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Connector having vibration absorption and noise removal properties

Abstract

A connector includes a spring structure having a vibration absorption property and an inductance component having noise removal properties. One end of the spring structure is configured to be connected to a wiring pattern provided on a board via a support member, and an opposite end of the spring structure is configured to be connected to an electric wire via a connector.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) This application is a Continuation of PCT International Application No. PCT/JP2020/025049, filed on Jun. 25, 2020, which is hereby expressly incorporated by reference into the present application.

TECHNICAL FIELD
(1) The present disclosure relates to a connector.
BACKGROUND ART
(2) Connectors are parts for connecting a flow of power or electric signals. Such a connector electrically connects an electric wire and electronic equipment, for example. Therefore, there is a case in which an electrical noise is transmitted from the electric wire to the electronic equipment via the connector. In this case, the electronic equipment to which the noise is propagated has a possibility of malfunctioning.
(3) In Patent Literature 1, a technique of reducing noises propagated to electronic equipment is described. The technique disclosed in Patent Literature 1 reduces a noise propagated to electronic equipment by providing a coiled conducting wire between the electric equipment and a coaxial cable.
CITATION LIST
Patent Literature
(4) Patent Literature 1: Japanese Unexamined Patent Application Publication No. JP S 53-78701 A
SUMMARY OF INVENTION
Technical Problem
(5) A connector electrically connects between an electric wire and electronic equipment, and also connects between them mechanically. Therefore, there is a case in which a mechanical vibration is transmitted either from the electric wire to the electronic equipment or from the electronic equipment to the electric wire. In this case, there is a possibility that either the electronic equipment or the connector gets damaged. It is impossible for the technique disclosed in Patent Literature 1 to absorb mechanical vibrations.
(6) The present disclosure is made in order to solve the above-mentioned problems, and it is therefore an object of the present disclosure to provide a connector that can achieve both the absorption of vibrations and the removal of noises using a single spring structure.
Solution to Problem
(7) A connector according to the present disclosure includes: a spring structure having a spring property as a result of being constituted by a conducting wire wound spirally, and functioning as a coil having an inductance component; a one end side support member to support one end of the spring structure, and to connect the one end of the spring structure to a wiring pattern provided on a board; and an other end side support member to support the other end of the spring structure, and to electrically connect the other end of the spring structure to an electric wire, in which the spring structure is constituted by a pair of conducting wires wound spirally and alternately each other, one ends of the pair of conducting wires are connected to a pair of respective wiring patterns provided on the board, the other ends of the pair of conducting wires are connected to a pair of respective electric wires contained in a single cable, the pair of conducting wires are provided coaxially and in a same winding direction, and an insulator is provided on each of outer peripheral surfaces of the pair of conducting wires.
Advantageous Effects of Invention
(8) According to the present disclosure, both the absorption of vibrations and the removal of noises can be achieved using a single spring structure.

Description

BRIEF DESCRIPTION OF DRAWINGS
(1) FIG. **1** is a plane view showing the configuration of a connector according to Embodiment 1;
(2) FIG. **2** is a side view showing the configuration of the connector according to Embodiment 1;
(3) FIG. **3** is a view showing a state in which the connector according to Embodiment 1 and an

electric wire are not connected mechanically and electrically;
(4) FIG. **4** is a plane view showing the configuration of a connector according to Embodiment 2;
(5) FIG. **5** is a side view showing the configuration of the connector according to Embodiment 2;
(6) FIG. **6**A is an outline view showing a double spring structure which is viewed from an axis direction thereof, and
(7) FIG. **6**B is an outline view showing the double spring structure which is viewed from the outside in a radial direction thereof; and
(8) FIG. **7** is a plane view showing the configuration of a connector according to Embodiment 3.

DESCRIPTION OF EMBODIMENTS

(9) Hereinafter, in order to explain the present disclosure in greater detail, embodiments of the present disclosure will be explained with reference to the accompanying drawings.

