

EDGE FOR SPEAKER DIAPHRAGM AND METHOD FOR MANUFACTURING THE SAME

5 INDUSTRIAL FIELD OF THE INVENTION

The present invention relates to an edge for speaker diaphragm such that an unprecedented new material is used and processed to skillfully form and finish the edge precisely and correctly, and also relates to a method for manufacturing the edge for speaker diaphragm.

10 PRIOR ART

In brief, the structure of the general speaker shown in Fig. 1 is of such an electrodynamic type as commonly known in the art. The reference numeral 1 indicates a speaker body, and the numeral 2 denotes a magnetic circuit comprising an electromagnet 2a secured to the base of a frame 7.

15 The numeral 3 denotes a voice coil suspended not to contact the magnetic domain wall within the toroidal magnetic gap 2b of said circuit 2. The tip central part of a truncated conical diaphragm 5 is firmly adhered to the tip of the voice coil bobbin 3a. The damper 4 connects the tip central part of diaphragm 5 to the frame 7, with the diaphragm edge 6 connecting the periphery of diaphragm 5 to the outer edge of frame 7. The damper 4 and diaphragm edge 6 respectively show a compliance axially of the speaker 1, such that the diaphragm 5 and voice coil 3 are held vibratably in the frame 7.

20 When an audio current flows through the voice coil 3, the direction of this current will intersect the magnetic flux present in the annular or toroidal magnetic gap 2b. Thus, a resultant driving force will force the diaphragm 5 to vibrate and put out sound waves.

At its inner and outer peripheries, the diaphragm edge 6 has an inner

margin 6a adhered to the outer periphery of diaphragm 5 and an outer margin 6c also adhered to the outer edge of frame 7, respectively. In-terposed between and integral with these margins 6a and 6c is a toroidal flexible part 6b that cooperates with the damper 4 to vibrantly support the diaphragm 5. This flexible part 6b shows a compliance when it moves axially of the speaker. In manufacture of such a speaker to be assembled, those diaphragms 5, voice coils 3, dampers 4 and edges 6 are respectively prepared as discrete parts. The outer periphery of each diaphragm 5 will be adhered to the inner margin 6a of edge 6, prior to assembling the speaker. The outer periphery of frame 7 will then be adhered to the outer margin 6b of edge 6, during assembly of the speaker 1.

The speaker diaphragm edges 6 as shown in Fig. 2 have been manu-actured usually starting from a rolled base fabric 10. A phenolic resin or melaminic resin as the shaping agent will be impregnated into this fabric before it is coated with a certain filler and a resonance inhibitor. The filler (usually serving also as the inhibitor) serves to prevent air from leaking inwards and/or outwards through the diaphragm. The treated fabric will then be hot pressed in a mold into a desired shape, thus giving a finished diaphragm edge. In some cases, the filler and resonance inhibitor are applied to a preliminarily molded diaphragm edge. In such a prior art method of manufacturing the speaker diaphragm edges, the shaping agent is impregnated into the entire base fabric, needing a large amount of this agent. The punching of diaphragm edges from the treated fabric will produce much waste or scrap thereof, which contains a considerable amount of such a shaping agent. Disposal of such a hazardous waste raises manufacture cost and increases labor consumption. The phenolic and melaminic resins are thermosetting resins such that the molded products tend to be hard to a

non-allowable degree. Therefore, the resin solution to be impregnated into the fabric have had to be diluted enough to ensure flexibility of the finished diaphragm edges. Diluted resin solutions have however resulted in weaker edges whose performance would early become unsatisfactory.

5 Uneven-ness in impregnation of the agent and in application of the other agents have also caused deterioration of the performance of speakers.

