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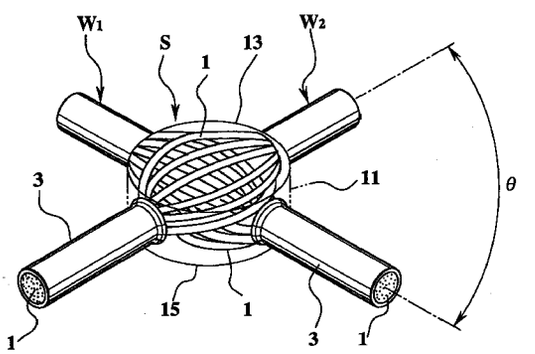
(54) Covered wire connection method and structure

(57) Two covered wires (W1,W2) conductively connected are overlapped with each other at connection portions. The overlapped connection portions are pinched by a pair of resin chips (13,15). By melting cover portions and pressing resin chips from outside, the conductive wire portions (1) of the covered wires are conductively contacted with each other at the connection portions. The pair of the resin chips (13,15) are melt-fixed to each other to seal the connection portions. A crossing angle θ of the two covered wires (W1,W2) at the connection portion is set to not less than 45° to not greater than 135°. Thus, the covered wires can be conductively connected with each other at cheap price easily. Further, a connecting state having an excellent electrical characteristic can be obtained stably.

FIG.1



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Description

BACKGROUND OF THE INVENTION

This invention relates to a connection method and structure for connecting covered wires with each other or connecting a covered wire to another member.

As a conventional connection structure for this kind of covered wires, an art proposed by this inventor (see Japanese Laid-Open Patent Application No. 7-320842) will be described.

For connecting two covered wires the outer periphery of which is coated with a cover portion made of resin, at their intermediate connection portions, a pair of resin chips which are of resin material, a horn for producing ultrasonic vibration, and an anvil for supporting the covered wires and resin chips at the time of connection are utilized. The anvil includes a base stand and a support portion projecting from the base stand. The support portion is designed in a substantially cylindrical shape. The support portion has a bore portion which is opened at the opposite side to the base stand side. Two pairs of grooves are formed on the peripheral wall of the support portion so as to cross with each other substantially at the center of the bore portion. The four grooves are formed so as to open on the same side as the bore portion, extending along the projection direction of the support portion and intercommunicate with one another through the bore portion.

The pair of resin chips are designed in a disc shape having a slightly smaller outer diameter than the diameter of the bore portion of the anvil. Furthermore, an end face of a head portion of the horn is designed in a disc shape having an outer diameter which is substantially equal to or slightly smaller than that of the resin chips.

The respective resin chips have solder as soldering material. The solder 15 is embedded substantially in the center of the bottom/top surface such that a circular top face thereof is flush with the bottom/top surface (melting surface) of the upper and lower resin chips.

In order to connect the two covered wires to each other, both of the covered wires are overlapped with each other at the connection portion thereof and the overlapped connection portions are pinched through a solder by the pair of resin chips from the upper and lower sides of the connection portions. Specifically, one of the resin chips (the resin chip at the lower side) is inserted into the bore portion of the anvil such that the melting surface thereof is directed upward. Then, one covered wire is inserted into the pair of confronting grooves from the upper side of the inserted resin chip. Then, the other covered wire is inserted into the other pair of the confronting grooves. Finally, the other (upper side) resin chip is inserted such that the melting surface is directed downward. The covered wires are arranged in the bore portion so that the respective connection portions thereof cross each other at the center of the bore portion. Through this arrangement, the connection portions of the covered wires are pinched substantially at the center of the melting surfaces of the upper and lower resin chips respectively in the overlapping direction.

Subsequently, the cover portions at the connection portions of the covered wires are melted so as to be dispersed by ultrasonic vibration. Furthermore, the conductive wire portions (core) of the covered wires are conductively contacted with each other at the connection portion by pressing the covered wires from the outside of the resin chips. Thereafter, the pair of the resin chips are mutually melt-fixed at the melting surfaces to seal the connection portion.

Specifically, the head portion of the horn is inserted into the bore portion from the upper side bore portion from the upper side of the finally-inserted upper (other) resin chip and placed on the upper resin chip to excite and press the connection portions of the covered wires from the outside of the upper and lower resin chips between the horn and the anvil. The cover portions are first melted and the conductive wire portions of the covered wires are exposed at the connection portion between the resin chips. At this time, the melted cover portions are extruded from the center side of the resin chips toward the outside thereof because the connection portions are pressed from the upper and lower sides, so that the conductive wire portions are more excellently exposed and surely conductively contacted with each other. Like the press direction, the direction of the excitation of the connection portions is set to be coincident with the overlapping direction of the covered wires, so that the action of extruding the melted cover portions from the center side of the resin chips to the outside thereof is promoted.

When the pressing and exciting operation on the connection portions is further continued after the melting of the cover portions, the resin chips are melted and the confronting melting surfaces of the resin chips are melt-fixed to each other. In addition, the outer peripheral surface portions of the cover portions which are adjacent to the conductively contacted conductive wire portions and the resin chips are melt-fixed. With this operation, the outer peripheral portions of the conductively-contacted conductive wire portions are kept to be coated with the resin chips.

The solder provided in the resin chips is melted by heat generated when the resin chips are melted. Consequently the conductive wire portions of the conductively contacted covered wires are soldered at the connection portions in the resin chips. As a result, a higher electric performance can be obtained at the connection portions thereby further stabilizing the conductive characteristic.

However, in this connection structure, solder must be melted accurately at the same timing in a series connecting process as when the cover portion is melted such that the conductive wire portion is exposed and contacted with each other. Thus, the solder needs to be

buried inside of the resin chips without being exposed from melting surfaces of resin chips respectively. When burying the solder inside of the resin chips, in production process of the resin chips, a special treatment for sealing opening portions for the burying with resin material is needed after the solder is buried in the resin chips. Thus, increase in cost of the resin chips cannot be avoided.

Further, to melt solder accurately at the above timing, detailed setting and management of a position of the solder in the resin chips and ultrasonic melting condition (particularly temperature) must be conducted. Thus, conductive connecting procedure becomes complicated and such an intrinsic effect of this technology that conductive connection is performed by a simple method may be lost.

Further, the solder needs to contain a mixture of chemical active substance (flux) for improving leaking characteristic for core wires composing the conductive wire portion. In this technology which solders the connection portions and simultaneously seals it, this kind of flux needs to be contained in the resin chips. Thus, there is a fear that the connection portions may corrode due to flux so that conversely reliability relating to electrical connecting performance may be reduced.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a covered wire connection method and connection structure in which covered wires can be conductively connected with each other at cheap price and easily and a connection state with excellent electric

characteristic can be obtained stably. In order to achieve the above object, according to the present invention, there is provided a covered wire connection method and structure including steps of and formed by steps of overlapping two covered wires each of which comprises a conductive wire portion composed of plurality of core wires and a covered portion covering an outer periphery of the conductive wire portion, pinching an overlapping portion of the covered wires between a pair of resin chips, pressurizing and exciting the overlapping portion pinched by the resin chips using an ultrasonic vibration welding apparatus so as to melt and disperse the cover portion, thereby to expose the conductive wire portion and electrically conductively connect the conductively wire portions of the covered wires at the overlapping portion and so as to melt-fix the pair of resin chips to seal the connected overlapping portion of the covered wires with the melted resin chips, characterized in that a crossing angle at the overlapping portion of the two covered wires is set to not less than 45° to not greater than 135°.

