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TITLE OF THE INVENTION

MOVABLE COIL UNIT FOR A SWINGING ACTUATOR WITH ARMS,
AND A METHOD FOR PRODUCING THE SAME

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FIELD OF THE INVENTION

The present invention relates to the field of a swinging actuator which includes a cylindrical base having a central hole
10 in which a bearing for holding a rotational spindle is fitted, arms integrally extending from one side of the front cylindrical base, and a movable coil on the opposed cylindrical base side from the arms, and is as its object to provide a movable coil unit for ensuring, at the assemblage, location of terminal pins having
15 connections with respective initial and terminal lead wire ends, each of which are introduced from the movable coil at the production, as well as precise locations of the movable coil and terminals with respect to the arms.

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BACKGROUND OF THE INVENTION

The conventional swinging actuator 11 (Fig. 3), for example, comprises a substantial cylindrical base 14 with a hole 15 in which a bearing (not shown) for a spindle is fitted, a plurality of arms
25 13 (an arm portion 12) extending integrally from one side of the cylindrical base 14, for example, in E block arrangement; and a hold connector 16, which is heat-resistant thermoplastic resin

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molded and shaped to completely cover the surfaces of the cylindrical base 14 except for the hole for bearing center the cylindrical base 14 and to connect a movable coil 22 to the side of the cylindrical base 14 on the opposite side from the arm portion
5 12.

Referring to Fig. 4, a conventional process that a movable coil 1 is located in a metallic mold in a step, wherein the hold connector 16 as seen in Fig. 3 is resin molded such that the movable coil 1 is coupled to the cylindrical base 14, is shown. The distal
10 and proximal ends 2 and 3 of the introduced lead wire from the movable coil 1 are connected respectively one to the corresponding terminal pins 4 by the solder process before the movable coil 1 is placed in the metallic mold. The movable coil 1 with the terminal pins 4 is located in the metallic mold, based on four
15 locating pins 5 at the respective corners inside thereof.

Problems with the locations of the movable coil 1 and the terminal pins 4 are that the terminal pins 4 are located nearer or farther the movable coil 1 than the need when the movable coil 1 and terminal pins 4 are placed together in the metallic mold.
20 Each of the connected terminal pins 4 with movable coil 1 swings when put in the metallic mold, since they only hangs on the distal and proximal ends 2 and 3 of the lead wire. This leads to difficulty in accurately locating the movable coil 1 and the terminal pins 4 at the fixed positions in the mold. In addition,
25 the terminal pins 4 often experience the separation from and the approach to the fixed position than the need when placed in the metallic mold, because the length of the lead wire from the movable

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coil 1 to terminal pins 4 is lengthened or shortened with respect to the fixed position, depending on the solder condition. It is noted that these problems impede automation of the manufacture having a series of steps to be automatized.

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SUMMARY OF THE INVENTION

In view of the above problems in the prior arts, the present invention has as its object to provide a movable coil unit for
10 a swinging actuator, which allows the accurate location of the terminal pins relatively with respect to the movable coil and is suitably coupled to the side of the cylindrical base on the opposite side from arms through a hold coupler, which completely covers the cylindrical base except for its central hole. The
15 invention involves further technical improvement in the swing actuator of Applicant's Japanese Patent Application No. 9-369473 (Publication No. 11-206095 of unexamined patent application), and a method for producing same, which the applicant has filed for the same purposes.

20 There is provided a movable coil unit which comprises a substantial trapezoidal-shaped frame member with a central coil window and a wound wire thereon, a terminal pin holder at the connection with a cylindrical base, having a terminal pin support to support a pair of terminal pins having respective connections
25 with initial and terminal lead wire ends that are introduced from the wound wire on the short edge side, the terminal pin holder being fixed to the distal short edge of the frame member and shaped

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to cover respective faces of the short edge. This structure allows fixed location of the terminal pins with respect to the movable coil.

A self-fusible lead wire is wound in the predetermined times
5 on the surface of the frame member. The frame member with the lead wire is electrically heated so that the wound wire firmly adheres on the surface of the frame member by the produced fusing film, and thereby is integrally fixed to the frame member so that the movable coil appears.

