United States Patent [19]

Bertagni

[11] **3,792,394**

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[54] **VOICE COIL**

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[30] **Foreign Application Priority Data**

Dec. 16, 1971 Argentina 239650

[52] **U.S. Cl.335/299,** 179/115.5 DV, 179/115.5 VC

[51] **Int. Cl.** **H01f 5/00**

[58] **Field of Search**..... 335/231, 299; 179/115.5 R, 179/115.5 DV, 115.5 VC

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[57] **ABSTRACT**

Voice coil having a tubular coil carrier defining an outside face and an inside face, a coil including at least a forward pitch layer of turns on said outside face and a backward pitch layer of turns on said inside face and preferably window openings in said carrier in the zone covered by said layers.

8 Claims, 8 Drawing Figures

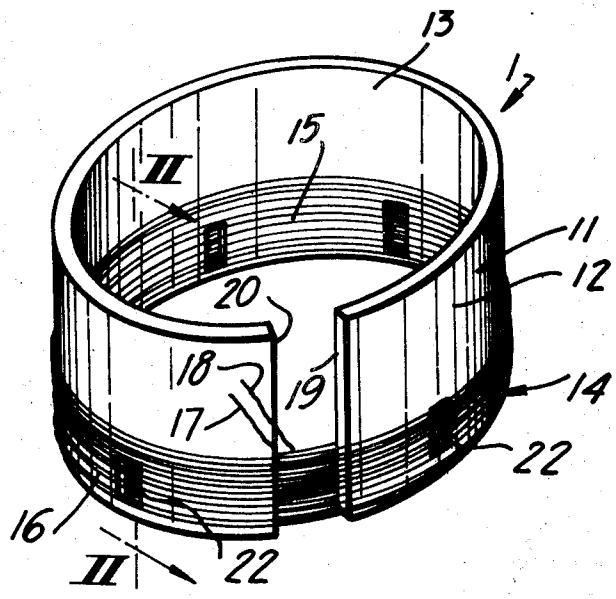


FIG. 1

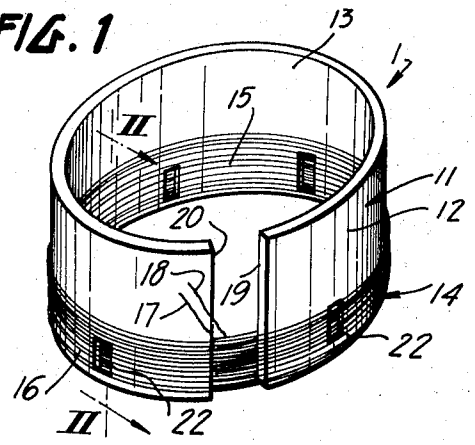
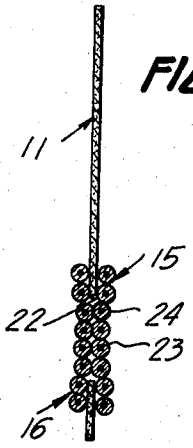


