

DESCRIPTION

TITLE OF THE INVENTION: AIR FILTER INSERT

5 TECHNICAL FIELD

[0001]

The present invention relates to an air filter insert which is used for trapping fine airborne particles in air-conditioning systems for buildings, industrial applications
10 and the like, and particularly relates to a block-shaped air filter insert by pleating a filter sheet.

BACKGROUND ART

[0002]

Conventionally, an air filter having an air filter
15 insert comprising a pleated filter sheet stored in a filter frame is widely used to eliminate dust and airborne contaminants. In general, air is permitted to pass through an air filter insert by arrangement of a separator that maintains a distance between folded filter sheets.

20 [0003]

For example, there is a case that projecting portions, which are formed in a filter sheet by embossing, are used as separators. The projecting portions arranged between adjacent filter sheets are projected toward each other so
25 that their top end faces abut against one another. In most

cases, the top end faces are bonded with an adhesive and a distance between the sheets is maintained.

PRIOR ART DOCUMENT

PATENT DOCUMENT

5 [0004]

PATENT DOCUMENT 1: Japanese Patent No. 2935432

PATENT DOCUMENT 2: Japanese Patent No. 2935433

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

10 [0005]

By the way, a filter sheet to be used in embossing is designed in consideration of stretching caused by embossing. That is, a filter sheet is designed to have ample thickness and mass per unit area (weight per unit area) to ensure
15 minimally required filtering performance even if the filter sheet becomes thinner due to stretching during embossing.

[0006]

With the design described above, since sections not stretched by embossing are excessively thick, overall filter
20 performance may be affected by greater pressure loss due to excessive filtering performance provided by the filter. Further, ensuring the effective filtering area of a filter to improve filtering performance has been considered. However, a simple method to enlarge the effective filtering area of a
25 filter has not been devised.

[0007]

To address the above issues, an object of the present invention is to provide an air filter insert having excellent filtering performance with an enlarged effective filtering area of a filter while using a simple method to suppress pressure loss of the filter.

MEANS FOR SOLVING THE PROBLEMS

[0008]

According to the present invention, an air filter insert for filtering air having a block-like structure in which a filter sheet is pleated includes a plurality of fold walls formed by folding the filter sheet, and first projecting portions and second projecting portions formed by embossing the respective fold walls are aligned in a fold line direction. Here, the first projecting portions arranged in pair of adjacent fold walls are projected toward each other with top ends thereof abutted against each other while the second projecting portions are projected so as not to abut on each other.

[0009]

It is preferable that the second projecting portions are placed respectively at the same positions in the fold line direction and are projected in the same direction. In this case, it is more preferable that a part of each of the second projecting portions, which are arranged respectively at the

fold walls, is positioned inside the second projecting portion that is arranged in a fold wall adjacent to the fold wall. Further, it is preferable that the second projecting portions projected in one direction and the second projecting portions projected in the opposite direction are alternately aligned in the fold line direction. The second projecting portions are preferably projected so as not to make contact with each other.

[0010]

10 It is preferable that a projecting height of the second projecting portions is approximately constant along a longitudinal direction thereof. Further, it is preferable that a top end face of the second projecting portions is a flat face which is parallel to the fold wall. The second projecting portions are preferably shaped to extend perpendicularly toward a fold line in each of the fold walls. Further, one or preferably both of a lateral cross-section and a longitudinal cross-section of the second projecting portions are trapezoidal.

20 [0011]

For example, it is preferable that the first projecting portions extend perpendicularly toward a fold line in each fold wall and have an increasing a projecting height along a longitudinal direction thereof. For example, the first and second projecting portions are alternately aligned along a

fold line direction.

EFFECT OF THE INVENTION

[0012]

According to an air filter insert of the present
5 invention, the effective filtering area of a filter can be
enlarged while suppressing pressure loss simply by the
arrangement of the second projecting portions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

10 Fig. 1 is a general view of an air filter.

Fig. 2 is a perspective view illustrating a filter sheet
before being pleated.

Fig. 3 is an enlarged perspective view illustrating an
air filter insert.

15 Fig. 4 is a cross-sectional view on arrows IV-IV of Fig.
3.

Fig. 5 is a cross-sectional view on arrows V-V of Fig. 3.

