A back draft damper includes a rectangular shell having a central opening which air can pass through. A plurality of vanes rotatably mounted in the shell are rotatable between open positions where air can pass through the shell and closed positions where air cannot pass through the shell. The axes the vanes rotate about are slightly offset from vertical.
BACK DRAFT DAMPER

BACKGROUND OF THE INVENTION

[0001] Large air handling systems often require back draft dampers to be placed at critical locations to prevent air from flowing in the direction opposite normal air flow when the fan that is creating the airflow is not operating. This is particularly true with multi-fan systems such as shown in Hopkins, U.S. Pat. Nos. 7,137,775 and 7,727,468. With multi-fan systems it is common to shut off one or more of the fans to allow the remaining fans to run at peak efficiency. When this occurs some air from the operating fans will flow back through the non-operating fans if the non-operating fans do not have back draft dampers.

[0002] There basically are three types of back draft dampers: manual systems where a blank off plate or damper is deployed to prevent reverse airflow; remotely actuated dampers where actuators are used to close a damper; and gravity actuated dampers where the damper is opened by the pressure of air passing through it and is closed by the force of gravity acting on its vanes. The prior art gravity actuated dampers typically comprise several stacked side-by-side vanes which are mounted in a shell and rotate about horizontal axes. The rotational axes are typically near the leading edge of the vanes to maximize the effect of gravity on the vanes so that gravity causes the vanes to be fully closed when there is no positive airflow past them. However, the down side of this is that it takes a considerable amount of airflow to fully open the vanes and if the airflow is too low to fully open the vanes they will create excess drag and overall efficiency of the system is reduced. While the gravity effect on damper vanes that rotate about horizontal axes can be reduced by counter weighting the vanes in some manner, this adds to the cost and in many situations the counter weighting has to be customized.

SUMMARY OF THE INVENTION

[0003] The subject invention typically mounts the vanes of a back draft damper generally vertically in the shell but with their rotational axes being slightly offset from vertical so that a small amount of gravitational force acts on the vanes to make them rotate to their closed positions. As a result, a small amount of force is required to overcome this gravitational force and rotate the vanes to their fully opened positions. This means that the vanes will open more quickly and with less force than vanes that rotate about horizontal axes and be more fully open at lower airflow levels.

[0004] The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a perspective view of a back draft damper embodying the subject invention.

[0006] FIG. 2 is a cross sectional view taken on the line 2-2 of FIG. 1.

[0007] FIG. 3 is a cross sectional view taken on the line 3-3 of FIG. 1.

[0008] FIG. 4 is a cross sectional view of one of the vanes of the subject invention.

[0009] FIG. 5 is a front elevation view of an alternative embodiment the damper.

[0010] FIG. 6 is a detailed view of how the damper is rotatably mounted in the shell.

[0011] FIG. 7 is a side elevation view of an alternate embodiment of the invention.

[0012] FIG. 8 is a front elevation view of an embodiment shown in FIG. 7.

[0013] FIG. 9 is a front elevation view of another embodiment of the invention.

[0014] FIG. 10 is a perspective view of yet another embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] Referring to FIG. 1 of the drawings, a back draft damper comprises a shell 10 which defines a central opening 12 having an inlet 11 and an outlet 13 through which air passes. The shell is constructed to fit into a duct or passageway (not shown) through which air flows, or be placed immediately upstream or downstream of a fan unit (not shown). The size of the shell depends upon the size of the duct, passageway or fan unit. In the preferred embodiment illustrated, which is sized for fans in a multiple fan array, the shell is 27\(\times\)27\(\times\) and has a depth of 8\(\). The shell is constructed of 16 gauge sheet metal and has a lip 14 located at its outlet which engages an optional egg crate flow straightener 16. The shell 10 has a top 18, bottom 19 and sides 20. The shell can be rectangular, as shown in FIGS. 1 and 2, or elliptical as shown in FIG. 9. The shell can be fabricated from many types of materials and have different dimensions based on the particular application.