Embodiment 1

(10) A connector **10** according to Embodiment 1 will be explained using FIGS. **1** to **3**.
(11) FIG. **1** is a plane view showing the configuration of the connector **10** according to Embodiment 1. FIG. **2** is a side view showing the configuration of the connector **10** according to Embodiment 1. FIG. **3** is a view showing a state in which the connector **10** according to Embodiment 1 and an electric wire **51** are not connected mechanically and electrically.
(12) As shown in FIGS. **1** and **2**, the connector **10** according to Embodiment 1 mechanically and electrically connects a single board **41** and the single electric wire **51**, for example. One end of the connector **10** is mechanically and electrically connected to the board **41**, and the other end of the connector **10** is mechanically and electrically connected to the electric wire **51**.
(13) The board **41** has a single wiring pattern **42**. This wiring pattern **42** is formed of, for example, copper or the like, and is provided on an upper surface of the board **41**. Further, the board **41** is fixed to a housing **43** of electronic equipment (not illustrated). More specifically, the board **41** is intended for controlling the electronic equipment.
(14) The electric wire **51** is the one in which a signal line **51***a* serving as a conductor is covered by an insulator **51***b*. To one end of this electric wire **51** is provided a socket **15** which will be mentioned later.
(15) The connector **10** includes a spring structure **11**, supporting members **12** and **13**, a plug **14** and the socket **15**.
(16) The spring structure **11** is supported between the support members **12** and **13**. This spring structure **11** has a function of absorbing mechanical vibrations and a function of removing electrical noises.
(17) Concretely, the spring structure **11** is the one in which a single conducting wire is spirally wound. Therefore, the spring structure **11** has a spring property. More specifically, the spring structure **11** can be elastically deformed in an axis direction thereof. The spring structure **11** also functions as a coil having an inductance component.
(18) The conducting wire has, for example, a circular cross section, but its cross section may have an elliptic shape, a rectangular shape or another shape. Further, the spring structure **11** is constituted by a conducting wire wound spirally, and, as a result, its cross section is a circle. In addition, as for the conducting wire which constitutes the spring structure **11**, a metal having high tensile strength and high electrical conductivity is suitable. The conducting wire is formed of, for example, at least one metallic material out of aluminum, copper, nickel, silver, etc.
(19) The supporting member **12** constitutes a one end side support member. This supporting member **12** is formed of, for example, an insulator. The supporting member **12** supports one end of the spring structure **11**. The one end of the spring structure **11** penetrates the supporting member **12**. Further, the supporting member **12** is fixed to the upper surface of the board **41** in such a way as to cover one end of the wiring pattern **42**. Then, the one end of the spring structure **11**, the one end penetrating the supporting member **12**, and the one end of the wiring pattern **42**, the one end being covered by the supporting member **12**, are connected.

