Nov. 27, 1956 H. M. GAARDER 2,772,195

FILTER AND METHOD OF MAKING SAME

Filed April 8, 1952

Fig. 1

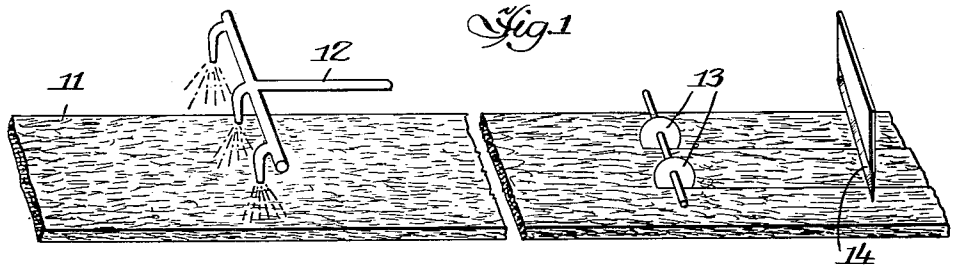


Fig. 2



Fig. 3

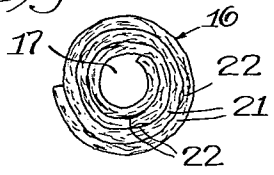


Fig. 5

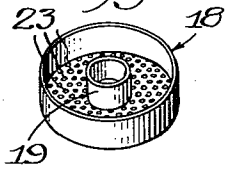


Fig. 4

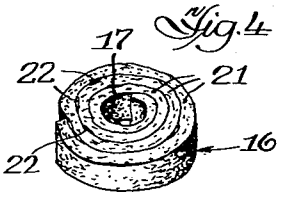
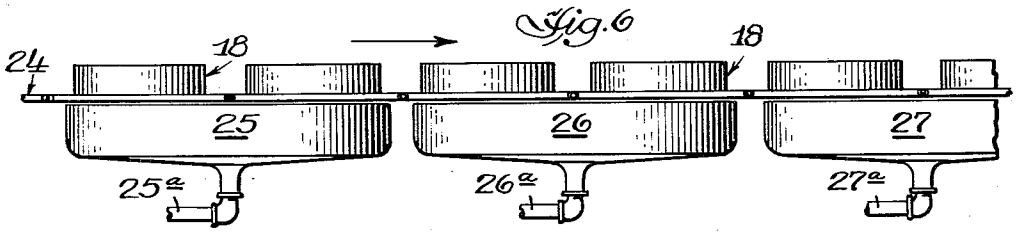


Fig. 6



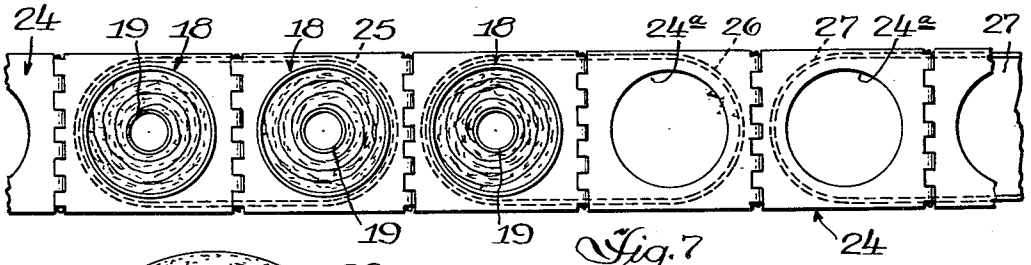


Fig. 7

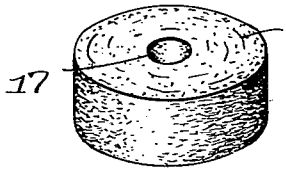


Fig. 8

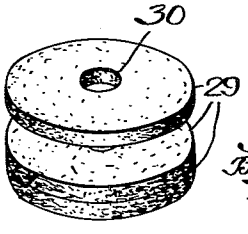


Fig. 9

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FILTER AND METHOD OF MAKING SAME

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14 Claims. (Cl. 154—101)

This invention relates to filters and to methods of making the same, particularly filters made from hair, especially short hairs or fibers. The filter of the present invention is particularly adaptable for use as an air cleaner for automobiles.