According to the construction described above, the covered wires are overlapped with each other at the connection portions (overlapping portion) and the overlapped connection portions are pinched by a pair of the resin chips. Then, the cover portions are melted and dispersed by ultrasonic excitation and further pressed from outside of the resin chips. With such a relatively simple method, the covered wires can be conductively contacted with each other with the connection portions in sealing condition.

After the covered wires are conductively contacted with each other at the connection portions, the pair of the resin chips are melt-fixed to each other so as to seal the connection portions. With melted and hardened resin chips, a high mechanical strength can be obtained at the connection portions.

The crossing angle of the covered wires is set to not less than 45° to not greater than 135° in which a pressure applied from the resin chips acts on the covered wires substantially equally without losing balance so that the core wires are excellently loosened and the loosened core wires are gradually spread to flat shape. Thus, the conductive wire portions of both the covered wires are in contact with each other at plural positions, so that connecting state having excellent electric characteristic and with low contact resistance can be obtained. That is, the crossing angle of the covered wires is set to not less than 45° to not greater than 135° in which a pressure applied from resin chips acts on covered wires substantially equally without losing balance so that the core wires are excellently loosened and the loosened core wires are gradually spread to flat shape. Thus, the conductive wire portions of both the covered wires are in contact with each other at plural positions. Thus, no special treatment is needed to the resin chips and a connecting state having excellent electric characteristic can be obtained stably at cheap price.

At least one of the resin chips may contain wire supporting portions for restricting the crossing angle of the two covered wires at the overlapping portion at a desired angle.

According to the construction described above, it is possible to set the crossing angle at a desired angle easily by means of the wire supporting portions provided in the resin chips without providing other member such as the anvil with a means for restricting the crossing angle.

At least one of the resin chips may be made of a transparent material.

According to the construction described above, the spreading of the core wires on the connection portions can be visually checked. Thus, simplification of quality inspection can be achieved.

A covered wire connection structure may more comprises a protective case for covering the overlapping portion of the two wires as well as neighboring portions thereof. The protective case may contain a case body and lid body, one side of the case body may be open, the lid body may be to close an opening portion of the case body, the resin chips may be formed in the case body and the lid body such that they are integral

therewith respectively, and at least one of the case body and the lid body may contain protruding portions for restricting the crossing angle of the two wires at the overlapping portion at a desired angle.

According to the construction described above, the pair of the resin chips are melt-fixed to each other to seal the connection portions with their conductive connecting state and at the same time, the case body is connected with the lid body. Thus, the connection portions and the neighboring portions are covered with protective cases. That is, by melt-fixing the pair of the resin chips to each other, the connection portions of two covered wires are sealed and at the same time, the case body is connected with the lid body in the protective case. Thus, for the connection of the case body with the lid body, other process is not required and increase of the number of processes is not induced despite an increase of parts. Further by the protective case, protection of the connection portions and the neighboring portions can be achieved.

Further, the two covered wires ca be maintained at a desired crossing angle because they are caught at the time of ultrasonic excitation. Thus, after the sealing, the connection portions are kept to be conductively contacted with each other while crossing at the desired crossing angle. Thus, a stabilized electrical performance can be exerted.

The protruding portions may be formed so as to have both side walls, the two covered wires may be in contact with and curved by the walls so as to cross each other at the desired crossing angle, and the protruding potions may be arranged so as to oppose each other adjacent to the resin chips.

According to the construction described above, the connection portions of the two covered wires are arranged so as to cross each other at the desired angle on the resin chip between the protruding portions disposed so as to oppose each other. Because the protruding portions are disposed adjacent to the resin chips, the width of the protruding portion (width between both the side walls) necessary for obtaining a desired crossing angle can be set to a small value so that the protruding portions can be designed in compact fashion. Further, a distance between the opposing protruding portions is reduced, so that the crossing state of the connection portions can be maintained stably.

At least one of the case body and the lid body may contain wire introducing portions for introducing the two covered wires from the protective case in parallel.

According to the construction described above, the two covered wires in which the connection portions are crossed at the desired crossing angle can be introduced in parallel through the wire introducing portions from the protective case. Thus, it is possible to provide such a covered wire connection structure which can be realized preferably as a wire harness.

The case body and the lid body may be formed integrally with each other through a hinge portion.

According to the construction described above, by turning the lid body through the hinge portion, the lid body can be set to the opening portion of the case body easily. Further, by this setting, the pair of the resin chips formed on the case body and the lid body each are arranged such that their melting surfaces oppose each other. That is, because the case body and the lid body are molded integrally through the hinge portion, management of parts is facilitated. Further, by only turning the lid body through the hinge portion, the lid body can be set to the opening portion of the case body. Thus, positioning of respective parts is not necessary thus simplifying assembly work.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing a covered wire connection structure according to a first embodiment,

Fig. 2 is an enlarged plan view of the connection portion of Fig. 1,

Fig. 3A shows side sectional views schematically showing states of resin chips currently being pressed and excited just after the connection; and shows a state magnified about nine times,

Fig. 3B shows side sectional views schematically showing states of resin chips currently being pressed and excited just after the connection; and shows a state magnified about thirty times,

Fig. 4A shows side sectional views schematically showing a state during connection of the resin chips being pressed and excited; and shows a state magnified about nine times,

Fig. 4B shows side sectional views schematically showing a state during connection of the resin chips being pressed and excited; and shows a state magnified about thirty times,

Fig. 5A shows side sectional views schematically showing a state after connection of the resin chips pressed and excited; and shows a state magnified about nine times,

Fig. 5B shows side sectional views schematically showing a state after connection of the resin chips pressed and excited; and shows a state magnified about thirty times,

Fig. 6A shows side sectional views schematically showing a state just after connection of the resin chips for reference; and shows a state magnified about nine times,

Fig. 6B shows side sectional views schematically showing a state just after connection of the resin chips for reference; and shows a state magnified about thirty times,

Fig. 7 is a side sectional view showing schematically a state after connection of the resin chips for reference magnified by about thirty times;

Fig. 8 is a diagram showing a relation between crossing angle and contact resistance;

Fig. 9 is a perspective view showing a connecting structure of the covered wires according to a second embodiment;

Fig. 10 is a sectional view taken along the lines X-X in Fig. 9;

Fig. 11A is a perspective view of a free state of a protective case for use in a third embodiment;

Fig. 11B is a perspective view of an appearance of major parts after two covered wires are connected according to the third embodiment; and

Fig. 12 is a plan view showing the conductive connecting state of the core wires of two covered wires according to a third embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

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

Fig. 1 is a perspective view showing a covered wire connection structure according to the instant embodiment. Fig. 2 is an enlarged plan view of the connection portion of Fig. 1. Figs. 3-5 are side sectional views showing schematically a state of a resin chip currently under pressing and excitation. Figs. 3A and 3B show a state just after the connection is started, Fig. 4A and 4B show a state during connection and Figs. 5A and 5B show a state after the connection is completed. Fig. 5A of the respective Figures indicates a state enlarged about nine times and Fig. 5B thereof indicates a state enlarged about thirty times. Figs. 6A, 6B and 7 are side sectional views showing schematically a state of resin chip for reference. Figs. 6A and 6B show a state just after the connection is started and Fig. 7 indicates a state after the connection is completed. Fig. 6A indicates a state enlarged about nine times and Fig. 6B indicates a state enlarged about thirty times. Fig. 8 is a diagram showing a relation between crossing angle and contacting resistance.