(20) The supporting member **13** constitutes an other end side supporting member. This supporting member **13** is formed of, for example, an insulator. The supporting member **13** supports the other end of the spring structure **11**. The other end of the spring structure **11** penetrates the supporting member **13**.
(21) The plug **14** is provided for the support member **13**. This plug **14** has a connection portion **14***a* in the inside thereof. This connection portion **14***a* is connected to the other end of the spring structure **11**, the other end penetrating the support member **13**. On the other hand, the socket **15** is provided for the one end of the electric wire **51**. This socket **15** has a connection portion **15***a*. This connection portion **15***a* is provided in a receptacle of the socket **15**. Then, the plug **14** can be inserted into the receptacle of the socket **15**. Further, the connection portion **14***a* of the plug **14** and the connection portion **15***a* of the socket **15** can be in contact with each other.
(22) More specifically, when the plug **14** is inserted into the inside of the socket **15**, the connection portion **14***a* of the plug **14** and the connection portion **15***a* of the socket **15** are brought into contact with each other, as shown in FIGS. **2** and **3**. In contrast with this, when the plug **14** is withdrawn from the inside of the socket **15**, the spring structure **11** enters a state in which the spring structure is mechanically and electrically connected to the board **41** while enters a state in which the spring structure is not mechanically and electrically connected to the electric wire **51**.
(23) At the time of insertion of the plug **14** into the socket **15**, when a vibration occurs in the housing **43** and the vibration propagates from the housing **43**, via the spring structure **11**, toward the electric wire **51**, the vibration is attenuated by the elastic deformation of the spring structure **11**. On the other hand, at the time of insertion of the plug **14** into the socket **15**, when a vibration occurs in the electric wire **51** and the vibration propagates from the electric wire **51**, via the spring structure **11**, toward the housing **43**, the vibration is attenuated by the elastic deformation of the spring structure **11**.
(24) Further, at the time of insertion of the plug **14** into the socket **15**, when a noise occurs in the wiring pattern **42** of the board **41** and the noise propagates from the wiring pattern **42**, via the spring structure **11**, toward the signal line **51***a* of the electric wire **51**, the noise is removed by the inductance component of the spring structure **11**. On the other hand, when a noise occurs in the signal line **51***a* of the electric wire **51** and the noise propagates from the signal line **51***a*, via the spring structure **11**, toward the wiring pattern **42**, the noise is removed by the inductance component of the spring structure **11**.
(25) As mentioned above, the connector **10** according to Embodiment 1 includes: the spring structure **11** having a spring property as a result of being constituted by a conducting wire wound spirally, and functioning as a coil having an inductance component; the support member **12** on a one end side to support the one end of the spring structure **11**, and to connect the one end of the spring structure **11** to the wiring pattern **42** provided on the board **41**; and the support member **13** on an other end side to support the other end of the spring structure **11**, and to electrically connect the other end of the spring structure **11** to the electric wire **51**. Therefore, the connector **10** can achieve both the absorption of vibrations and the removal of noises using the single spring structure **11**.
(26) Further, the connector **10** includes the plug **14** provided for the support member **13** and connected to the other end of the spring structure **11**, and the socket **15** which is provided for the electric wire **51** and into which the plug **14** can be inserted. Therefore, the connector **10** makes it easy to make a mechanical connection and an electrical connection to the electric wire **51**.
Embodiment 2
(27) A connector **20** according to Embodiment 2 will be explained using FIGS. **4** to **6**. Components having the same functions as those of components explained in the connector **10** according to Embodiment 1 are denoted by the same reference signs, and an explanation of the components will be omitted.
(28) FIG. **4** is a plane view showing the configuration of the connector **20** according to

Embodiment 2. FIG. **5** is a side view showing the configuration of the connector **20** according to Embodiment 2. FIG. **6**A is an outline view showing a double spring structure **21** which is viewed from an axis direction thereof. FIG. **6**B is an outline view showing the double spring structure **21** which is viewed from the outside in a radial direction thereof.

(29) As shown in FIGS. **4** and **5**, the connector **20** according to Embodiment 2 electrically connects a single board **41** and a single cable **61** by means of a pair of transmission lines, for example. One end of the connector **20** is mechanically and electrically connected to the board **41**, and the other end of the connector **20** is mechanically and electrically connected to the cable **61**.

(30) The board **41** has a pair of wiring patterns **42**. These wiring patterns **42** are arranged in parallel.

(31) The cable **61** is the one in which a pair of electric wires **51** are covered by a sheath **61***a*, for example. The sheath **61***a* is formed of, for example, a resin material. At one end of the cable **61** is disposed a socket **25**.

(32) The connector **20** includes the spring structure **21**, support members **22** and **23**, a plug **24** and the socket **25**.

(33) The spring structure **21** is supported between the support members **22** and **23**. This spring structure **21** has a function of absorbing mechanical vibrations and a function of removing electrical noises.

(34) Concretely, as shown in FIGS. **6**A and **6**B, the spring structure **21** is the one in which two spring structures **11** are superposed on each other. In other words, the spring structure **21** is constituted by a pair of conducting wires wound spirally and alternately each other. Thus, the pair of conducting wires which form a double helix structure are provided coaxially and in the same winding direction, and each of the outer peripheral surfaces of the pair of conducting wires is covered with an insulator (not illustrated).

