2
B1
122
CYL2
121
10
CYL1
132
W
62
61
131
M4
P1
61a
111
PL
112

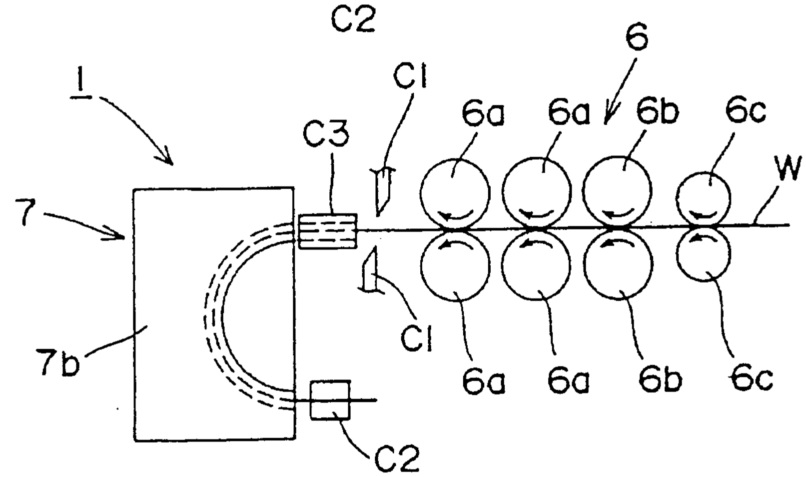
FIG. 3

PRIOR ART

(a)



(b)



(c)