According to the instant embodiment shown in Fig. 1, two covered wires W1, W2 each of which comprises a conductive wire portion 1 and a cover portion 3 which is formed of resin and coated around the outer periphery of the conductive wire portion, are conductively connected to each other at connection portions (overlapping portion) S thereof as shown in Fig. 1. The respective conductive wire portions 1 of the covered wires W1, W2 are each composed of seven core wires (see Fig. 2).

In order to connect two covered wires W1, W2, a pair of resin chips 13, 15 which are resin materials 11, a horn for producing ultrasonic vibration (not shown) and an anvil (not shown) for supporting the covered wires W1, W2 and the resin chips 13, 15 at the time of the connection are utilized. The anvil has a bore portion which is open upward and has a circular cross section and two pairs of groove portions which confront each other with respect to substantially the center of the bore portion for containing the covered wires W1, W2. These four groove portions are open on the same side as the bore portion and the mutually facing groove portions intercommunicates with each other through the bore portion. A crossing angle of lines connecting the mutually facing groove portions is the crossing angle θ in which the covered wires W1, W2 are conductively connected with each other. That angle is set to not less than 45° to not greater than 135° (90° in the instant embodiment). Meanwhile, because the structures of the horn and the anvil are substantially the same as conventional, a detailed description thereof is omitted.

The pair of the resin chips 13, 15 are formed in a circular shape having a slightly smaller than the bore of the anvil and contains no soldering material unlike conventional case. The resin chips 13, 15 are made of acrylic resin, ABS (acrylonitrile-butadiene-styrene copolymer) resin, PC (polycarbonate) resin, PVC (polyvinyl chloride) resin, PE (polyethylene) resin, PEI (polyetherimide), PBT (polybuthylene terephtalate) or the like. Generally, the material is harder than vinyl chloride for use in the cover portion 3. With respect to the suitability of these resin for use as the resin chips 13, 15, the applicability can be recognized in all the resins in term of the conductivity and conductivity stability and if judging from appearance and insulation performance as well, particularly PEI resins and PBT resins are suitable.

The respective resin chips 13, 15 have melting surfaces 13a, 15a (see Figs. 3-5) which are contacted with each other when the resin chips 13, 15 are overlapped with each other vertically in the bore portion of the anvil and the connection portions S in which two covered wires W1, W2 cross each other are located in the center of the melting surfaces 13a, 15a.

In order to connect the two covered wires W1, W2, first the covered wires W1, W2 are overlapped with each other at the connection portions S and the overlapped connection portions S are pinched vertically by a pair of the resin chips 13, 15. Concretely, one resin chip 15 is inserted into the bore portion of the anvil so that its melting surface 15a is directed upward and one covered wire W1 is inserted into confronting groove portions of one pair such that it is located over the resin chip 15. Then, the other covered wire W2 is inserted into the other confronting groove portion. Finally, the other (upper) resin chip 13 is inserted with its melting surface 13a directed downward. Both the covered wires W1, W2 are arranged such that the respective connection portions S cross each other in the center of the bore portion. Consequently, the connection portions S are pinched in the center of the melting surfaces 13a, 15a of the upper and lower resin chips 13, 15 vertically in the overlapping direction. With this condition, the crossing angle θ between the cored wires W1 and W2 is limited to substantially 90° which is a crossing angle of the confronting groove portions.

Subsequently, the cover portions 3 at the connec-

tion portions S of the covered wires are melted so as to be dispersed by ultrasonic vibration. Furthermore, the conductive wire portions (core) of the covered wires W1, W2 are conductively contacted with each other at the connection portion S by pressing the covered wires from the outside of the resin chips 13, 15. Thereafter, the pair of the resin chips 13, 15 are mutually melted at the melting surfaces 13a, 15a to seal the connection portion S (see Figs. 3-5).

Specifically, the horn is inserted onto the upper side (other side) of the finally-inserted upper resin chip 13 and the connection portions S are excited and pressed from the outside of the upper and lower resin chips 13, 15 between the horn and the anvil. The press of the connection portion S is performed by pressing the horn toward the anvil, and the press direction is coincident with the overlapping direction of the covered wires.

When the resin materials 11 are melt-fixed to each other by the ultrasonic vibration, the excitation is preferably performed in a direction which substantially perpendicularly intersects to the connection surface of the resin materials 11 because it provides the most excellent melt-fixing state. Therefore, the direction of the excitation of the connection portion S is set to a direction which crosses the confronting surfaces 13a, 15a of the resin chips 13, 15, that is, it is set to be coincident with the overlapping direction of the covered wires W1, W2. With this arrangement, longitudinal vibration is produced from the horn.

When the connection portions S are pressed and excited in the above state, the cover portions 3 are first melted and the conductive wire portions 1 of the covered wires W1, W2 are exposed at the connection portion S between the resin chips 13 and 15. At this time, the melted cover portions 3 are extruded from the center side of the resin chips 13, 15 toward the outside thereof because the connection portions S are pressed from the upper and lower sides, so that the conductive wire portions 1 are more excellently exposed and surely conductively contacted with each other. Like the press direction, the direction of the excitation of the connection portions S is set to be coincident with the overlapping direction of the covered wires W1, W2, so that the action of extruding the melted cover portions 3 from the center side of the resin chips 13, 14 to the outside thereof is promoted.

If the pressing and excitation of the connection portions S are continued after the cover portions 3 are melted, the resin chips 13, 15 are melted such that the melting surfaces 13a, 15a of both the resin chips 13, 15 are melt-fixed to each other. Outer peripheral faces of the cover portions 3 adjacent to the conductive wire portions 1 which are conductively contacted with each other are melt-fixed to the resin chips 13, 15. Consequently, the outer peripheral faces of the conductive wire portions 1 conductively contacted are covered with the melted resin chips 13, 15 (see Fig. 1).

Because the crossing angle θ between the covered wires W1 and W2 is set to 90°, a force from the resin chips 13, 15 is applied to the covered wires W1, W2 (core wires of the conductive wire portion 1) substantially equally with keeping a balance when the connection portions S are pressed and excited. As a result, first the core wires are loosened and the loosened core wires are spread gradually so that they become flat (see Figs. 3-5). Consequently, the conductive wire portions 1 of both the covered wires W1, W2 are contacted with each other at plural positions (see Fig. 2).

Here, an example of results of the experiments will be shown. If the crossing angle θ is 90°, it has been recognized that the number of contact points between both the core wires exceeds 30 points. This indicates that they are contacted with each other at very many points because the maximum number of contact points is 49 (see Fig. 2) if seven core wires are made to contact other seven core wires.

Further, if a percentage of occurrence of unbalanced spreading of the core wires is obtained when the crossing angle θ is changed in a range between 90° and 30°, it is 0% in a range between 90° and 60° and it is as low as 11% when the crossing angle is 45°. However, it is recognized that the percentage is as high as 89% when the crossing angle is 30°. If the crossing angle θ is small (about 30°), as shown in Figs. 6, 7, the core wires of the upper covered wire W2 enter in between the core wires of the lower covered wire W1 easily so that a force applied from the resin chips 13, 15 acts with lost balance. On the other hand, if the crossing angle θ is large (90°), as shown in Figs. 3-5, the core wires of the upper covered wires W2 are unlikely to enter in between the core wires of the lower covered wires W1. This is because a force applied from the resin chips 13, 15 act equally with keeping balance.

If a relationship between the crossing angle θ and contact resistance is obtained through experiments, as shown in Fig. 8, the contact resistance is less than 5mΩ, when the crossing angle θ is 90°-45°. If the crossing angle becomes smaller than 45°, the contact resistance rises largely and when 30°, the contact resistance exceeds 5mΩ.