(35) Therefore, the spring structure **21** has a spring property. More specifically, the spring structure **21** can be elastically deformed in an axis direction thereof. The spring structure **21** also functions as a coil having an inductance component. In addition, because the outer peripheral surface of each of the conducting wires is covered with an insulator, the spring structure **21** is placed in a state in which the conducting wires do not conduct with each other even though the conducting wires come into contact with each other.

(36) The insulator provided on the outer peripheral surface of each of the conducting wires has elasticity. Therefore, even though the pair of conducting wires in the spring structure **21** are elastically deformed, the insulator can follow the elastic deformation.

(37) The support member **22** constitutes a one end side support member. This support member **22** is formed of, for example, an insulator. The support member **22** supports each of one ends of the pair of conducting wires in the spring structure **21**. More specifically, the support member **22** supports one end of each of the spring structures **11**. Each of the one ends of the pair of conducting wires in the spring structure **21** penetrates the support member **22**.

(38) Further, the support member **22** is fixed to an upper surface of the board **41** in such a way as to cover each of one ends of the pair of wiring patterns **42**. Then, the one end of one of the conducting wires, the one end penetrating the support member **22**, and the one end of one of the wiring patterns **42**, the one end being covered by the support member **22**, are connected. On the other hand, the one end of the other conducting wire, the one end penetrating the support member **22**, and the one end of the other wiring pattern **42**, the one end being covered by the support member **22**, are connected.

(39) The support member **23** constitutes an other end side support member. This support member **23** is formed of, for example, an insulator. The support member **23** supports each of other ends of the pair of conducting wires in the spring structure **21**. More specifically, the support member **23** supports the other end of each of the spring structures **11**. Each of the other ends of the pair of conducting wires in the spring structure **21** penetrates the support member **23**.

(40) The plug **24** is provided for the support member **23**. This plug **24** has a pair of connection

portions **24***a* in the inside thereof. One end of one of the connection portions **24***a* is connected to the other end of one of the conducting wires, the other end penetrating the support member **23**. Further, one end of the other connection portion **24***a* is connected to the other end of the other conducting wire, the other end penetrating the support member **23**.

(41) On the other hand, the socket **25** is provided for the one end of the cable **61**. This socket **25** has a pair of connection portions **25***a*. The pair of connection portions **25***a* are provided in the inside of a receptacle of the socket **25**.

(42) The plug **24** can be inserted into the receptacle of the socket **25**. Further, the one of the connection portions **24***a* and one of the connection portions **25***a* can be in contact with each other. On the other hand, the other connection portion **24***a* and the other connection portion **25***a* can be in contact with each other.

(43) More specifically, when the plug **24** is inserted into the inside of the socket **25**, the pair of connection portions **24***a* in the plug **24** are in contact with the pair of respective connection portions **25***a* in the socket **25**. In contrast with this, when the plug **24** is withdrawn from the inside of the socket **25**, the spring structure **21** enters a state in which the spring structure is mechanically and electrically connected to the board **41** while enters a state in which the spring structure is not mechanically and electrically connected to the cable **61**.

(44) At the time of insertion of the plug **24** into the socket **25**, when a vibration occurs in a housing **43** and the vibration propagates from the housing **43**, via the spring structure **21**, toward the cable **61**, the vibration is attenuated by the elastic deformation of the spring structure **21**. On the other hand, at the time of insertion of the plug **24** into the socket **25**, when a vibration occurs in the cable **61** and the vibration propagates from the cable **61**, via the spring structure **21**, toward the housing **43**, the vibration is attenuated by the elastic deformation of the pair of conducting wires in the spring structure **21**.

(45) Here, a pair of transmission lines are formed between the board **41** and the cable **61**, as can be seen clearly from the above-mentioned explanation. One of the transmission lines is constituted by one of the electric wires **51** in the cable **61**, the one of the conducting wires in the spring structure **21** and the one of the wiring patterns **42** in the board **41**. The other transmission line is constituted by the other electric wire **51** in the cable **61**, the other conducting wire in the spring structure **21** and the other wiring pattern **42** in the board **41**.