The present applicants have already proposed employment of the silk-screen printing technique to apply not only the shaping agent but also the filler, resonance inhibitor and the like. This method has proved
10 favorable to reduce the overall quantity of applied agents, enhancing uniformity of formed layers and rendering the speaker edges lighter in weight. Performance and cost of the speakers are thus improved to a noticeable degree, though the applying of the shaping agent all over the fabric has naturally delimited an extent to which consumption of said agent
15 would be reduced. In view of such an unresolved problem, the present applicants hereby pro-poses it to make the best use of the silkscreen printing in order to minimize the consumption of shaping agent and to improve the speakers in perform-ance and economy. In short, the shaping agent will now be applied only to necessary regions of a base fabric 10, as shown in
20 Fig. 5. Composition of said agent is also subject to further reviews and studies, while employing the silkscreen printing in application of the filler and resonance inhibitor. The recent efforts made by the present applicants has succeeded to provide a much better speaker diaphragm edge as well as a more advanced method of making same.

25 DISCLOSURE OF THE INVENTION

The present invention will now be summarized using the reference numerals shown in the drawings. A first species of the present invention

provides a speaker diaphragm edge obtained by hot-forming, into a desired edge shape, a resin-treated base material (11) preliminarily prepared by the silkscreen printing method to apply a shaping agent layer (17) only to necessary portions of a base fabric (10).

5 A second species of the present invention provides a speaker dia-phragm edge obtained by hot-forming, into a desired edge shape, a resin-treated base material (11) preliminarily prepared by the silkscreen printing method to apply a shaping agent layer (17) only to necessary portions of a base fabric (10), and by then applying a hot-melt adhesive (14)
10 to areas that are to be bonded to a diaphragm (5) and a frame (7).

 A third species of the present invention provides a speaker diaphragm edge obtained by hot-forming, into a desired edge shape, a resin-treated base material (11) preliminarily prepared by the silkscreen printing method to apply a shaping agent layer (17) only to necessary portions of a base
15 fabric (10), and by then forming a surface coating agent layer (12) on a surface of the shaping agent layer (17) so as to improve the physical functionality of the diaphragm edge.

 A fourth species of the present invention provides a speaker diaphragm edge obtained by preliminarily preparing a resin-treated base material (11)
20 by the silkscreen printing method to apply a shaping agent layer (17) only to necessary portions of a base fabric (10), and subsequently to form a surface coating agent layer (12) on a surface of the shaping agent layer (17) so as to improve physical functionality of the diaphragm edge, and finally by hot-forming, into a desired edge shape, the resin-treated base material
25 (11).

 A fifth species of the present invention provides a method of making a speaker diaphragm edge comprising the steps of: applying a shaping agent

only to necessary portions of a base fabric (10) so as to form a shaping agent layer (17), thus preparing a resin-treated material (11) by the silkscreen printing technique, subsequently hot-forming into a specified shape each of treated portions of the resin-treated material (11) in
5 con-formity with the necessary portions the base fabric, and finally severing from the thus hot-formed resin-treated material (11) such rings as serving as the diaphragm edge in conformity with contour of the speaker diaphragm.

A sixth species of the present invention provides a method of making a speaker diaphragm edge comprising the steps of: applying a shaping agent
10 only to necessary portions of a base fabric (10) so as to form a shaping agent layer (17), thus preparing a resin-treated material (11) by the silkscreen printing technique, then hot-forming into a specified shape each of treated portions of the resin-treated material (11) in conformity with the necessary portions the base fabric, subsequently severing from the thus
15 hot-formed resin-treated material (11) such rings as serving as the dia-phragm edge in conformity with contour of the speaker diaphragm, each ring having an outer peripheral zone to be connected to a frame (7) and an inner peripheral zone to be connected to the diaphragm (5), and finally applying a hot-melt adhesive (14) to both the outer and inner peripheral
20 zones of each ring severed from the resin-treated material (11).

A seventh species of the present invention provides a method of making a speaker diaphragm edge comprising the steps of: applying a shaping agent only to necessary portions of a base fabric (10) so as to form a shaping agent layer (17), thus preparing a resin-treated material (11) by
25 the silk-screen printing technique, then hot-forming into a specified shape each of treated portions of the resin-treated material (11) in conformity with the necessary portions of the base fabric, subsequently applying a surface

coating agent layer (12) to necessary portions of the resin-treated and hot-formed material (11), and finally severing from the thus coated material (11) such rings as serving as the diaphragm edge in conformity with contour of the speaker diaphragm.