10 The frame member and the pair of terminal pins are placed in the fixed positions on a metallic mold. In the metallic mold, location means are disposed for fixed location of principal elements, including the short side of the frame member and the terminal pins so as to ensure fixed location of respectively the
15 movable coil and the terminal pins, respectively. The terminal pin holder is formed by injection of heat-fusing resin into the mold, in which both of the movable coil and the terminal pins are located at the fixed position by location means. At the time, the terminal pins are integrally connected to the movable coil
20 through covers formed by the terminal pin holder, which respective ones cover the outside front, top, bottom, and partial inside surfaces and both sides of the short sides of the frame member for integration of the terminal pin holder with the movable coil.

The terminal pin holder has a plate projection piece
25 projecting from the front bottom thereof. The movable coil unit, after the terminal pin holder being fixed thereto, is carried in next step to a mold, in which the cylindrical base with arms is

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placed, by automatic machinery such as industrial robots chucking the plate protrusion.

After the coil holder unit is placed in the second mold, the injection of fusing resin into the mold is performed for
5 formation of a hold coupler, which is shaped to cover the surfaces of the cylindrical base and to couple the movable coil unit to the side of the cylindrical base on the opposite side from arms so that a swinging actuator appears.

The movable coil unit according to the present invention
10 assists in locating terminal pins in the fixed position relatively to the coil holder because of the terminal pin holder being fixedly connected to the movable coil thorough the mold, in which the location means for the movable coil and terminal pins are provided. It contributes to the automation of production because of the form
15 being easily carried by machinery such as industrial robots chucking the hand protrusion.

The movable coil unit according to the present invention has more advantages in combination with the hold coupler which is shaped to cover the whole surface of the cylindrical base except
20 for its central hole for bearing and to couple the movable coil to the cylindrical base in a step for production of a swinging actuator. It is because that it eliminates the displacement of the terminal pins from the desired position in the mold and obtains the suitable tension of the lead wire for the fixed location of
25 the terminal pins in the terminal pin holder relatively to the movable coil, and thus contribute to automation of the manufacture.

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BRIEF DESCRIPTION OF DRAWING

Fig. 1 is a whole oblique view of a movable coil according to the present invention as seen down from the obliquely right
5 top;

Fig. 2 is a whole oblique view of the movable coil of Fig. 1 as seen up from the obliquely left;

Fig. 3 is a whole oblique view of an example of a swinging actuator, which is formed in combination with a movable coil unit
10 according to the present invention; and

Fig. 4 is a plan view of an example of a conventional movable coil.

PREFERRED EMBODIMENT OF THE INVENTION

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Fig. 1 and 2 show an example of a movable coil unit according to the present invention. Referring to the figures, the movable coil unit 22 comprises a substantially trapezoidal-shaped frame member 23 with a wound wire 24, having four edges, two of which
20 are a distal short edge 25 and a proximal backward curbed long edge 26, respectively, and a central coil window 27; and a terminal pin holder 31 which is fixed to the short edge 25 of the frame member 23 and has the outside, top, bottom, inside coupling, right side and left side covers 32, 33, 34 35, 36 and 37 which cover
25 the outside, top, bottom, partial inside, right side and left side faces of the short edge 25 of the frame member 23, respectively for the integration with the frame member 23 such that it is not

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displaced, a terminal pin support 38, which is along the front and in which terminal pins 28 having connections with initial and terminal ends of the lead wire to be introduced from the movable coil unit 22 are perpendicularly supported, and a plate protrusion
5 piece 39 projecting from the front bottom for chucking by automatic machinery such as industrial robots.

In accordance with the invention, the wound wire 24, which is wound in the predetermined times on the frame member 22 preferably comprises a self-fusible material to be firmly adhered
10 to the surface of the movable coil so that it is integrally attached to the frame member because of the fusing film being produced when it is electrically heated.

The description now will be made about the pair of terminal pins 28 that are fixedly located at the desired positions of the
15 terminal pin holder 31 relatively to the movable coil unit 22.

The short edge 25 of the frame member 23, and the terminal pins 28 are placed at the fixed locations in a first mold (not shown) after adhesion of the wound wire 24 to the surfaces of the frame member 23, and then heat-fusing resin is injected into
20 the first mold so as to surround the faces of the short edge 25 of the frame member 23 except for the partial inside face such that the terminal pin holder 31 is integrally formed and fixed through the surround on the short edge faces of the frame member 23, and to provide support of the terminal pins 28 in the terminal
25 pin support 38.