FIG. 2



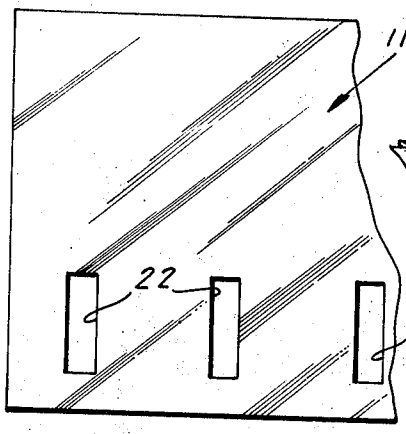


FIG. 3

FIG. 5

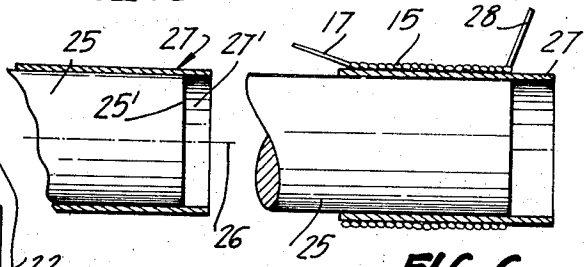


FIG. 6

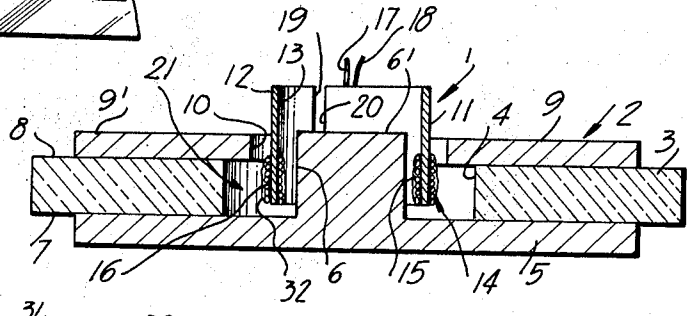


FIG. 4

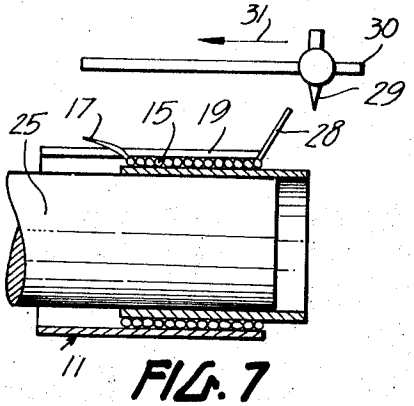


FIG. 7

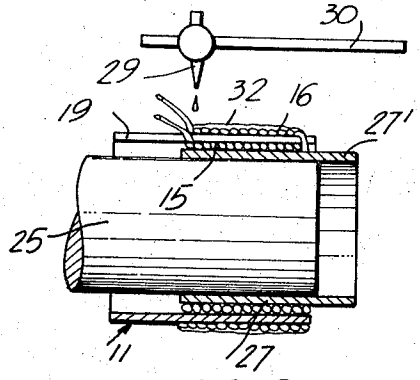


FIG. 8

VOICE COIL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention refers to a coil and coil carrier assembly to be used as a voice coil for electromagnetic assemblies in sound transducers and the like, as well as to a method for manufacturing said first mentioned assembly.

2. Description of the Prior Art

In recent developments of high output loudspeakers, specially in the field of flat loudspeakers, it is an aim to be able to generate a more energetic vibration through the electromagnetic assembly and more particularly through the voice coil which includes the coil carrier, to improve thereby the quality of the sound reproduction. To achieve this aim it is however necessary to provide suitable means which prevent the coil from being removed from the winding area of the coil carrier, due to the rather outstanding impacts to which the voice coil is subject during its to and fro movement.

The coil and coil carrier assemblies which are so far on the market, consist of a tubular coil carrier on the outer face of which two or more layers of turns are wound and define thus the actual coil. Since the mass of the coil is larger than that of the coil carrier, upon the assembly starting its vibratory movement or in other words its rectilinear reciprocating movement, the difference in mass between the coil and coil carrier generates different kinetic and potential energies in both masses, so that the coil starts to move relatively along the coil carrier until it finally tends to be discharged therefrom.

SUMMARY OF THE INVENTION

The present invention overcomes the above outlined difficulty and consists in a coil and coil carrier assembly for an electromagnetic assembly for sound transducers and the like and comprises a tubular coil carrier defining an outer face and an inner face, a coil mounted on said coil carrier ahd having at least a first layer of loops arranged on said inside face of said coil carrier and at least a second layer of loops arranged on the outside face of said coil carrier and said first and second layers at least partially facing each other.

According to this concept of the present invention, the coil carrier becomes clamped between the layer of turns or windings and thus a better anchorage of the coil is achieved. If it is borne in mind that the heat generated, when the electromagnetic assembly is operating, is larger in the zone corresponding to the first layer of turns, or in other words the winding arranged on the inside face, it will be understood that the loops tend to expand in a larger proportion than the loops of the outside winding or second layer, whereby an additional anchoring pressure is generated.

In order to further improve the anchoring system, the coil carrier has spaced apart windows in the zone on which the two winding layers are arranged, whereby these enter the openings defined by said windows.

Finally, it has also been realized that if the coil carrier is manufactured of fibrous or porous material capable of absorbing epoxy resin, that the assembly may be coated with such a resin, whereby at least a partial anchorage is achieved, because such resin enters the pores or interstices of the coil carrier thereby further enhancing the anchorage.

As to the method for manufacturing the assembly or voice coil of the present invention, it consists in first winding a first layer of turns on a supporting member, mounting on said layer the coil carrier and to then continue the winding of the same conductor on the outside face of said coil carrier.