In the past, hair filters have been made almost exclusively from long staple, curled cattle tail hair. This type of hair is relatively expensive and frequently in limited supply. Short hair, for example hog hair, horse tail and mane hair combings and the like, is relatively inexpensive and plentiful. Prior to the present invention, loose, intermeshed filters such as air cleaning filters and the like, have not been formed successfully from short hair or fiber. The short hairs could not be uniformly distributed, and would also shed. When formed from batts by methods hitherto attempted, open spaces would be present between the layers of material, with resulting channeling and loss of efficiency in filtering action. The filter of the present invention is uniform and substantially free from such voids or open texture areas and is consequently very efficient. The layers or spirals of hair are bonded to one another and the hairs in one layer are intermingled with the hairs of the adjacent layer. Employing the method of the present invention, filters may be made from short coarse hair or coarse fiber which has been initially formed into a batt of intermingled fibers in the conventional manner. The batt is sprayed with a suitable adhesive preferably a thermoplastic adhesive, and then cut into strips of desired width and length. The strips are shaped into the desired form, for example, by rolling into a coil or spiral, and the coil is then steamed to soften and relax the hair and also to soften the thermoplastic adhesive. After steaming, the shaped filter is dried and cooled, thereby setting it in its final form and setting the adhesive to a hardened condition.

By the present invention I am able to produce an inexpensive hair air cleaner which is easily and quickly fabricated. The hairs in the filter are uniformly distributed throughout the filter. There are no excessive voids or open spaces between adjacent layers or within layers to cause channeling and ineffective filtration.

Other advantages of the filter of the present invention and the method of making same will be apparent upon examination of the following specification taken in conjunction with the accompanying drawings in which:

Figure 1 is a schematic representation in perspective of apparatus suitable for continuously spraying a batt of hair and cutting said batt into strips of desired width and length;

Fig. 2 is a perspective view of a strip of hair batt prior to its being rolled into a filter-body;

Fig. 3 is a top plan view of a spirally coiled batt prior to final treatment;

Fig. 4 is a view similar to Fig. 3, showing the coiled batt or filter-body in perspective;

Fig. 5 is a perspective view of a container or mold having a perforated bottom, and into which the coiled batt or filter-body is placed in carrying out the present invention;

Fig. 6 is a side elevation of a conveyor system, schematically showing the perforated containers or molds, which contain the filter-bodies, passing over treating means in accordance with the present invention;

Fig. 7 is a top plan view of a plurality of molds positioned on the conveyor belt as shown in Fig. 6;

Fig. 8 is a perspective view of a coiled filter after it has been completely processed; and

Fig. 9 is a perspective view of a modified form of laminated filter, showing the method of assembly.

The filter of the present invention is made from a batt of short hairs or fibers which has been preformed in a conventional manner. By "short" I mean hairs of from about one-half inch to five inches in length, the hairs employed in the present invention ranging from about one to three inches in length, generally in admixture.

The hairs employed may be either naturally curled, artificially curled or straight. They may be coarse natural animal hair such as hog hair, cattle tail hair, horse tail hair, and horse mane hair. Coarse natural vegetable fibers such as tula, tampico, or coconut fibers, or coarse synthetic fibers may also be used. Coarse hair and fibers are preferred because they do not have the tendency to felt or mat as do fine hair and fibers, such as cattle body hair.

Referring to the drawings, in an illustrative example, a batt of short hairs **11**, as hereinbefore described is sprayed with a thermoplastic adhesive, dried as by passing it through a conventional drying tunnel (not shown) and then cut into strips of desired length and width. The spraying, drying and cutting may be a continuous operation. As shown in Figure 1, the batt **11** passes under a spray mechanism **12** attached to a suitable source of supply of a thermoplastic adhesive (not shown). After passing under the spray mechanism, batt **11** is passed through suitable drying means (not shown) and is then cut into strips of desired width by means of cutter blades **13**. The strips are cut into suitable lengths by cutter blade **14**. The strip or batt of desired width and length, cut from a larger batt by cutter blades **13** and **14**, is shown in Fig. 2 identified by the numeral **15**.

Although both sides of the strip may be sprayed with adhesive if desired, it is preferred to spray but one side of batt **15**. Spraying one side only is found to be as effective as spraying both sides, and is quicker and cheaper and shortens the subsequent steaming operation described below. It is preferred that the adhesive be applied by spraying, but it may also be applied by dipping the batt in an adhesive. The adhesive may be applied in the form of a solution, dispersion or in the molten state. An aqueous dispersion is preferred because of the ease of application and for safety reasons.

Any thermoplastic type of adhesive may be used. Thermoplastic synthetic resins such as polystyrene, polyvinyl chloride, polyvinyl acetate, polyvinyl chloride-acetate, polyethylene, etc. may be used. Where water resistance is not a factor, water soluble adhesives such as gum arabic, vegetable glues, animal glues, fish glues, casein or other protein adhesives may be also employed. The adhesive used should be capable of softening under the influence of steam and/or heat and it is preferable to use an adhesive which softens completely around 100° C.