5 An eighth species of the present invention provides a method of making a speaker diaphragm edge comprising the steps of: applying a shaping agent only to necessary portions of a base fabric (10) so as to form a shaping agent layer (17), thus preparing a resin-treated material (11) by the silkscreen printing technique, then applying a surface coating agent
10 layer (12) to necessary portions of the resin-treated material (11) in conformity with the necessary portions of the base fabric, subsequently hot-forming into a specified shape each of the necessary portions of the resin-treated and coated material (11), and finally severing from the thus hot-formed coated material (11) such rings as serving as the diaphragm
15 edge in conformity with contour of the speaker diaphragm.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a conventional electrodynamic speaker shown partly in cross section that is taken along the central vertical plane;

20 Fig. 2 is a perspective view of a diaphragm edge provided in a first embodiment of the present invention and designed for incorporation into the speaker shown in Fig. 1;

Fig. 3 is an enlarged cross section of the edge's part indicated by a phantom circle in Fig. 2;

25 Fig. 4 is a scheme showing the process employed in the method of making the diaphragm edge in accordance with a second embodiment of the present invention;

Fig. 5 is a perspective view of a printed pattern formed on a

resin-treated material;

Fig. 6 is a perspective view of a diaphragm edge provided in a third embodiment of the present invention; and

Fig. 7 is an enlarged cross section of the edge's part indicated by a dot-and-dash circle in Fig. 6.

BEST MODES OF CARRYING OUT THE INVENTION

Now, the best modes of carrying out each species of the present invention will be described using the reference numerals used in the drawings. Generally, a base fabric 10 is a woven fabric (e.g., cotton cloth, silk cloth). However, it also may be a non-woven fabric composed of a synthetic fiber, or an elastic woven fabric made of one kind of raw thread. In the non-woven fabric or elastic woven fabric, there is no obvious orientation in alignment of the fiber, so that its characteristics are conducive to flexibility and homogeneity of material. The shaping agent may be a thermosetting resin such as a phenolic resin, a melaminic resin, an epoxy resin, a silicon resin, etc. However, it also may be an elastomer, or a resin composition rendered more flexible by blending the thermosetting resin (e.g., phenolic resin) with a polyvinyl alcohol or any other alcoholic polymer resin. These thermosetting resins themselves or the blended compositions thereof are advantageous in that they are flexible and permeation of solutes is excellent, thereby facilitating the application of the silkscreen printing. Accuracy and appearance of the coating formed with such a resin or its composition. The resin layer of the speaker edge will repeat deformation in response to and following the vibration of the diaphragm 5, but it does no longer deteriorate so early as to shorten the life of speakers. Smooth deformation of the speaker edge will enhance linearity of the speaker performance, decreasing nonlinear acoustic

distortion in reproduced sounds.

A surface coating agent layer 12 may be formed to cover the speaker diaphragm edge discussed above. This layer 12 has to meet three re-quirements as to physical properties of said edge, and these requirements
5 are (1) that this layer should function as a filler for keeping airtight the front side against the rear side of diaphragm, (2) that a mechanical internal loss of the edge should prevent resonance thereof with the diaphragm so as to avoid degradation in the reproduced sounds emitted from this speaker, and (3) that weather resistance should be improved to maintain the desirable
10 performance of speaker for a long time. The surface coating agent layer 12 may consist of a plurality of sub-layers each meeting any one of these three requirements, or alternatively may consist of a single layer that meets all the requirements. A synthetic rubber emulsion paint may be useful in the latter case, and other examples of the paints employed in the former
15 case are a one-liquid type paint composed of a methacrylic resin blended with a plasticizer, and an emulsion type methacrylic paint also plasticized such that water is used as a solvent. Such a surface coating agent layer 12 may be formed by the silkscreen printing technique similarly to the shaping agent layer, or its multiple sub-layers may be formed one after another
20 through a series of steps, or may be applied to a speaker edge previously prepared.