Fig. 6 is a side view illustrating the air filter insert
without the first projecting portions.

20 EXPLANATION OF REFERENCES

[0014]

12: Air filter insert

13: Filter sheet

14: Fold wall

25 21: First projecting portion

22: Second projecting portion

EMBODIMENT OF THE INVENTION

[0015]

In the following, an embodiment of the present invention
5 will be described with reference to the drawings.

Fig. 1 is a perspective view illustrating an air filter according to an embodiment of the present invention.

An air filter 10 is provided with an air filter insert 12 that filters air and an air filter frame 11 that holds the
10 air filter insert 12 and is structured by inserting the air filter insert 12 inside of the air filter frame 11. The air filter frame 11 is a rectangular-shaped frame made of wood, metal such as aluminum, or the like. The air filter insert 12 is a filter material formed into a block shape by pleating
15 a filter sheet 13.

[0016]

Next, a structure of the air filter insert 12 will be described more specifically. As illustrated in Fig. 2, the filter sheet 13 is pleated (zigzag) at constant heights along
20 folding lines S extended in a width direction of the sheet 13. The structure of the air filter insert 12 has a number of planar fold walls 14 that are overlapping due to the pleating of the filter sheet 13, as illustrated in Fig. 3. In the following description, the x-direction denotes a direction in
25 which the fold walls 14 are overlapped. Further, as

illustrated in Fig. 3, air passes through the air filter insert 12 from a front face 13A side to a back face 13B side of the filter sheet 13. That is, the direction of moving air is from the upper side to the lower side in Fig. 3.

5 [0017]

Any filter material may be adopted for the filter sheet 13 as long as it is capable of filtering airborne particles and can be formed in the shape of the air filter insert 12. For example, filter paper made of glass fibers or non-woven
10 fabric such as polyolefin series and polyester series is used as the filter sheet 13. However, as long as a filter sheet satisfies filtering performance, it is not specifically limited to the above.

[0018]

15 Large numbers of first and second projecting portions 21, 22 are formed in the filter sheet 13 by embossing. The filter sheet 13 is embossed between two rollers with concave-convex outer circumferential faces in a longitudinal direction, for example, while being fed through a space
20 between the two rollers. As illustrated in Fig. 2, the first and second projecting portions 21, 22 are sunk into one face side (the front face 13A or the back face 13B side) of the sheet 13 and raised from the other face side (the back face 13B side or the front face 13A side).

25 [0019]

The first projecting portions 21 and the second projecting portions 22 are alternately aligned along a fold line direction (width direction of the sheet 13) in each of the fold walls 14. An interval between the first projecting portions 21 in the fold line direction is in a range of 25 to 75 mm preferably, and is ideally on the order of 50 mm. Similarly, an interval between the second projecting portions 22 in the fold line direction is in a range of 25 to 75 mm preferably, and is ideally on the order of 50 mm.

10 [0020]

The first and second projecting portions 21, 22 formed in each fold wall 14 are arranged at the same positions in the fold line direction, respectively, as the first and second projecting portions 21, 22 formed in another fold wall 14. That is, in the filter sheet 13, the first projecting portions 21 and the second projecting portions 22, which are lined up respectively in the longitudinal direction of the sheet 13, are alternately aligned as illustrated in Fig. 2.

[0021]

20 The first projecting portions 21 are plurally aligned in the fold line direction to be projected alternately toward the front face 13A side and the back face 13B side of each fold wall 14. That is, the plurality of first projecting portions 21 arranged at the same positions in the fold line direction (i.e., aligned in the longitudinal direction of the

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sheet 13) are projected toward the same face side (the front face 13A side or the back face 13B side) of the filter sheet 13. Therefore, the plurality of first projecting portions 21 arranged at the same positions in the fold line direction are
5 to be projected alternately in one direction along the x-direction and in the opposite direction when pleated, as illustrated in Fig. 3.

[0022]

With the structure described above, in a pair of the
10 adjacent fold walls 14, 14, the first projecting portions 21 are projected toward each other so that their top end faces 21A, 21A abut against each other. The abutted top end faces 21A, 21A are fixed with adhesive (not illustrated) applied therebetween, so that the adjacent fold walls 14, 14 are kept
15 from being separated. Here, the first projecting portions 21 that project toward the front face 13A side keep the fold walls 14, 14 separated from the front faces 13A, 13A thereof. The first projecting portions 21 that project toward the back face 13B side keep the fold walls 14, 14 separated from the
20 back faces 13B, 13B thereof.