From what has been said above, it is found that if the crossing angle θ is decreased from 90°, the condition of spreading of the core wires is deteriorated so that the number of contact points between the core wires is reduced and then contact resistance increases. A range of the crossing angle θ in which stable conductive contacting can be obtained with a low contact resistance is preferably 90°$\pm$45° (45° - 134°). Particularly 90° is the most appropriate.

According to the connection method of the instant embodiment, by pressing the resin chips 13, 15 from outside so as to melt and disperse the cover portion 3 with the covered wires W1, W2 overlapped at the connection portions S and the connection portions S pinched by a pair of the resin chips 13, 15, the covered wires W1, W2 can be conductively connected with each

other at the connection portions S. Thus, when conductively connecting the covered wires W1, W2, it is not necessary to remove the cover portion 3 and obtain conductive connection by a simple operation.

Further, according to the connection method and the connection structure obtained thereby, after the covered wires W1, W2 are conductively connected with each other at the connection portions S, the upper and lower resin chips 13, 15 are melt-fixed to each other to seal the connection portions S. Thus, by the melted and hardened resin chips 13, 15, a high mechanical strength can be obtained at the connection portions S.

Further, because the resin chips 13, 15 have only to have a dimension capable of pinching the connection portions S to be conductively contacted from up and down, area necessary for the connection can be restricted to a small area. Further, because the connection portions S are sealed by the resin chips 13, 15, it is possible to ensure a sufficient insulation.

Thus, by such a high mechanical strength and a sufficient insulation, conductive characteristic between the covered wires W1 and W2 at the connection portions S can be stabilized.

Furthermore, the covered wires W1, W2 are pinched by the pair of the resin chips 13, 15 in the overlapping direction thereof and the connection portions S are pressed and excited between the horn and the anvil from the outside of the resin chips 13, 15 and the direction of the pressing is set to the same as the direction in which the covered wires W1,W2 are overlapped with each other. Thus, when the connection portion S is pressed, the melted cover portions 3 are extruded out from the center portion of the resin chips 13, 15 toward outside so that the conductive wire portions 1 are exposed excellently thereby obtaining a secure conductive contacting state. Further, because the direction of excitation to the connection portion S is set to the same as the direction in which the covered wires W1, W2 are overlapped with each other like the pressing direction, it is possible to obtain excellent melting condition of the resin chips 13, 15 and enhance an action of pushing out the cover portions 3.

Further, the crossing angle θ between the covered wires W1 and W2 is set to be not less than 45° to not greater than 135° in which a pressure applied from the resin chips 13, 15 acts substantially equally on the core wires without losing balance so that they are excellently loosened, the conductive wire portions 1 of the covered wires W1, W2 are contacted with each other at plural positions. Consequently, a stable connecting state with an excellent electric characteristic can be obtained. Particularly, in the instant embodiment, the crossing angle θ is set to 90° in which the core wires can be loosened most excellently. Thus, it is possible to achieve improvement of electric characteristic and stabilization thereof.

Further, it is not necessary to make special treatment for the pair of the resin chips 13, 15 such as embedding of solder unlike conventional case. Thus, they can be structured in a cheap construction. Further, different from a case in which solder is provided, no flux is produced at the connection portions S, so that reliability of electric connection performance is not reduced.

Further, by making at least one of the resin chips 13, 15 with a transparent material, it is possible to visually check the spreading of the core wires on the connection portions S. Thus, the conductive connecting state between the covered wires W1 and W2 can be visually recognized thereby simplifying quality inspection.

It is permissible to use the resin chips 13, 15 having a relatively low viscosity at the time of melting. Then, when melting the resin chips 13, 15 so as to surround the connection portion S, the melted resin chips 13, 15 may be filled in gaps between plural core wires composing the conductive wire portion 1 in the neighboring conductive wire portions 1 excluding the connection portion S to fill gaps formed between the cover portions of the covered wires W1,W2 and the core wires or gaps formed between the core wires with resin material 11 thereby obtaining an effect of sealing against water inside of the covered wires W1, W2. Thus, for example, in a case in which one end of the covered wires W1, W2 is connected to a portion requiring waterproof (waterproofed portion) and the other end thereof is connected to a portion not requiring water proof (non-waterproofed portion), water or the like enters inside of the covered wires W1, W2 from the other end due to capillary phenomenon and flows inside of the covered wires W1, W2. However, water is prevented from entering to the one end by the aforementioned effect of sealing against water. Thus, it is possible to secure water proof performance at the one end without providing the other end with water proof structure. That is, if both ends of the covered wires W1,W2 are connected to the water proofed portion and the non-waterproofed portion, it is possible to secure waterproof performance in the waterproofed portion without providing the non-waterproofed portion with a waterproofing structure, by a simple and cheap method and structure.

Next, a second embodiment of the present invention will be described with reference to the accompanying drawings.

Fig. 9 is a perspective view showing a covered wire connection structure according to the instant embodiment. Fig. 10 is a sectional view taken along the lines X-X. The same components as the aforementioned first embodiment are provided with the same reference numerals and a description thereof is omitted.

According to the instant embodiment, the lower resin chip 45 is provided with wire containing grooves 53 which are wire supporting members for restricting the crossing angle θ at the connection portions S between the two covered wires W1 and W2 to a desired angle.

The lower resin chip 45 comprises a chip body 47 which is of substantially cylindrical shape and in which a top surface thereof is a melting surface 47a, a circum-

ferential portion 51 formed around the chip body 47 in a doughnut shape and a groove portion 49 formed between the chip body 47 and the circumferential portion 51 which is open upward and in a donut configuration. The circumferential portion 51 has two pairs of wire containing grooves 53 (four positions) which confront with each other with respect to the center of the melting surface 47a and are open upward. The crossing angle of a line connecting the mutually facing wire containing grooves 53 is the crossing angle θ used when conductively connecting the covered wires W1 and W2. That angle is set to be not less than 45° to not greater than 135° (90° in the instant embodiment) like the first embodiment. The melting surface 47a of the chip body 47 is formed at a position (height) deviated upward or downward from a bottom of the wire containing groove 53. If the covered wires W1, W2 are set in the mutually confronting wire containing grooves 53 and pressed, the covered wires W1, W2 are bent at peripheral portions of the chip body 47 and the groove portion 49 and then contained in the wire containing grooves 53 such that they are temporarily held. Both the covered wires W1, W2 cross each other at a desired crossing angle θ substantially in the center of the lower melting surface 47a. Meanwhile, the upper resin chip 43 is formed in a circular shape so that a bottom face thereof is a melting surface 43a like the first embodiment. The upper and lower melting surfaces 43a, 47a are of substantially the same shape and dimension. Although according to the instant embodiment, only the lower resin chip 45 is provided with the wire containing grooves 53, it is possible to provide both the upper and lower resin chips 43, 45 with such wire containing grooves 53 or provide only the upper resin chip 43 with the wire containing grooves.

According to the instant embodiment, in addition to the effects of the first embodiment, it is possible to set the crossing angle θ at any desired angle by means of the wire containing grooves 53 provided in the lower resin chip 45 without providing additional groove portions for restricting the crossing angle θ in the anvil like the first embodiment.

Further like the first embodiment, by making at least one of the resin chips 43, 45 with a transparent material, it is possible to visually check the conductive connecting state between the covered wires W1 and W2 to some extent, and it is possible to ensure waterproofing effect within the covered wires W1, W2 by filling gaps between neighboring core wires excluding the connection portions S with melted resin chips 43, 45 when the resin chips 43, 45 are melt-fixed to each other with the connection portions S set therebetween.