(46) When currents flow through the pair of conducting wires in the spring structure **21** in the same direction, the conducting wires mutually strengthen their respective magnetic fields caused by the currents flowing through the conducting wires. Therefore, a noise occurring from the board **41** or the cable **61** is removed by the inductance component of each of the conducting wires. The above-mentioned noise is referred to as a so-called common mode noise.

(47) As mentioned above, in the connector **20** according to Embodiment 2, the spring structure **21** is constituted by the pair of conducting wires wound spirally and alternately each other. The one ends of the pair of conducting wires are connected to the pair of respective wiring patterns **42** provided on the board **41**. The other ends of the pair of conducting wires are connected to the pair of respective electric wires **51** contained in the single cable **61**. The pair of conducting wires are provided coaxially and in the same winding direction, and an insulator is provided on each of the outer peripheral surfaces of the pair of conducting wires. Therefore, the connector **20** can achieve both the absorption of vibrations and the removal of common mode noises using the single spring structure **21**.

(48) Further, in the connector **20**, the insulator provided on each of the outer peripheral surfaces of the pair of conducting wires in the spring structure **21** has elasticity. Therefore, even though the pair of conducting wires in the spring structure **21** be elastically deformed, the insulator can follow the elastic deformation.

Embodiment 3

(49) A connector **30** according to Embodiment 3 will be explained using FIG. **7**. Components

having the same functions as those of components explained in the connector **20** according to Embodiment 2 are denoted by the same reference signs, and an explanation of the components will be omitted.
(50) FIG. **7** is a plane view showing the configuration of the connector **30** according to Embodiment 3.
(51) As shown in FIG. **7**, the connector **30** according to Embodiment 3 electrically connects a single board **41** and multiple cables **61** by means of the same number of transmission lines as the number of cables **61**, for example. One end of the connector **30** is mechanically and electrically connected to the board **41**, and the other end of the connector **30** is mechanically and electrically connected to the cables **61**. FIG. **7** shows an example in which the number of cables **61** is two.
(52) When one pair of wiring patterns **42** are defined as one set, the board **41** has two sets of wiring patterns. These wiring patterns **42** are arranged in parallel. Further, to one ends of the two cables **61** is provided a single socket **35**.
(53) The connector **30** includes two spring structures **21**, a single support member **32**, two support members **23**, a single plug **34**, and the single socket **35**.
(54) The two spring structures **21** are arranged in parallel. These spring structures **21** are supported between the support member **32** and the support members **23**. The number of installed spring structures **21** is the same as the number of sets of pair of wiring patterns **42** and the number of cables **61**.
(55) The support member **32** constitutes a one end side support member. This support member **32** is formed of, for example, an insulator. The support member **32** supports each of one ends of a pair of conducting wires in each of the spring structures **21**. Each of the one ends of the pair of conducting wires in each of the spring structures **21** penetrates the support member **32**.
(56) Further, the support member **32** is fixed to an upper surface of the board **41** in such a way as to cover each of one ends of the two sets of wiring patterns **42**. Then, one end of one of the conducting wires in each of the pairs, the one end penetrating the support member **32**, and one end of one of the wiring patterns **42** in each of the sets, the one end being covered by the support member **32**, are connected. On the other hand, one end of the other conducting wire in each of the pairs, the one end penetrating the support member **32**, and one end of the other wiring pattern **42** in each of the sets, the one end being covered by the support member **32**, are connected.
(57) One of the support members **23** supports each of the other ends of the pair of conducting wires in one of the spring structures **21**. The other support member **23** supports each of the other ends of the pair of conducting wires in the other spring structure **21**. Each of the other ends of the pair of conducting wires in the one of the spring structures **21** penetrates the one of the support members **23**. Each of the other ends of the pair of conducting wires in the other spring structure **21** penetrates the other support member **23**.
(58) The plug **34** is provided in such a way as to cross over the two support members **23**. When one pair of connection portions **34***a* are defined as one set, this plug **34** has two sets of connection portions in the inside thereof. Each of one ends of one of the sets of connection portions **34***a* is connected to the other ends of the pair of conducting wires, the other ends penetrating the one of the support members **23**. Each of one ends of the other set of connection portions **34***a* is connected to the other ends of the pair of conducting wires, the other ends penetrating the other support member **23**.
(59) In contrast with this, the socket **35** is provided in such a way as to cross over the one ends of the two cables **61**. When one pair of connection portions **35***a* are defined as one set, this socket **35** has two sets of connection portions. The connection portions **35***a* in each of the sets is provided in a receptacle of the socket **35**.
(60) The plug **34** can be inserted into the receptacle of the socket **35**. Further, the one of the sets of connection portions **34***a* and the one of the sets of respective connection portions **35***a* can be in contact with each other. On the other hand, the other set of connection portions **34***a* and the other