[0023]

The plurality of second projecting portions 22 arranged at the same positions in the fold line direction (i.e., aligned in the longitudinal direction of the sheet 13) are
25 projected alternately toward the front face 13A side and the

back face 13B side along the longitudinal direction of the sheet 13. Therefore, the second projecting portions 22 arranged at the same positions in the fold line direction are to be projected in the same direction along the x-direction
5 when pleated. Here, the second projecting portions 22 are not abutted against each other in the air filter insert 12.

[0024]

Similarly to the first projecting portions 21, the second projecting portions 22 are plurally aligned in the
10 fold line direction to be projected alternately toward the front face 13A side and the back face 13B side in each fold wall 14. Therefore, as illustrated in Fig. 3, the second projecting portions 22 projected in one direction along x-direction and the second projecting portions 22 projected in
15 the opposite direction are alternately aligned in the fold line direction in the air filter insert 12.

[0025]

The first and second projecting portions 21, 22 are shaped to extend perpendicularly toward a fold line S in each
20 fold wall 14. That is, the projecting portions 21, 22 are extended in the longitudinal direction of the filter sheet 13 and slightly inclined toward the direction of moving air in the air filter insert 12.

[0026]

25 The first projecting portions 21 are plurally aligned in

the longitudinal direction of the sheet 13 and are continuous by being connected to the adjacent first projecting portion 21 at the folding line S. That is, the length of the first projecting portions 21 becomes the same as the width (i.e., a folding height) of the fold wall 14. In contrast, the second projecting portions 22 are not formed in the vicinities of the folding lines S and are not connected to the adjacent second projecting portion 22 at the folding line S. That is, the second projecting portions 22 are plurally aligned discontinuously in the longitudinal direction of the sheet 13 and the length of the second projecting portions 22 are in a range of one half to two thirds of the folding height.

[0027]

The projecting height of the first projecting portion 21 increases along the longitudinal direction. Here, the height of the first projecting portion 21 that projects toward the front face 13A side gradually decreases in the direction of moving air while the height of the first projecting portion 21 that projects toward the back face 13B side gradually increases in the direction of moving air. Accordingly, the distance between front faces 13A, 13A of the adjacent fold walls 14, 14 gradually becomes shorter in the direction of moving air and the distance between back faces 13B, 13B gradually becomes longer in the direction of moving air.

[0028]

As illustrated in Figs. 4 and 5, a lateral cross-section of the first projecting portion 21 is trapezoidal, the width thereof gradually decreases from a base end to a top end, and a top end face 21A is a flat face. Here, the width of the base end of the first projecting portion 21 is approximately constant in the longitudinal direction of the projecting portion 21.

[0029]

Meanwhile, as illustrated in Figs. 4 to 6, the lateral cross-section and the longitudinal cross-section of the second projecting portion 22 are trapezoidal, the width and the length thereof gradually decreasing from a base end to a top end, and a top end face 22A is a flat face being parallel to the fold wall 14. Here, the width of the second projecting portion 22 (e.g., the width at the top end and the base end) is approximately constant in the longitudinal direction of the projecting portion 22. The width at the base end of the projecting portion 22 is in a range of 5 to 15 mm preferably, and is ideally on the order of 10 mm.

[0030]

Further, the projecting height of the second projecting portion 22 is constant in the direction perpendicular to the fold line S. The projecting height of the second projecting portion 22 is between the highest height and the lowest height of the first projecting portion 21 and is specifically

in an approximate range of 3 to 5 mm preferably. This is because that filtering area of the air filter insert 12 is insufficient when the height is less than 3 mm, and that there is a risk of damaging the filter sheet at the time of embossing when the height is greater than 5 mm.