It is to be recalled that the coil carriers are tubular, discontinuous members, so that there is no problem in transferring the continuation of the conductor from the last turn or last loop of the first layer towards the outside face of the coil carrier. If desired, simultaneously with the winding of the outside layer of turns, the epoxy resin may be supplied. Once the winding step has been concluded, the assembly is removed from the supporting member, whereby the remaining voice coil may be housed in an electromagnetic unit.

It will be evident to those skilled in the art, that the coil and coil carrier assembly of the present invention may be applied to any other desired field, such as for instance to microphones.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and details of the present invention will become more apparent during the course of the following description, wherein reference is made to the accompanying drawings, which facilitate the explanation of the present invention and where a preferred embodiment of the voice coil is shown by way of example. More particularly:

FIG. 1 is a perspective view of the voice coil or in other words of the coil and coil carrier assembly, in accordance with the present invention.

FIG. 2 is a longitudinal section along line II-II of FIG. 1.

FIG. 3 is a plan view of a portion of a developed coil carrier.

FIG. 4 is a section through an electromagnetic assembly including the voice coil of the present invention.

FIGS. 5 to 8 are schematical longitudinal sections showing the main steps of the method for manufacturing the voice coil.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The coil and coil carrier assembly or voice coil 1 (FIG. 1) of the present invention is to be used in an electromagnetic assembly 2 (FIG. 4) for sound transducers and the like.

The electromagnetic assembly comprises a cylindrical magnet 3 of small height, having a cylindrical through passage 4.

A first disc 5 provides a cylindrical central projecting core 6, the diameter of which is smaller than that of passage 4 and the height of which is larger than that of the magnet 3, which rests by means of its lower face 7 on the magnet 3. Conveniently, the first disc 5 has a diameter which is slightly larger than that of magnet 3 and is adhered thereto by a suitable adhesive. A second disc 9 rests on the upper face 8 of magnet 3 and is adhesively adhered thereto. Second disc 9 has substantially the same diameter as the first disc 5 and a perforation 10, the diameter of which is larger than that of the core 6, but smaller than that of the cylindrical through passage 4. The height of the core 6 is such that, when the three members 2, 5 and 9 are assembled, the top face 6' of core 6 is at level with the top face 9' of the second disc 9.

The voice coil 1 (FIG. 1) comprises a tubular coil carrier 11 defining an outside face 12 and an inside face 13. A coil 14 is mounted on the lower portion of the coil carrier 11. This coil 14 has at least a first layer of turns defining a first winding 15 which is arranged on the inside face 13 and at least a second layer of turns defining a second winding 16, wound on the outside face 12 of the coil carrier 11. End portions 17 and 18 of the conductor defining the coil 14 are likewise shown.

The coil carrier 11 is a slit tubular member, the end edges 19 and 20 of which are facing each other, as is already known in the art.

Returning now to FIG. 4, it may be appreciated that the lower portion of the voice coil 1 is housed in the air gap 21; the volume of said gap 21 which faces the second winding 16 is larger than that which faces the first winding 15. If it is borne in mind that copper or a copper alloy is usually used for the conductor for manufacturing the windings, bearing in mind that copper is a good electricity and heat conductor, and that the copper wire is obviously sheathed with an insulating layer, then it will be understood that upon operating the electromagnetic assembly 2, the first layer of turns or winding 15 will operate at a higher temperature than the second layer of turns or winding 16, whereby the first layer of turns 15 tend to expand in a larger amount than said second layer of turns 16. Thus, a clamping pressure is exerted between the two windings 15, 16 on the coil carrier 11, so that the coil 14 becomes better anchored on the coil carrier 11. Thus, a simple and improved anchoring system is achieved, which permits that the voice coil operates at a higher range and thereby a better impact transmitting characteristic for the diaphragm of the loudspeaker is achieved.

In order to further increase the anchoring feature, in a more sophisticated embodiment of the invention, (FIGS. 1 to 3), it has been thought to provide the coil carrier 11 in the lower portion thereof, which has to support the coil, with spaced apart windows 22, so that upon winding the layers 15 and 16 — the total height of which is larger than that of the windows — on the zone corresponding to the windows, these turns will enter the windows, such as clearly shown in FIG. 2 and increase thereby the anchorage. In FIG. 2 the copper conductor 23 is shown with more details in that likewise the insulating layer 24, which sheathes the conductor 23, is illustrated. Thus, the windings 15 and 16 may enter in contact in the zones of the window openings 22.

The coil carrier 11 is conveniently manufactured of a porous or fibrous material, which is capable of absorbing an epoxy resin, for reasons which will be explained in relationship with a preferred method for manufacturing the voice coil, and reference will now be made to FIGS. 5 to 8 in connection therewith.