After the fixed terminal pin holder 31 being formed the coil holder unit 22 is placed at a position in a second mold (not shown).

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At the time carry of the coil holder unit 22 from the first mold is performed by the automatic machinery such as industrial robots chucking the plate protrusion 39, which is at the front edge of the terminal pin holder 31.

5 The description now will be made about the pair of terminal pins 28, each of which is fixedly located relatively to arms 13 (arm portion 12) opposedly extending from the cylindrical base 14 side with respect to the coil holder unit 22.

 The cylindrical base 14 also is placed at a position of the
10 second mold in which the coil holder unit 22 is received. The terminal pins 28 with the initial and terminal lead wire ends 24a and 24b connected thereto, respectively, are fitted, while being held by locating pins disposed at positions of the second mold, into holes which are formed on the second mold.

15 After the placement of the movable coil unit 22 in the second mold, resin is injected into the second mold to form a hold coupler 15 which is shaped to cover surfaces of the cylindrical base 14 except for its central hole for bearing, and the surfaces of terminal pin holder 31 and to surround around the movable coil
20 surfaces 23 such that the movable coil unit 22 is coupled to the cylindrical base 14. In the embodiment, a heat-resistant thermoplastic resin such as polyphenylene sulfide (P.P.S.) resin, liquid crystal polymer (L.C.P.) or polyimide (PI) resin, or heat-fusible resin that is mixed into appropriate thermosetting
25 resin is preferred for a used resin material as the hold coupler 15.

 Thus, the movable coil unit 22, that is, the movable coil

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is coupled to the cylindrical base 14 through the hold coupler 16 such that it is located to the fixed positions with excellent accuracy relatively to the arm pieces 13 extending from the opposite side of the cylindrical base 14 therefrom, and that the
5 pair of terminal pins 28 are accurately located with respect to the movable coil and the cylindrical base 14, since the cylindrical base 14 with the arms 12 is placed at the position in the second mold, in which the movable coil unit 22 and terminal pins 28 are fixedly located at the respective positions therein.

10 It should be noted that the design of the terminal pin holder is not limited to a construction that is illustrated in the figures. The most important principle of the terminal pin holder allows accurate locations of the pair of terminal pins, and integral support of the pair of terminal pins by the terminal pin support
15 in combination therewith.

As above described, in accordance with the present invention, terminal pins 28 were fixedly located in the first mold when the terminal pin holder 31 was produced, and the movable coil unit 22 having the terminal pins 28 which were integrally supported
20 in the terminal pin support of the terminal pin holder 31 were fixedly located when coupled to the cylindrical base 14, in the second mold that the cylindrical base 14 with arms 12 was placed. These contribute to the automation of the production of swinging actuators.

CLAIMS

1. A swinging actuator having a cylindrical base (14) with a central hole for bearing (15), at least one or more arms (13) extending from one side of said cylindrical base (14) perpendicularly to the axis, a movable coil (1) fixed to said cylindrical base (14) on the opposite side from the arms (12) and comprising a substantial trapezoidal shaped frame member on which a wire is wound and in which a central coil winder (27) is formed, the swinging actuator having a pair of terminal pins (4) for connecting initial and terminal lead wire ends (2, 3) of said wound wire thereto, the terminal pins being provided on the side of the short edge of the movable coil (1), and a hold coupler (16) for coupling said movable coil (22) to said cylindrical base (14), wherein characterized in that said swinging actuator includes a movable coil unit (22), which comprises said movable coil and a terminal pin holder (31), the terminal pin holder having an outside, top, bottom, inside coupling, right side and left side covers (32,, 33, 34, 35, 36 and 37), which respectively cover the outside, top, bottom, partial inside, right side and left side faces of said short edge of the member (23), and a terminal pin support (38) provided on the outside thereof, said terminal pins (28) being fixedly supported in the terminal pin support of said terminal pin holder (31).
2. The swinging actuator of claim 1, wherein said terminal pin holder (31) includes a protrusion (31) outwardly extending from the outside.
3. The swinging actuator of claim 1, wherein said initial and terminal lead wire ends of said wound wire of the movable coil are introduced through aerial regions over said movable coil.
4. The swinging actuator of claim 1, wherein around said movable coil of the movable coil unit (22) is surrounded and the cylindrical base (14) except for its central hole for bearing are covered by said hold coupler (16) so that the movable coil unit (22) is integrally coupled to the cylindrical base (14).