The resin-treated base material 11 coated as described above will then be hot pressed in a mold that will have been heated to a proper temperature suited to the shaping agent and the surface coating agent. A speaker
25 diaphragm edge 6 thus formed will have a flexible portion 6b that is shown in the drawings as a roll edge. This edge is formed arcuate in its radial cross section and convex towards the outside. However, any other type of

edge, such as the so-called corrugation type or pleats type edge consisting of flexible and concentric bellows continuing one to another, may be formed.

Next, some modes of a method of making the speaker diaphragm edge will be described, referring back to the fifth to eighth species of the present invention. A mask 29 (see Fig. 4) will be laid on a silkscreen 28 coming into contact with a raw fabric 10, so that areas other than necessary portions of this fabric are masked. A shaping agent penetrating unmasked areas of the screen 28 will thus form a pattern of shaping agent layers 17 on the not masked necessary portions of the fabric 10, providing a resin-treated base material 11. In addition to a pair of such a silkscreen 28 and mask 29 used to form the shaping agent layer 17, another screen of a different mesh may be combined with another mask of a different pattern so as to form a surface coating agent layer overlying the shaping agent layer. These layers of shaping agent and surface coating agent may be of different types or of the same type in their nature or properties. Multiple coating carried out this way will be useful to vary physical property from place to place in each speaker edge, corresponding to local variation in rigidity of each diaphragm, so as to improve the performance of a speaker. In addition to the shaping agent layer and coating agent layer 12, hot melt adhesive layers 14 may also be produced by the silkscreen printing. In this case of forming the adhesive layers, a further printing unit or units 20 each composed of the silkscreen 28, mask 29 and a drying heater 27 will be employed and arranged in series together with those for previously forming the said agent layers. A proper colorant such as a dyestuff and/or pigment may be added to the shaping and/or coating agent in order to raise commercial value, if so desired.

An appropriate mesh selected and adopted for the silkscreen 28 ap-plying the shaping agent and coating agent will produce layers thereof each of a predetermined thickness. The pattern of each mask 29 is designed to avoid any superfluous or excessive application of those agent to
5 such waste areas as being discarded later, after completion of manufacture of the speaker diaphragm edges. Both the shaping and coating agents may be applied to the base fabric at a single step, to thereby reduce labor consumption and economize the manufacture process. The most preferable materials may be selected as the shaping and/or coating agents so
10 that the speaker edge 6 can be adjusted freely and reliably as to its compliance and mechanical internal loss against or relative to its oscillating displacement and/or resonance. As compared with the prior art dipping or impregnation method, the silkscreen printing of the shaping and/or coating agents will diminish consumption thereof, while making each finished
15 speaker edge lighter and more uniform. A speaker with the present diaphragm edge incorporated therein will show a higher electro-acoustic transducing efficiency and a stable vibration not adversely affecting the diaphragm, thus improving the speaker's performance over the full spectrum of reproduced sound and contributing to economical production
20 and commercial value of the speakers.

Figs. 2 and 3 show the structure of a speaker diaphragm edge provided in a first embodiment. This edge is of the so-called roll type and has an inner peripheral zone or margin 6a for adhesion to an adjacent member, and an outer peripheral zone or margin 6c for adhesion to another adjacent
25 member. Interposed between the inner and outer margins and formed integral therewith is a toroidal flexible part 6b. As seen in Fig. 3, this part 6b is arc-shaped in its radial cross section so as to be convex to the forwards

of a speaker. This edge is composed of a base fabric 10 covered with a two-layer coating. One of these layers is a shaping agent layer 17 formed of a phenolic resin that contains a polyvinyl alcohol as a softener. The other layer is a surface coating agent layer 12 formed of an emulsified methacrylic resin whose vibration-attenuating property, weather resistance, airtightness and waterproof are satisfactory. A hot melt adhesive layer 14 is formed on the back side of each margin 6a and 6c.