set of respective connection portions **35***a* can be in contact with each other.
(61) More specifically, when the plug **34** is inserted into the inside of the socket **35**, the two sets of connection portions **34***a* in the plug **34** are connected to the two sets of respective connection portions **35***a* in the socket **35**. In contrast with this, when the plug **34** is withdrawn from the inside of the socket **35**, the two spring structures **21** enter a state in which the spring structures are mechanically and electrically connected to the single board **41** while enters a state in which the spring structures are not mechanically and electrically connected to the two cables **61**.
(62) As mentioned above, in the connector **30** according to Embodiment 3, the same number of spring structures **21** each of which is constituted by a pair of conducting wires wound spirally and alternately each other are provided as the number of sets of wiring patterns **42** when one pair of wiring patterns are defined as one set, and as the number of cables **61**. Therefore, the connector **30** can achieve both the absorption of vibrations and the removal of common mode noises even using the multiple spring structures **21**.
(63) It is to be understood that an arbitrary combination of two or more of the above-mentioned embodiments can be made, various changes can be made in an arbitrary component in each of the above-mentioned embodiments, or an arbitrary component in each of the above-mentioned embodiments can be omitted within the scope of the present disclosure.
INDUSTRIAL APPLICABILITY
(64) The connector according to the present disclosure can achieve both the absorption of vibrations and the removal of noises by including a spring structure constituted by a conducting wire wound spirally, and thus is suitable for use as a connector and so on.
REFERENCE SIGNS LIST
(65) **10**, **20**, **30** connector, **11**, **21** spring structure, **12**, **13**, **22**, **23**, **32** support member, **14**, **24**, **34** plug, **15**, **25**, **35** socket, **14***a*, **15***a*, **24***a*, **25***a*, **34***a*, **35***a* connection portion, **41** board, **42** wiring pattern, **43** housing, **51** electric wire, **51***a* signal line, **51***b* insulator, **61** cable, and **61***a* sheath.

Claims

1. A connector comprising: a first spring structure having: a first conducting wire wound spirally and having a spring property and an inductance component; a second conducting wire wound spirally and having a spring property and an inductance component, the second conducting wire being wound alternately and coaxially in a same winding direction with respect to the first conducting wire; a first support member supporting a first end of the first conducting wire and a first end of the second conducting wire, and configured to connect the first end of the first conducting wire and the first end of the second conducting wire to separate wiring patterns provided on a board; and a second support member supporting a second end of the first conducting wire, opposite to the first end of the first conducting wire, and a second end of the second conducting wire opposite to the first end of the second conducting wire, to electrically connect the second end of the first conducting wire and the second end of the second conducting wire to separate electric wires contained in a single cable, wherein an insulator is provided on an outer peripheral surface of each of the first and second conducting wires.
2. The connector according to claim 1, wherein the insulator has elasticity.
3. The connector according to claim 1, further comprising: a second spring structure including: a third conducting wire wound spirally and having a spring property and an inductance component; and a fourth conducting wire wound spirally and having a spring property and an inductance component, the fourth conducting wire being wound alternately and coaxially in a same winding direction with respect to the third conducting wire; wherein the wiring patterns and the single cable are provided for each of the first spring structure and the second spring structure.
4. The connector according to claim 1, further comprising: a plug provided for the second support member and connected to the second end of the first conducting wire and the second end of the

second conducting wire; and a socket which is provided for the separate electric wires and into which the plug can be inserted.