The adhesive aids in binding together the hairs in the batt or strip **15** and likewise serves to cause adjacent layers of the batt **15**, when coiled or laminated, to become bonded together. It also serves to aid in intermingling and thus securing the hairs of one layer with the hairs of an adjacent layer.

After batt **15** has been sprayed with adhesive, as shown in Figs. 3 and 4 it may be rolled into a coil or spiral **16**, jelly roll fashion. The layers of the coil are designated by numeral **21**. Even if the strip or batt had been sprayed only on one side, when coiled the sprayed side will always be in contact with the unsprayed side, thus assuring the presence of the adhesive between the coils or layers. It

will be noted that, in the form illustrated, a central axial aperture **17** is left in the coil. Most automobile air filters have such an aperture; however, if the item is to be made for a different purpose, the coil may be wound into a solid cylinder.

Coil **16**, which constitutes a filter-body, is wound so that its outside diameter is no smaller than, and preferably is slightly greater than the inside diameter of a container or mold **18**. The coil or filter-body **16** is then squeezed or tucked into mold **18** before being subjected to further treatment, mold **18** serving to hold the filter-body in shape during such further treatment. If filter-body **16** is provided with a central aperture **17**, mold **18** is provided with an internal cylindrical tube **19** to aid in maintaining the proper shape of the filter-body.

It will be noted that at this juncture in my method, layers **21** of the filter-body are not bonded to one another. There are frequently voids or open spaces, indicated in an exaggerated way at **22** in Figs. 3 and 4, between adjacent layers **21**. If these voids are not closed, the filter will channel and be inefficient. The further steps of my method serve to close such voids and cause the coil to be bonded into a homogeneous unit in which the hairs are uniformly and intimately dispersed throughout the entire unit.

Mold **18** has provisions for the admission of steam and air, such as a perforated bottom **23**. The bottom may either be a wire screen, preferably from 5 to 20 mesh (although it may be as coarse as 2 mesh), or a perforated plate. If a perforated plate is used, the perforations may suitably be from one-eighth to one-half inch in diameter, and at least 50% of the entire area of the bottom should be perforated.

Molds 18 having filter-bodies **16** positioned therein, are placed on a narrow conveyor belt **24**, as shown in Figs. 6 and 7. The conveyor belt is of conventional linked plate construction and is provided with an opening **24***a* in each plate, of a shape corresponding to the shape of the mold but of a somewhat smaller size so that the mold may be supported on the belt over the opening, as shown. The mold may also be made with a downwardly depending flange to securely hold it in opening **24***a*, or the mold may fit into the opening in any other suitable manner. The conveyor belt carrying the molds **18** travels in the direction indicated by the arrow in Fig. 6.

In their travel, the filter-bodies in the molds are successively subjected to treatment with steam, hot air and cold air which pass through openings **24***a*, through the perforated bottoms of the molds and through filter-bodies **16**. For this purpose, a sequence of treating means may be provided below the conveyor belt **24**. As shown in Fig. 6, these treating means are diagrammatically illustrated as three sets of chambers **25**, **26** and **27**. Chamber **25** is connected by connection **25***a* to a source of steam; chamber **26** is connected by connection **26***a* to a hot air supply, and chamber **27** is connected by connection **27***a* to a cold air supply. As the filter-bodies in the molds pass over steam chamber **25**, steam passes upwardly through the perforated bottoms **23** of molds **18** and copiously steams the filter-bodies **16**. The moisture and heat in the steaming step soften the adhesive and the hairs and cause the hairs to shift position whereby the denser areas open up and fill adjacent voids or areas which are less dense, thereby securing a greater uniformity and distribution of the hair. After the filter-bodies have been steamed, they pass over hot air chamber **26** or other suitable heating means, which dries the steamed filter-bodies **16**. The dried filter-bodies are then cooled by passing them over chamber **27**, which supplies cold air to cool the filter-bodies **16** and set the resin or adhesive. After being so treated, the layers of the filter-body are bonded together, any unduly large voids or open areas between or within the layers are dissipated and the filter-body has been transformed into a completed filter **28** (Fig. 8).

The steam bath serves to soften the thermoplastic adhesive and also softens and relaxes the hair. This action, particularly when the filter-body is confined in the molds **18**, causes the hairs of adjacent layers **21** to intermingle with one another and the thermoplastic adhesive aids in maintaining such intermingling. After the filter-body has been steamed, the hot air blast serves to dry and restore the hairs to their natural unsoftened condition. The subsequent cold air blast serves to cool the coil and set the thermoplastic adhesive. The coil may be cooled merely by exposing it to the air if rapid cooling is not desired.