Fig. 4 shows a process employed a second embodiment, and this process is employed in the method of making a speaker diaphragm edge 6 as described above in the first embodiment. A base fabric 10 used here is (for example) a cotton cloth whose warps and wefts are cotton yarns of 80 count, with the warp density and weft density being 75×75 per unit length. This fabric 10 to be fed onto an extension table is supplied in the form of a roll around a winding spool 8 because it is convenient to storage and less susceptible to damage. Driven synchronously with the fabric 10 are an endless silkscreen belt 28 and an endless mask belt 29, both overlaid on the fabric up and down in this order. A coater with a squeeze 18 will operate to apply a modified phenolic resin 17a to the fabric through said belts 28 and 29, in order to print a pattern of rings as illustrated in Fig. 5. The resin 17a is softened with a polyvinyl alcohol, and each ring has a predetermined outer diameter and a predetermined inner diameter. Such printed rings that will then be dried by a heater 27 are arranged in a staggered or zigzag pattern as seen in Fig. 5, for the purpose of a higher yield of products per unit area of fabric. Drive mechanisms for the silkscreen 28 and mask 29, the coater and the heater 27 constitute a printing unit 20. Usually, one or more printing units 20 are disposed one after another and in series, and the number of such units depends on the number of layers laminated on the

5 fabric one on another. In the second embodiment for making the two-layer diaphragm edges as described in first embodiment, two units are employed, one being for the shaping agent layer 17 and the other for the surface coating agent layer 12. Then, a hot press 21 operates to press each printed ring portion of the fabric into the predetermined shape as mentioned above. Subsequently, an applicator 22 will operate to apply a hot melt adhesive onto the desired zones of each printed ring portion so as to form thereon adhesive layers 14, before a punching press 23 severs those ring portions from the fabric. The thus punched pieces are the desired speaker
10 dia-phragm edges, and the remaining ground having been surrounding each ring and the round eyelets or cores each having been encircled by the ring are wastes 16 to be discarded.

In one of modifications not shown, only one printing unit will suffice for conducting a single process if the shaping agent layer 17 in the second
15 embodiment does also serve as the surface coating agent layer 12. The other modification may be such that three printing units are employed, with one of them serving to apply an additional coating to a selected area of the edge of the first embodiment. In this case, an elliptic edge will be produced such that rigidity varies along the periphery of such an
20 diaphragm edge in order to control the vibration mode of diaphragm and to thereby improve the speaker's performance.

Figs. 6 and 7 show a third embodiment, wherein an elliptical dia-phragm edge having resonance inhibiting layers 13 and 13 are formed at regions each extending across one of the opposite ends of the major axis.
25 Rigidity of this edge is thus made higher, more surely preventing resonance from occurring in the speaker. As seen in Fig. 7 that is a cross section taken along such a major axis of this ellipse, the composite coating formed

on such regions are of a three-layer structure consisting of the shaping agent layer 17, surface coating agent layer 12 and resonance inhibiting layer 13. A modified apparatus for making this type of edges may comprise three printing units 20, each being of a structure as described above.

- 5 The representative embodiments discussed above do not delimit the scope of the present invention, but may be modified insofar as they meet the requirements and achieve the objects noted above and afford the following advantages.

ADVANTAGES AFFORDED HEREIN

- 10 As is evident from the foregoing, the speaker diaphragm edge of the present invention is of the described structure that is formed by the silkscreen printing of a shaping agent layer and coating agent layer that contributes to resonance inhibition and weather resistance. These layers can be applied to circular necessary portions of a base fabric, even if the
- 15 latter is elastic. One third or less of the coating material amount having been used in the prior art system will now suffice well, economically lowering material cost, since it need be applied only to the necessary portions of the base fabric. The amount of industrial waste to be treated in the legislated manner is also reduced, since any noticeable mass of coated
- 20 fabric need not be thrown away. Un-coated raw fabric pieces for disposal will not raise any serious problem of environmental pollution, and uniform coating layers will increase the yield of products coming up to the standard, thus lowering manufacture cost. Variedly colored edges may be provided on demand, enabling users to visually distinguish one edge from the other.