Next, a third embodiment of the present invention will be described with reference to the accompanying drawings.

Fig. 11A is a perspective view of a free state of a protective case for use in the instant embodiment. Fig. 11B is a perspective view of an appearance of major parts after two covered wires are connected according to the instant embodiment. Fig. 12 is a plan view showing a conductive contacting state of the core wires of two covered wires according to the instant embodiment.

The instant embodiment of the present invention is constructed mainly of a pair of the resin chips 13, 15 and a protective case 60 having a protruding portion 64 for restricting the crossing angle of two covered wires W1, W2 to a desired angle.

The protective case 60 comprises a case body 61 in which a wire containing portion 61a for two covered wires W1, W2 is formed so as to open to one side and a lid body 62 formed in a plate shape having a thick portion 62a for closing an opening portion of the wire containing portion 61a.

Of the pair of the resin chips 13, 15, one resin chip 13 is formed so as to protrude substantially in the center of an inside surface (side located inside of the case 60 when closed) of a thick portion 62a of the lid body 62 integrally with the lid body 62. The other resin chip 15 is formed so as to protrude substantially in the center of a bottom of the wire containing portion 61 integrally with the wire containing portion 61. The resin chips 13, 15 have melting surfaces 13a, 15a respectively which are protruded therefrom. The resin chips 13, 15 are constructed so that the respective melting surfaces 13a, 15a face each other when the lid body 62 is closed.

The protruding portions 64 are formed in the wire containing portion 61a of the case body 61 in one pair. That is, the pair of the protruding portions 64, 64 are formed to have both side walls 64a, 64a with which two covered wires W1, W2 are in contact so as to be bent at a desired crossing angle, and allocated adjacent to the resin chip 15 so as to oppose each other. At this protruding portion 64, the crossing angle may be controlled by a distance between the side walls 64a and 64a, that is, a width of the protruding portion 64. This protruding portion 64 is formed with such a width to obtain a desired crossing angle. At this time, the protruding portion 64 is protruded over the melting surface 15a of the resin chip 15 and lower than a depth of the wire containing portion 61. Both the side walls 64a, 64a of this protruding portion have the aforementioned function.

Preferably as in the instant embodiment, wire introducing portions 65 for introducing two covered wires W1, W2 from the protective case 60 in parallel are formed. The wire introducing portions 65 are formed by cutting in a U-shaped groove form both ends of the wire containing portion 61a in which the pair of the protruding portions 64, 64 are located, such that they are opened in the same direction as that of the wire containing portion 61a and go through those ends. Two wire introducing portions 65 are provided on each of both the ends of the wire containing portion 61a. Corresponding to the wire introducing portions 65, square pillar pressing portions 66 which enter into the wire introducing portions 65 for pressing the covered wire W1(W2) when the lid body 62 is closed are formed on both sides of the thick portion 62a of the lid body 62.

Preferably as in the instant embodiment, the case body 61 and the lid body 62 are formed integrally with a hinge portion 63.

In the instant embodiment having the above protective case 60, a covered wire connection structure is obtained in the following manner.

First, as shown in Fig. 11, two covered wires W1, W2 are set in the case body 61. That is, the respective covered wires W1, W2 are placed such that their connection portions S cross each other substantially in the center of the melting surface 15a of the resin chip 15 and both sides of the connection portion S are curved along both the side walls 64a of the protruding portions 64 and engaged in the corresponding wire introducing portions 65. The respective connection portions S of two covered wires W1 and W2 are caught by the pair of the protruding portions 64, 64 such that they intersect each other at a desired crossing angle.

Next, the lid body 62 is turned via the hinge portion 63 and the pressing portions 66 are engaged into the wire introducing portions 65. Then, the wire containing portion 61a of the case body 61 is closed with the lid body 62. In this closing state, the connection portions S are pinched by the melting surfaces 13a, 15a of the resin chips 13, 15 in the center thereof vertically in a direction of overlapping the resin chips 13, 15.

The same covered wire connection structure as in the first embodiment can be obtained by ultrasonic excitation using the horn as in the first embodiment. According to this connection structure, as shown in Fig. 11B, the two covered wires W1, W2 are introduced in parallel from both ends of the protective case 60 in such a state in which both sections of the covered wires adjacent to the connection portions S are pressed by the pressing portions 66 and engaged in the wire introducing portions 65.

According to the instant embodiment, in addition to the effects of the first embodiment, the following particular effects may be exerted.

That is, the pair of the resin chips 13, 15 are melt-fixed to each other such that the connection portions S are sealed in a state in which they are conductively connected and the case body 61 is connected with the lid body. Consequently, the connection portions S and the neighboring portions are covered with the protective case 60 and protected against any external force.

Further, the two covered wires W1, W2 are fixed at the protruding portions 64 by ultrasonic excitation such that they are maintained at a desired crossing angle. After sealing, the connection portion S is in conductive connecting state so that the core wires 1 cross each other at a crossing angle θ (substantially 90° in the instant embodiment) thereby exerting a stabilized electric performance.

Because the protruding portions 64 are disposed adjacent to the resin chips 15, a width of the protruding portion 64 necessary for obtaining a desired crossing angle at the connection portion S may be designed to be small. Consequently, it is possible to design the protective case 60 in a compact size. Further, a distance between the opposing protruding portions 64 and 64 is reduced such that the connection portion S located therebetween can be maintained stably at a desired crossing angle.

Further, according to the instant embodiment, as shown in Fig. 11B, the two covered wires W1, W2 in which the connection portions S are intersected at a desired crossing angle are introduced in parallel through the wire introducing portions from the protective case 60. Thus, this may be preferably applicable as wire harness.

Further, according to the instant embodiment, the case body 61 and the lid body 62 are formed integrally with each other through the hinge portion 63. Thus, management of the parts is facilitated and only by turning the lid body 62 via the hinge portion 63, it can be set to the open portion of the case body 61. Thus, positioning of the parts is not necessary and the assembly work may be simplified.

As a modification of the instant embodiment, the following may be considered.

If at least one of the resin chips 13, 15 is made with a transparent material and then a case 61 (or lid body 62) in which that resin chip 15 (or 13) is disposed is also made with a transparent material, the conductive connecting state of the two covered wires W1, W2 can be visually checked thereby simplifying quality inspection.

Further, the protruding portions 64 and the wire introducing portions 65 may be provided on the lid body 62. Further, the hinge portion 63 may be cut off after the lid body 62 is connected to the case body 61.

Claims

1. A covered wire connection method including steps of overlapping two covered wires each of which comprises a conductive wire portion composed of a plurality of core wires and a cover portion covering an outer periphery of the conductive wire portion, pinching an overlapping portion of said covered wires between a pair of resin chips, pressurizing and exciting said overlapping portion pinched by said resin chips using an ultrasonic vibration welding apparatus so as to melt and disperse said cover portion, thereby to expose the conductive wire portion and electrically conductively connect the conductively wire portions of said covered wires at said overlapping portion and so as to melt-fix said pair of resin chips to seal the connected overlapping portion of said covered wires with said melted resin chips, characterized in that

   a crossing angle at the overlapping portion of said two covered wires is set to not less than 45° to not greater than 135°.