In FIG. 5, a supporting member, more particularly a spindle 25 is shown, adapted to rotate about the axis 26.

Conveniently, an expandable and collapsible bushing 27 is mounted on spindle 25 with its end portion 27' projecting out of the free end 25' of the spindle 25. The winding of the first layer of turns 15 (FIG. 6) is then started on bushing 27 leaving the end portion 17 of the conductor free; when the winding of the first layer of turns 15 has been concluded, portion 28 of the conductor remains connected to the supply source (not shown).

The coil carrier 11 is then mounted on the first layer 15, so that the channel between the end edges 19 and 20 enable the passing of the end portion 17 and the portion 28 of the conductor and thereafter the winding continues so as to form the second layer of turns 16 on the coil carrier 11. To this end, the pitch is reversed, that is to say for instance during the forming of the first layer 15, a forward pitch was followed, while during the forming of the second layer 16, a backward pitch is used. Simultaneously, while carrying out the winding of the second layer 16, a nozzle 29 is moved behind the winding arrangement (not shown), at the same time as said nozzle 29 drops epoxy resin drops on the second layer 16. Due to capillarity, these resin drops pass through the coil carrier 11 and become thus likewise linked to the first winding 15. The epoxy resin is therefore an additional anchoring means for the coil with regard to the coil carrier. The nozzle 29 moves to this end along a guide 30 in the direction shown by arrow 31 in FIG. 7. The epoxy resin layer is schematically shown in FIG. 8 and has been identified by reference numeral 32.

Having thus concluded with the winding, the assembly is withdrawn from the spindle by pulling on the end portion 27' of the collapsible bushing 27, which is then collapsed in order to decrease the diameter of the bushing, to withdraw the thus manufactured voice coil therefrom. It is obvious that if the spindle 25 is perfectly polished, the bushing 27 may not be required in order to remove the manufactured voice coil from the spindle 25.

Windings 15 and 16 may be formed of several superposed layers, if desired. Although the windings 15 and 16 have been shown as being layers of the same length which are mutually facing each other when arranged on the coil carrier, this is not a fundamental requirement since it is sufficient that a portion of each winding face each other in order to create the anchoring effect hereinabove described.

It will be understood that improvements may be introduced in the embodiment described by way of example and modifications may be made in the method employed, without departing from the scope of the invention, specifically defined in the following claims.

I claim:

1. A coil and coil carrier assembly for an electromagnetic assembly for sound transducers and the like, comprising a porous tubular coil carrier defining an outside face and an inside face, a coil mounted on said coil carrier and having at least a first layer of turns of wire defining a first winding arranged on the inside face of said coil carrier and at least a second layer of turns of wire defining a second winding arranged on the outside face of said coil carrier, said first and second windings at least partially facing each other, said second winding being coated with a resin which also extends into pores of said carrier adjacent said second winding to anchor said winding to said carrier.

2. A coil and coil carrier assembly according to claim 1, wherein said resin coats at least part of said first winding.

3. A coil and coil carrier assembly according to claim 1, wherein said resin is an epoxy resin.

4. A coil and coil carrier assembly according to claim 1, wherein said first and second windings face each other substantially throughout their entire height.

5. A coil and coil carrier assembly for an electromagnetic assembly for sound transducers and the like, comprising a tubular coil carrier defining an outside face and an inside face, a coil mounted on said coil carrier and having at least a first layer of turns of wire defining a first winding arranged on the inside face of said coil carrier and at least a second layer of turns of wire defining a second winding arranged on the outside face of said coil carrier, said first and second windings at least partially facing each other, said carrier having in the zone in which said first and second windings face each other a plurality of circumferentially spaced apart windows therethrough, parts of said first and second windings extending laterally into said windows to mechanically anchor said coil to said carrier.

6. The coil and coil carrier assembly according to claim 1, wherein said windows are elongated windows, and the height of said first and second windings is larger than the height of said windows, so that upper and lower turns of each of said windings are arranged on zones of said coil carrier free of window openings.

7. The coil and coil carrier assembly according to claim 6, wherein said first and second windings face each other throughout their entire height.

8. The coil and coil carrier assembly according to claim 1, wherein said carrier has in the zone in which said first and second windings face each other a plurality of circumferentially spaced apart windows therethrough, said first and second windings extending laterally into said windows to mechanically anchor said coil to said carrier.

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