- 25 Even in a case wherein small lots are processed, the silkscreen printing enables easier choice of proper shaping and coating agents and free control of their concentration and application rate. Diaphragm edges are now

easier to meet the requirements and/or specifications as to their shape and/or physical properties, so that quality of reproduced sounds can be regulated finely in view of their usage. If a softer shaping agent is used, then the speakers will be of an improved durability against successive
5 vibration. Uniform application of the coating agent diminishes variation of the basic resonance frequency (f_0), also improving the speakers' performance. Both the shaping and coating agents are composed of stable resin molecules that are products of complete chemical reactions, so that there is no afraid that any pinholes would be produced during a long-term
10 usage of the speaker, thus avoiding deterioration or degradation thereof that would otherwise affect stable quality in the course of time.

Compliance of the resinous material for producing the edge of the invention can be changed, adjusted or amended while processing said material. Stiffness as well as resonance inhibiting effect can be modified
15 partially and along the periphery of each diaphragm edge while processing same, taking into account the usage of each lot of speakers. This means that resonance of each speaker can either be suppressed or intensified, thus enabling fine adjustment of frequency characteristics of speakers and there-by further improving the performance and quality of speakers.

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CLAIMS:

1. A method of forming an edge of a speaker diaphragm comprising:
providing a plurality of successively disposed process sections;

a first forming step of forming, in a first of said plurality of process sections, a resin-treated base fabric from a base fabric by applying a silkscreen printing technique for depositing a shaping agent layer to a necessary portion of said base fabric;

a second forming step of forming, in a second of said plurality of process sections, a surface coating agent layer on said base fabric for improving, physical functionality of said diaphragm edge[[],]:

hot-forming said base fabric to a desired edge shape;

a third forming step of forming, in a third of said plurality of process sections, a hot -melt adhesive layer on said base fabric onto an area of bonding between said diaphragm and a frame; and

said first, second and third forming steps each separately heating said shaping agent layer, said coating agent layer and said hot-melt adhesive layer, respectively.

2. The speaker diaphragm edges described in Claim 1, such that the shaping agent layer is formed by using a phenolic resin.

3. The speaker diaphragm edges described in Claim 1, such that the shaping agent layer is formed by using a phenolic resin composite whose coatability was improved by blending a polyvinyl alcohol resin into the phenolic resin.

4. The speaker diaphragm edges described in Claim 1, such that the

shaping agent layer is formed by using a phenolic resin composite whose coatability was improved by blending an alcohol other than polyvinyl alcohol resin into the phenolic resin.

5. The speaker diaphragm edges described in Claim 1, such that the shaping agent layer is formed by using a thermosetting synthetic resin.

6. The speaker diaphragm edges described in any one of the proceeding claims, such that either or both the shaping agent layer and the surface coating agent layer are formed by using a material colored by means of a dye or pigment, and the surface coating agent layer is formed from material selected from a group consisting of rubber emulsion dye and methacrylic dye.

7. A speaker diaphragm edge manufacturing method in which a resin-treated base material is formed by using a silkscreen printing technique to apply a shaping agent only to the necessary portion of a base fabric, thereby forming the shaping agent layer; followed by a step whereby the aforementioned resin-treated base material is hot-formed into a specified shape; a step whereby a surface coating agent layer is applied and formed at desired locations on said material; followed by a step whereby a hot-melt adhesive is applied to an area of bonding between a peripheral diaphragm and a frame from among an edge material within a base material which has been once again hot-formed into shaped and lastly a step whereby the coated base material after being coated is cut into rings corresponding to the circumferential shapes of the desired diaphragms.