In place of steam, the filter-body **16** may be first dipped in water to soften the hair and then heated to soften the adhesive. The treated filter-body is then dried and cooled as described above.

The filter **28**, which is removed from mold **18** after the mold has been cooled, is substantially uniform in texture and in distribution of the hair. Voids or open areas **22** which existed in the filter-body before final treatment no longer exist, the hairs being completely intermingled and bonded by the thermoplastic adhesive at the points where voids **22** originally existed. Normally, the hairs on the outside surfaces of filter **28**, when formed as herein described will not shed, but to obviate any possible shedding of the hairs, filter **28** may be sprayed lightly with any suitable adhesive binder.

In Fig. 9 there is shown a modified form of filter. This filter is made by punching disks or pads **29** from a batt such as batt **11** after the batt has been sprayed with a thermoplastic adhesive. The disks may be provided with an aperture **30** if desired. After the disks have been punched from the batt, they are stacked one on top of another, as indicated in Fig. 9. If batt **11** was sprayed only on one side, disks **29** are stacked so that each adjacent pair of disks has a layer of adhesive therebetween. The disks are then placed in a mold **18** and together constitute a filter-body which is subjected to the same treatment above described in connection with filter-body **16**. The steaming, heating and cooling serves to bond disks **29** together in the same manner that layers **22** of filter-body **16** are bonded together; the hairs of each disk are intermingled with the hairs of each adjacent disk and each disk is securely bonded to each adjacent disk by the thermoplastic adhesive.

The filters of the present invention may vary in density from about between 0.4 gram per cubic inch to about 0.8 gram per cubic inch. A density between 0.5 gram and 0.7 gram per cubic inch is preferred.

I have described, in considerable detail, my novel hair filter together with the method of making same but it is to be understood that the description herein contained is intended to be illustrative rather than restrictive as modifications may be made without departing from the spirit or scope of the invention. For example, it is not necessary that the filters of the present invention be made cylindrical, but, any shape which is desired may be produced whether it be made from a coil or from a plurality of laminae. Accordingly, I do not intend to be restricted by the details of the examples of the invention herein set forth except in so far as contained in the accompanying claims.

I claim:

1. The method of forming a hair filter of substantially uniform texture from short hairs comprising the steps of forming the hairs into layers, placing such layers in juxtaposition to form a filter-body, providing thermoplastic adhesive between the juxtaposed layers, steaming the filter-body to soften the hair and adhesive and to secure uniformity of distribution of the hairs, and drying and cooling the filter-body to set the adhesive and bond the adjacent layers of said batt to one another.

2. The method of forming a hair filter of substantially uniform texture from short hairs which comprises the steps of forming the hairs into layers, placing such layers in juxtaposition to form a filter-body, providing thermoplastic adhesive between the juxtaposed layers, placing the filter-body in a confining mold provided with openings for the admission of steam, steaming the filter-body

within said mold to soften the hair and adhesive and to secure uniformity of distribution of the hairs, and drying and cooling the filter-body within the mold, thereby bonding the adjacent layers and setting and giving final form to the filter.

3. The method of making a hair filter of substantially uniform texture from short hairs comprising the steps of forming the hairs into a batt, spraying only a surface of said batt with a thermoplastic adhesive, winding said sprayed batt into a coil, said coil being so wound that said sprayed surface of each layer or turn is in contact with the unsprayed surface of the adjacent layer or turn, steaming said coil, thereby softening and relaxing the hair and softening the adhesive, drying said coil, and then cooling said coil, thereby setting the adhesive and bonding the adjacent layers of said coil to one another.

4. The method of making a hair filter of substantially uniform texture from short hairs comprising the steps of forming the hairs into a batt, spraying only the surface of said batt with a thermoplastic adhesive, winding said sprayed batt into a coil so that said adhesive is positioned between adjacent layers of said coil, moistening said coil, heating said coil, thereby softening and relaxing the hair and softening the adhesive, and then cooling said coil to set the adhesive and bond the adjacent layers of said batt to one another.

5. The method of making a hair filter of substantially uniform texture from a batt of short hairs comprising the steps of spraying a side of said batt with a thermoplastic adhesive, winding said sprayed batt into a coil so that said adhesive is positioned between adjacent layers of said coil, placing said coil in a mold, said mold having openings for admission of steam, and then steaming, drying and cooling said coil while it is in said mold to first soften and relax the hairs and cause the hairs of adjacent layers of said coil to intermingle and then to set the adhesive to bond said adjacent layers together.