5. The swinging actuator of claim 1, wherein said wound wire (24) on the surface of said substantially trapezoidal frame member (23) comprises self-fusible material, whereby is firmly adhered to the member (23) through the produced fusing film at the electric heat.

6. The swinging actuator of any one of claims 1 to 5, wherein said movable coil unit (22) is integrally coupled to the cylindrical base (14) with arms by the method, in which the pair of terminal pins (28) of said terminal pin holder (31) are fitted into holes which are formed on a mold, while being held at a portion of the mold relatively to said arms when the movable coil unit (22) is placed for the formation of said hold coupler, through locating means.

7. The swinging actuator of claim 6, wherein said mold further has locating pins provided therein for location of said terminal pins and said initial and terminal lead wire ends.

8. A movable coil unit comprising:

(a) a substantially trapezoidal shaped frame member (23) having a short edge and a long edge;

(b) a wire (23) wound on the surfaces of said trapezoidal shaped member (23);

(c) a terminal pin holder (31) having an outside, top, bottom, inside coupling, right side and left side covers (32, 33, 34, 35, 36 and 37), which respectively cover the outside, top, bottom, partial inside, right side and left side faces of said short edge (25) of the frame member (23), a terminal pin support (38) provided on the outside, and a protrusion (39) outwardly extending from the outside; and

(d) terminal pins (28) fixedly supported in the terminal pin support (38) of said terminal pin holder (31).

9. The movable coil unit of claim 8, wherein said wound wire (24) on the surface of said substantially trapezoidal frame member (23) comprises self-fusible material, whereby is firmly adhered to the member (23) through the produced fusing film at the electric heat.

10. The movable coil unit of claim 8, wherein the fixed support of said terminal pins (28) in said terminal pin support (38) is accomplished by the method, in which heat-fusing resin is injected into a mold, in which said short edge (25) of the frame member (23), and the terminal pins (28) are at the fixed locations, respectively after the adhesion of the wound wire (25) on the frame member (23), for formation of said terminal pin holder (31), whereby the terminal pins (28) are fixedly supported in said terminal pin support (38) integrally formed with said terminal pin holder (31).

11. The movable coil of claim 10, wherein said first mold further has an area in which the short edge of said movable coil unit and said paired terminal pins are fixedly located, whereby said terminal pin holder is fixed to said movable coil.

12. A method for producing a swinging actuator which includes a cylindrical base (14) having at least one or more arms (12) extending from one side thereof perpendicularly to the axis, a movable coil unit (22) having a movable coil which comprises a substantially trapezoidal shaped frame member (23) with a wound wire thereon and a central coil window (27), the frame member having a distal short edge (25); a terminal pin holder (31), which is fixed to the short edge of the frame member (23) and which has a terminal pin support (38) in which a pair of terminal pins (28) for connection of initial and terminal lead wire ends (24a, 24b) from said wound wire on the short edge side (25) therewith are individually supported; and a hold coupler (16) for coupling of said movable coil unit (22) to said cylindrical base (14), said method comprising steps of producing in a first mold said movable coil unit (22) having said frame member (23) and terminal pin holder (31), carrying the movable coil unit (22) to a second mold, in which said cylindrical base (14) with the arms (12) is placed; and locating the movable coil unit (22) in a position of said second mold for production of said hold coupler (16) for coupling of the movable coil unit (22) to the cylindrical base (14).

13. The method for producing a swinging actuator of claim 12, wherein said first mold further has an area in which the short edge of said movable coil unit and said paired terminal pins are fixedly located, whereby said

terminal pin holder is fixed to said movable coil.

14. The method for producing a swinging actuator of claim 12, wherein said wound wire comprises self-fusible material and is firmly adhered to the surfaces of said frame member by the produced fusing film during its heat.

15. The method for producing a swinging actuator of claim 12, wherein said movable coil unit (22) includes said terminal pin holder (31) with a protrusion (38) at a position thereof and is carried by automatic machinery holding said protrusion of the terminal pin holder (31), whereby placed in a second mold.

16. The method for producing a swinging actuator of claim 12 or 15, wherein the pair of terminal pins (28) of said movable coil unit (22) are individually fitted into holes at positions in said second mold while being held by locating pins in second mold, when the movable coil unit (22) is located or placed in the second mold.