2. A covered wire connection structure formed by steps of overlapping two covered wires each of which comprises a conductive wire portion composed of a plurality of core wires and a cover portion covering an outer periphery of the conductive wire portion, pinching an overlapping portion of said covered wires between a pair of resin chips, pressurizing and exciting said overlapping portion pinched by said resin chips using an ultrasonic vibration welding apparatus so as to melt and disperse said cover portion, thereby to expose the conductive wire portion and electrically conductively connect the conductively wire portions of said covered wires at said overlapping portion and so as to melt-fix said pair of resin chips to seal the connected overlapping portion of said covered wires with said melted resin chips, characterized in that

a crossing angle at the overlapping portion of said two covered wires is not less than 45° to not greater than 135°.

3. A covered wire connection structure according to claim 2 characterized in that

at least one of said resin chips contains wire supporting portions for restricting the crossing angle of said two covered wires at the overlapping portion at a desired angle.

4. A covered wire connection structure according to claim 2 characterized in that

at least one of said resin chips is made of a transparent material.

5. A covered wire connection structure according to claim 2 characterized in that

said covered wire connection structure more includes a protective case for covering the overlapping portion of said two wires as well as neighboring portions thereof,
said protective case contains a case body and lid body,
one side of the case body is open,
said lid body is to close an opening portion of said case body,
said resin chips are formed in said case body and said lid body such that they are integral therewith respectively, and
at least one of said case body and said lid body contains protruding portions for restricting the crossing angle of said two wires at said overlapping portion at a desired angle.

6. A covered wire connection structure according to claim 5 characterized in that

said protruding portions are formed so as to have both side walls,
said two covered wires are in contact with and curved by said walls so as to cross each other at the desired crossing angle,
and said protruding portions are arranged so as to oppose each other adjacent to said resin chips.

7. A covered wire connection structure according to claim 5 characterized in that

at least one of said case body and said lid body contains wire introducing portions for introducing said two covered wires from said protective case in parallel.

8. A covered wire connection structure according to claim 5 characterized in that

said case body and said lid body are formed integrally with each other through a hinge portion.