[0031]

Since the projection height of the second projecting portions 22 is constant, the top end side thereof is arranged so that it exceeds the fold line S in the vicinity of the fold line S as viewed from the upper side, as illustrated in Fig. 5. Here, as described above, the plurality of second projecting portions 22 arranged at the same positions in the fold line direction are projected toward the same direction as each other along the x-direction and the top end side of the second projecting portions 22 is smaller than the base end side in width and length. Therefore, as illustrated in Figs. 5 and 6, the top end side of the second projecting portion 22 exceeding the fold line S is positioned partially inside (concave inside) of the base end side of the adjacent second projecting portion 22. Accordingly, the second projecting portions 22 do not make contact with each other. Here, as illustrated in Fig. 6, in the present embodiment, the plurality of second projecting portions 22 are arranged at the same positions in the fold line direction in a repeating structure so that one end of one second projecting

portion 22 in the longitudinal direction is positioned inside of another end of another projecting portion 22 and one end of another projecting portion 22 is positioned inside of the other end of the one projecting portion 22.

5 [0032]

As described above, in the present embodiment, since the second projecting portion 22 is formed by embossing between the first projecting portions 21, which are separators, the area of the air filter insert 12 can be increased. Here, since the second projecting portions 22 do not abut against or make contact with another projecting portion, the area increased by the second projecting portions 22 functions directly as an increased amount of effective filtering area. Thus, the effective filtering area can be effectively enlarged. Then, since sections where the second projecting portions 22 are arranged becomes thin and filtering performance thereof becomes appropriate, pressure loss across the air filter insert 12 can be suppressed as well.

[0033]

20 In the present embodiment, the second projecting portions 22 placed at the same positions in the fold line direction are projected in the same direction as each other and a part of each second projecting portion 22 is positioned inside another second projecting portion 22. Accordingly, 25 the projecting height of each second projecting portion 22

can be set to be relatively large and the effective filtering area can be increased. Further, since the top end face 22A of the second projecting portion 22 is a flat face and the lateral cross-section and the longitudinal cross-section are trapezoidal, the stiffness of each fold wall 14 can be improved as well while effectively improving the filtering area. Furthermore, since the width and height of each second projecting portion 22 are approximately constant in the longitudinal direction, air is more likely to pass through in the direction of moving air.

[0034]

Further, in the present embodiment, the second projecting portions 22 projected in one direction along the x-direction and the second projecting portions 22 projected in the opposite direction are alternately aligned in the fold line direction. Accordingly, it becomes easy to pass air evenly through the air filter insert 12 while further improving the stiffness of the fold walls 14.

CLAIMS

[CLAIM 1]

An air filter insert for filtering air having a block-like structure in which a filter sheet is pleated, comprising:

a plurality of fold walls formed by folding the filter sheet, first projecting portions and second projecting portions formed by embossing the respective fold walls and aligned in a fold line direction;

the first projecting portions arranged in a pair of adjacent fold walls being projected toward each other with top ends thereof abutted against each other;

the second projecting portions being projected so as not to abut on each other;

the second projecting portions being arranged respectively at the same positions along the fold line direction and are projected in the same direction;

a part of each of the second projecting portions, which are arranged respectively, in the fold walls, being positioned inside the second projecting portion that is arranged in a fold wall adjacent to the fold wall.

[CLAIM 2]

The air filter insert according to claim 1, wherein the second projecting portions that project in one direction and the second projecting portions that project in the opposite direction are alternately aligned in the fold line direction.

[CLAIM 3]

The air filter insert according to claim 1, wherein the second projecting portions are projected so as not to make contact with each other.

[CLAIM 4]

The air filter insert according to claim 1, wherein the

second projecting portions are shaped to extend perpendicularly toward a fold line in each of the fold walls.

[CLAIM 5]

The air filter insert according to claim 4, wherein at least one of a lateral cross-section and a longitudinal cross-section of the second projecting portions is trapezoidal.

[CLAIM 6]

The air filter insert according to claim 5, wherein both of the lateral cross-section and the longitudinal cross-section of the second projecting portions are trapezoidal.

[CLAIM 7]

The air filter insert according to claim 4, wherein a projecting height of the second projecting portions is approximately constant along a longitudinal direction thereof.

[CLAIM 8]

The air filter insert according to claim 1, wherein a top end face of the second projecting portions is a flat face that is parallel to the fold wall.

[CLAIM 9]

The air filter insert according to claim 1, wherein the first projecting portions extend perpendicularly toward a fold line in each fold wall and have an increasing projecting height in a longitudinal direction thereof.

[CLAIM 10]

The air filter insert according to claim 1, wherein the first and second projecting portions are alternately aligned along a fold line direction.