6. The method of making a hair filter of substantially uniform texture from a batt of short hairs comprising the steps of spraying at least one side of said batt with a thermoplastic adhesive, punching said batt into a plurality of formed layers, stacking said layers in alignment on top of one another with adhesive between the adjacent layers, thereby forming a filter-body, steaming the filter-body to soften the hair and adhesive and to secure uniformity of distribution of the hair, and drying and cooling the filter-body, thereby setting the filter and bonding the adjacent layers to one another.

7. The method of making a hair filter of substantially uniform texture from a batt of short hairs, comprising the steps of spraying at least one side of said batt with a thermoplastic adhesive, punching said batt into a plurality of formed layers, placing said layers on top of one another with adhesive therebetween to form a laminated filter-body, placing the filter-body in a confining mold provided with openings for the admission of steam, steaming the filter-body within said mold to soften the hair and adhesive and to secure uniformity of distribution of the hairs, and drying and cooling the filter-body within the mold, thereby setting and giving final form to the filter and bonding the adjacent layers to one another.

8. The method of forming a fiber filter of substantially uniform texture from short fibers comprising the steps of forming the fibers into layers, placing such layers in juxtaposition to form a filter-body, providing thermoplastic adhesive between the juxtaposed layers, steaming the filter-body to soften the fiber and adhesive and to secure uniformity of distribution of the fibers, and drying and cooling the filter-body to set the adhesive and bond the adjacent layers of said batt to one another.

9. The method of forming a fiber filter of substantially uniform texture from short fibers which comprises the steps of forming the fibers into layers, placing such layers in juxtaposition to form a filter-body, providing thermoplastic adhesive between the juxtaposed layers, placing the filter-body in a confining mold provided with openings for the admission of steam, steaming the filter-body within said mold to soften the fiber and adhesive and to secure uniformity of distribution of the fibers, and drying and cooling the filter-body within the mold, thereby bonding the adjacent layers and setting and giving final form to the filter.

10. The method of making a fiber filter of substantially uniform texture from short fibers comprising the steps of forming the fibers into a batt, spraying only a surface of said batt with a thermoplastic adhesive, winding said sprayed batt into a coil, said coil being so wound that said sprayed surface of each layer or turn is in contact with the unsprayed surface of the adjacent layer or turn, steaming said coil, thereby softening and relaxing the fiber and softening the adhesive, drying said coil, and then cooling said coil, thereby setting the adhesive and bonding the adjacent layers of said coil to one another.

11. The method of making a fiber filter of substantially uniform texture from short fibers comprising the steps of forming the fibers into a batt, spraying only the surface of said batt with a thermoplastic adhesive, winding said sprayed batt into a coil so that said adhesive is positioned between adjacent layers of said coil, moistening said coil, heating said coil, thereby softening and relaxing the fiber and softening the adhesive, and then cooling said coil to set the adhesive and bond the adjacent layers of said batt to one another.

12. The method of making a fiber filter of substantially uniform texture from a batt of short fibers comprising the steps of spraying a side of said batt with a thermoplastic adhesive, winding said sprayed batt into a coil so that said adhesive is positioned between adjacent layers of said coil, placing said coil in a mold, said mold having openings for admission of steam, and then steaming, drying and cooling said coil while it is in said mold to first soften and relax the fibers and cause the fibers of adjacent layers of said coil to intermingle and then to set the adhesive to bond said adjacent layers together.

13. The method of making a fiber filter of substantially uniform texture from a batt of short fibers comprising the steps of spraying at least one side of said batt with a thermoplastic adhesive, punching said batt into a plurality of formed layers, stacking said layers in alignment on top of one another with adhesive between the adjacent layers, thereby forming a filter-body, steaming the filter-body to soften the fiber and adhesive and to secure uniformity of distribution of the fiber, and drying and cooling the filter-body, thereby setting the filter and bonding the adjacent layers to one another.

14. The method of making a fiber filter of substantially uniform texture from a batt of short fibers, comprising the steps of spraying at least one side of said batt with a thermoplastic adhesive, punching said batt into a plurality of formed layers, placing said layers on top of one another with adhesive therebetween to form a laminated filter-body, placing the filter-body in a confining mold provided with openings for the admission of steam, steaming the filter-body within said mold to soften the fiber and adhesive and to secure uniformity of distribution of the fibers, and drying and cooling the filter-body within the mold, thereby setting and giving final form to the filter and bonding the adjacent layers to one another.

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