FIG.1

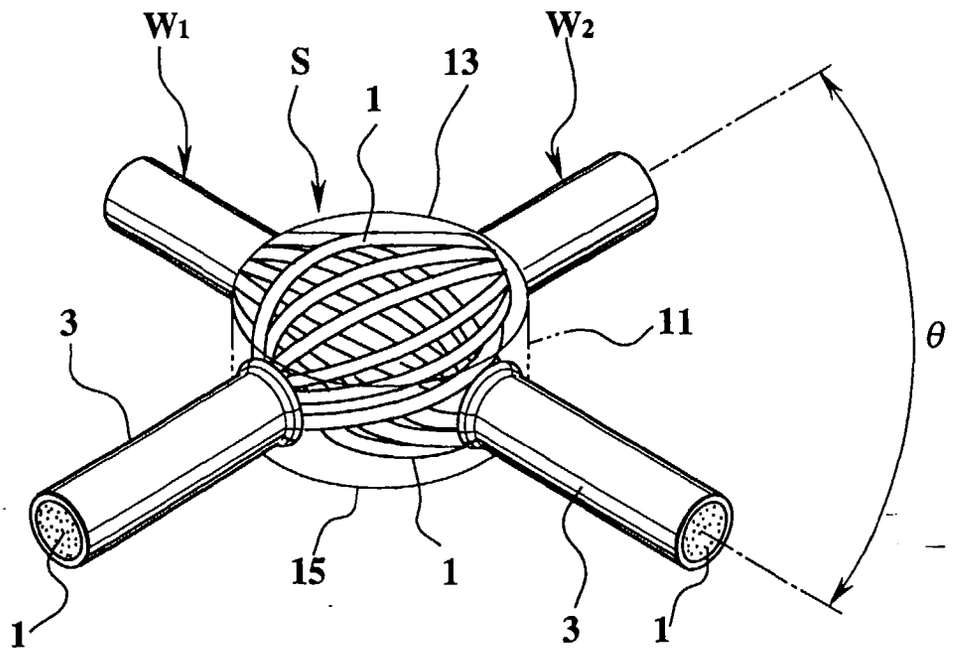


FIG.2

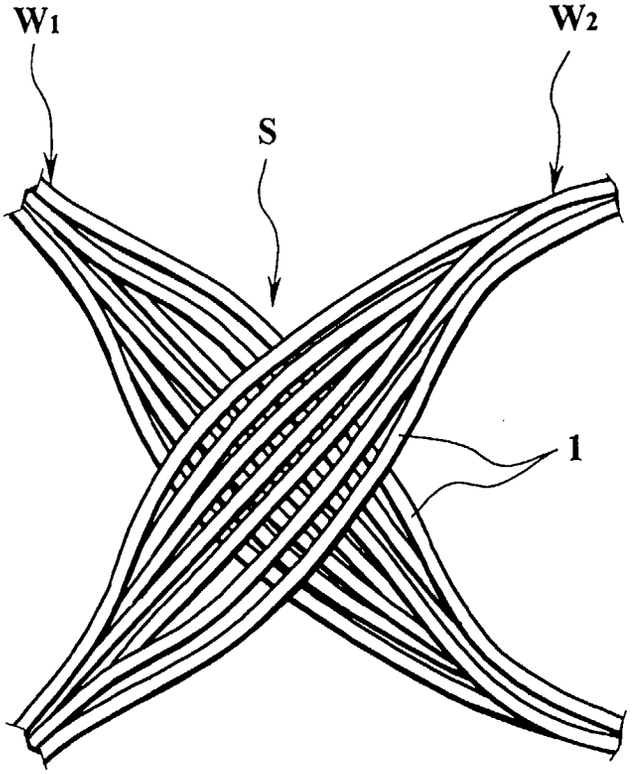


FIG.3A

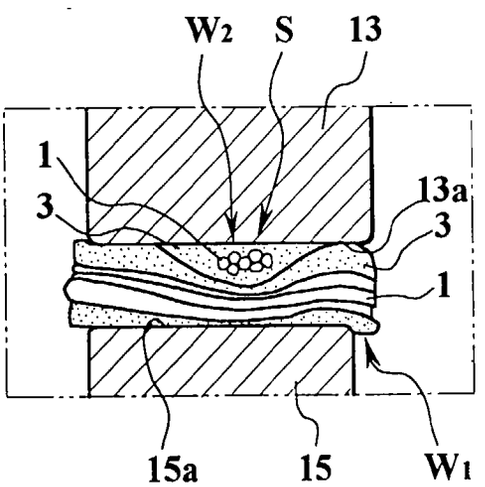


FIG.3B

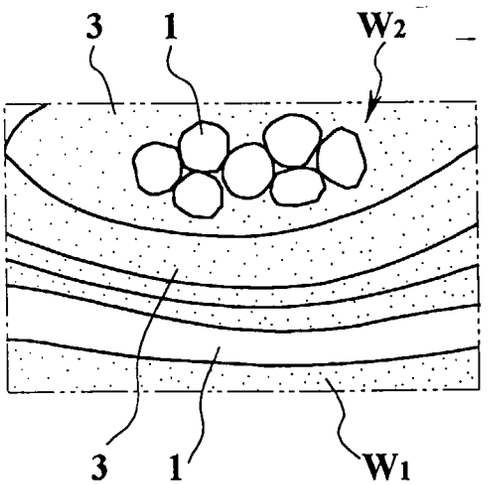


FIG.4A

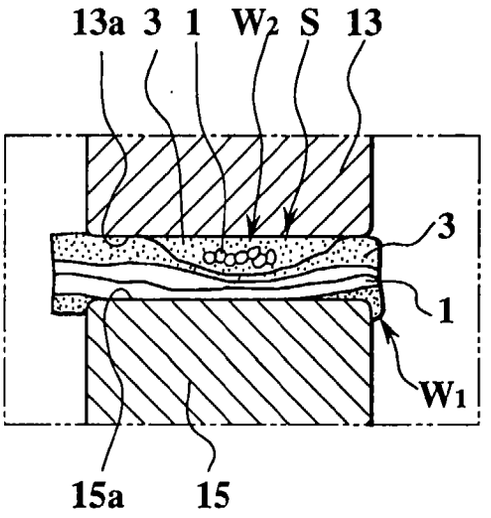


FIG.4B

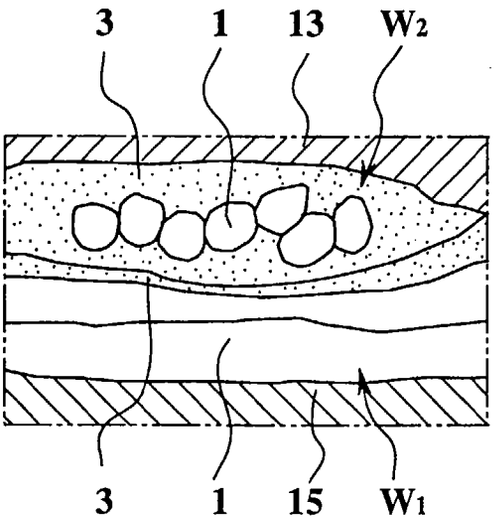


FIG.5A

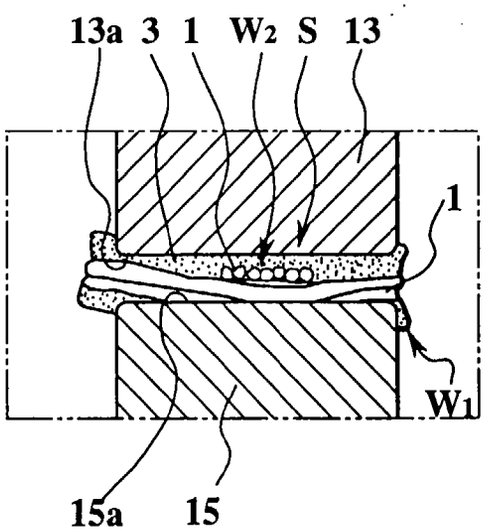


FIG.5B

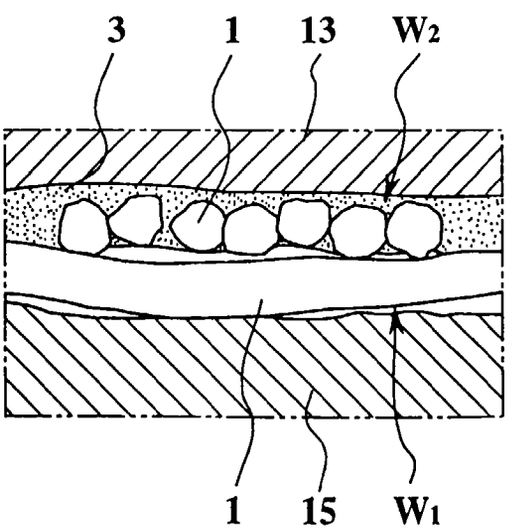


FIG.6A

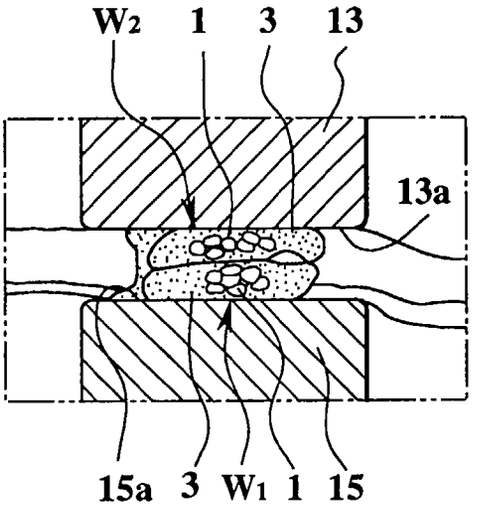


FIG.6B

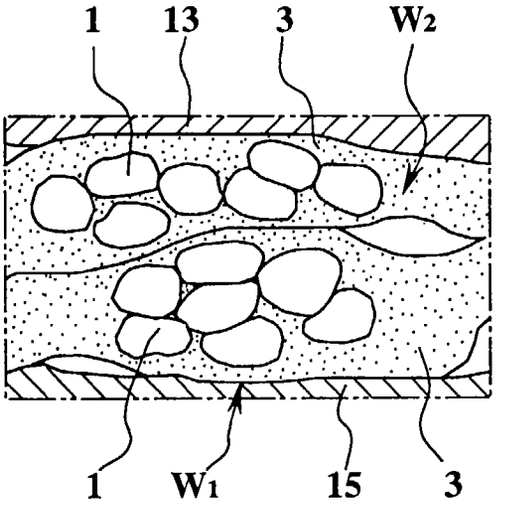
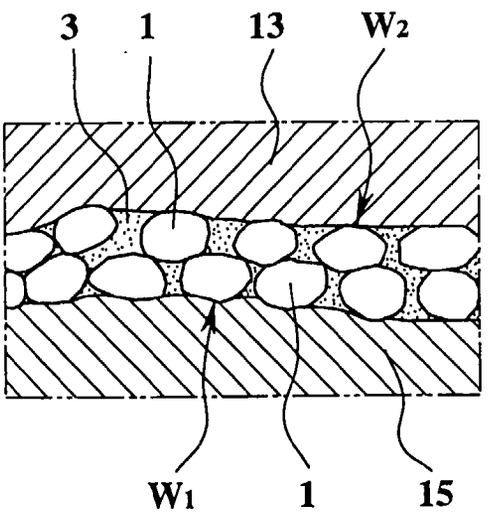


FIG.7



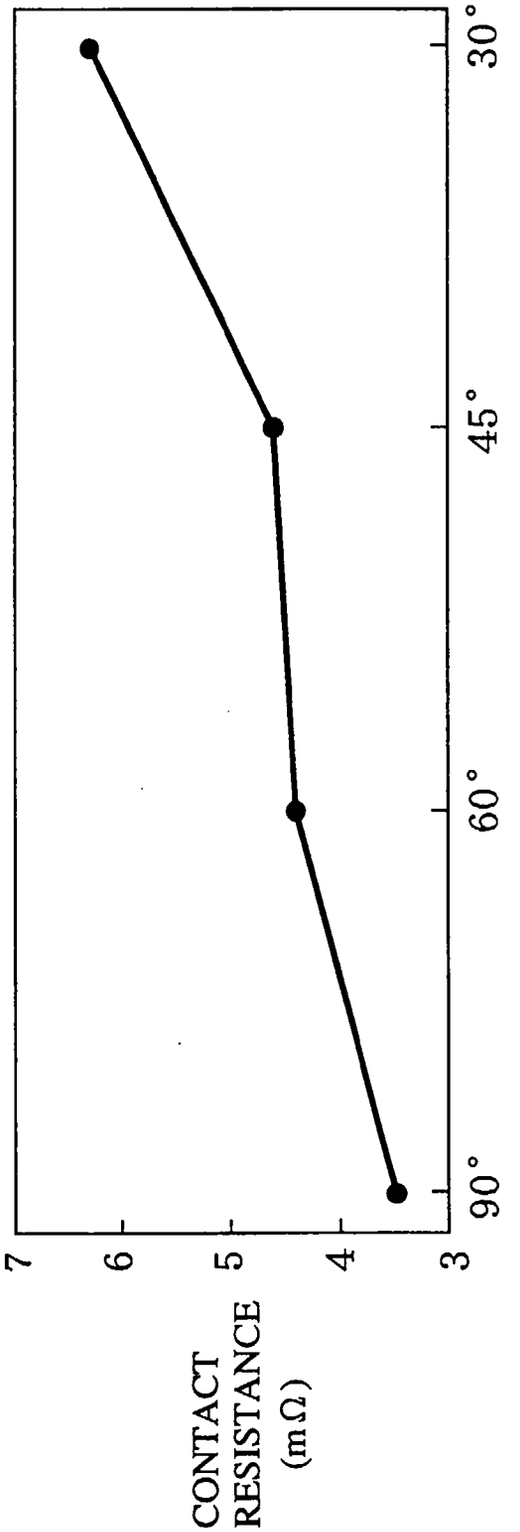


FIG.8

FIG.9

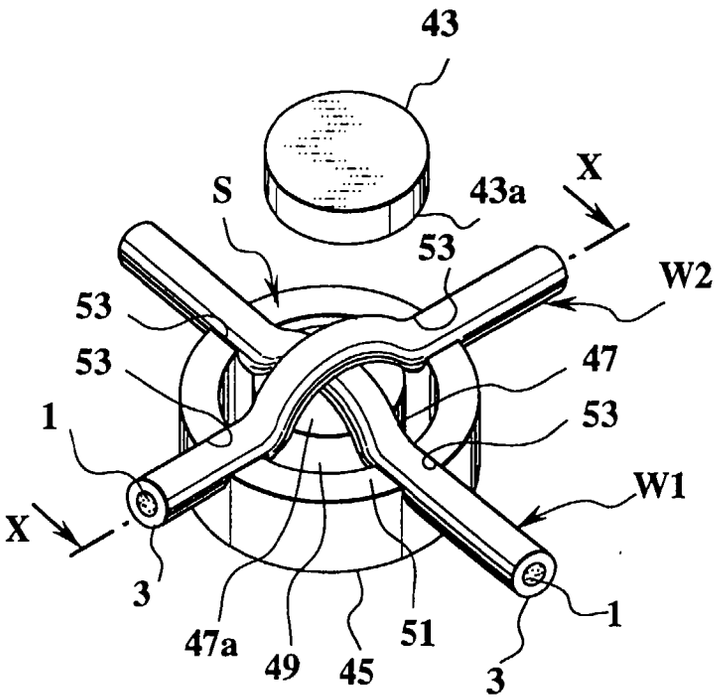

43
S
43a
X
53
W2
53
53
47
1
53
W1
X
3
47a
49
45
51
1
3

FIG.10

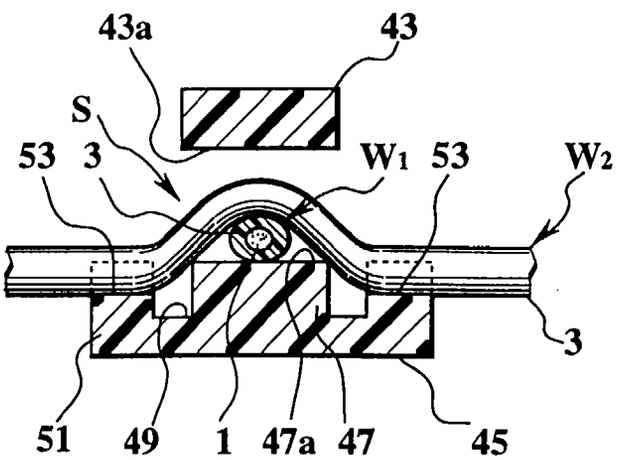

43a
43
S
53
3
W1
53
W2
3
51
49
1
47a
47
45

FIG.11A

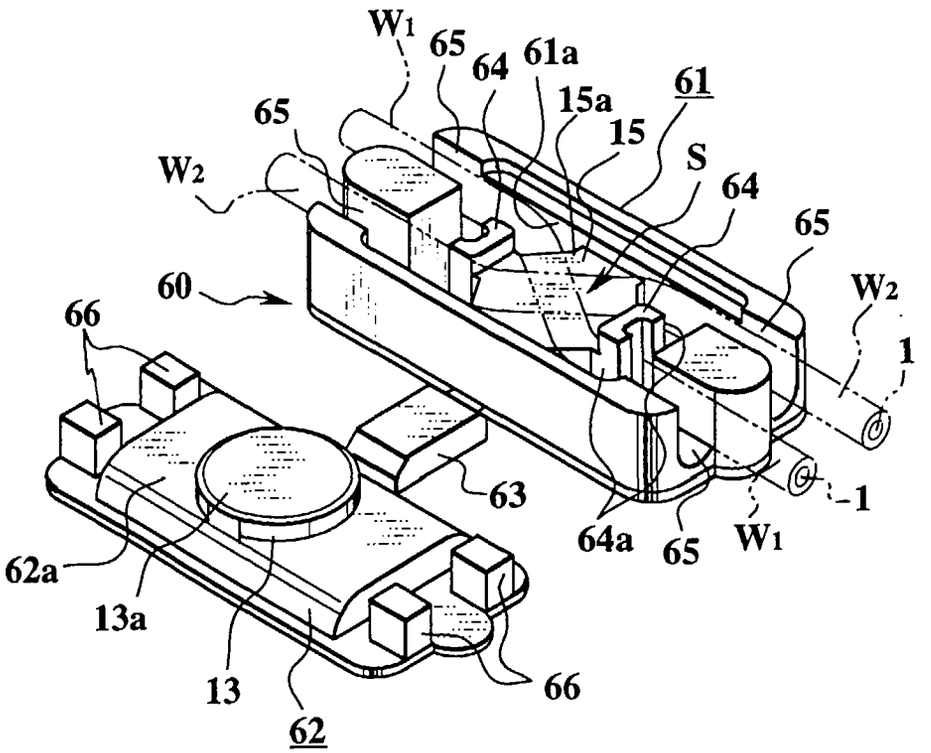


FIG.11B

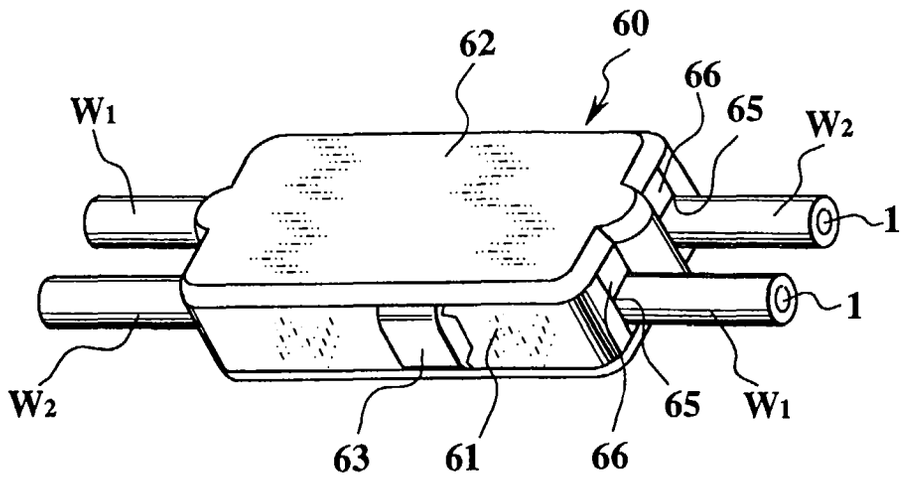


FIG.12