[0016] A plurality of vanes 22 extend between the top and bottom surfaces, 18, 20 of the shell 10. The vanes move between open positions, FIG. 1 and solid line in FIG. 2, where air can flow substantially unimpeded through the central opening 12, and closed positions, dashed line in FIG. 2 and FIG. 5, where air cannot flow through the central opening. Referring now also to FIG. 4, the vanes 22 have top ends and bottom ends, rounded leading edges 24 and sides 26 which converge to thinner trailing edges 28 resulting in a neutral aerodynamic shape which creates little drag due to air flowing over the vanes. In the preferred embodiment referred to above, the vanes have a width which is less than or equal to the depth of the shell and a length which is slightly less than the height of the shell. With the 27\(\times\)27\(\times\)8 inch shell described above the vanes have a length of approximately 26\(\%\) inches and a width of between 6 and 8 inches, and have a thickness of between 0.250 and 0.400 inches at their leading edge 24 and between 0.050 and 0.100 inches at their trailing edge 28. In a preferred embodiment the blades have a thickness of 0.320 inches at their leading edge and 0.086 inches at their trailing edge. The vanes preferably are formed from an aluminum extrusion and are hollow to reduce their weight. In the preferred embodiment described above the vanes weigh approximately 2 pounds each. Cylindrical openings 24 extend through the vanes at their leading edge, the center line of which acts as the axes 36 the vanes rotate about. The axes 36 are located close to the inlet 11. The top and bottom portions of the openings 34 are threaded. In the embodiment illustration in FIGS. 1 and 2 the vanes 22 are rotatably mounted in the shell 10 such that their axes of rotation 36 are slightly offset from center to back from the vertical at an angle A, with the tops of the vanes being closer to the inlet 11 than the bottoms of the vanes. The amount of offset depends on the size and weight of the vanes and the amount of airflow that will pass through the damper. The purpose of the offset is to
cause gravity to rotate the vanes to their fully closed position when there is no positive airflow through the damper, much in the same manner that a refrigerator door closes. However, the offset should be as little as possible to obtain this result so that the vanes can rotate to their open positions quickly when there is any positive airflow through the shell. Moreover, it is desired to have the vanes become fully opened with as little airflow as possible. Thus the angle of the offset should be quite small and in the embodiment described above is 1.6 degrees. In general the angle could be as low as 0.5 and probably would never exceed 46 degrees.

[0017] If desired the axes 36 of the vanes 22 can also be offset at an angle B from side-to-side with the tops of the vanes being closer to the vertical center line L of the shell than the bottoms of the vanes, FIG. 5. This may help cause the vanes to rotate to their closed positions, particularly if one of the vanes rotates past being aligned with the airflow. The angle B of the side-by-side offset is similar to that of the angle A of front to back offset.

[0018] In the embodiment illustrated in FIGS. 7 and 8, the shell has a vertical center line L. and a horizontal center line D and rather than offsetting the axes 36 of the vanes 22 relative to the shell 10, the vertical center line L. of the shell is offset from the vertical by angle A to create the offset of the axes 36 front to back. The horizontal center line D of the shell also may be offset from the horizontal by angle B to create the offset of the axes 36 from side to side.

[0019] Referring now to FIG. 6, the vanes rotate in the shell 10 on bearings 38. The outer race 40 of each bearing is press fit into an opening 42 in the shell and the inner race 44 is positioned on the shoulder 46 of a bolt 48 which fits into the circular opening in the vane. A bearing 38 is located at the top and bottom of each vane 22. The bearing may be a ball bearing but other types of bearing and rotating techniques can be utilized.

[0020] Preferable the vanes rotate independently of one another so that each vane is aligned with the localized direction of the air flowing over it. In most cases this means that most of the blades will be oriented at an oblique angle with their trailing edges being closer to the center of the shell than their leading edges. This, along with the axes 36 of the vanes being offset from vertical causes the vanes on one side of the shell to rotate clockwise as they rotate to toward their closed positions and the vanes on the other side of the shell to rotate counterclockwise as they rotate toward their closed positions. Preferable there are on even number of vanes 22, one half of which are located on each side of the vertical center line of the shell. In the embodiment illustrated there are six vanes and they slightly overlap when they are in their closed position to provide a seal between them.

[0021] Referring now to FIG. 10 a plurality of the dampers 10 of the subject invention could be incorporated into a single shell 50 which is placed next to a fan array of the type disclosed in U.S. Pat. Nos. 7,137,775 and 7,727,468. While the embodiment illustrated is a 5x5 rectilinear array it can be made to mate with any type of fan array.

[0022] The terms and expressions which have been employed in the foregoing specification are used therein as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding equivalents of the features shown and described or portions thereof; it being recognized that the scope of the invention is defined and limited only by the claims which follow.

What is claimed is:
1. A damper comprising:
   a. a shell having a central opening through which air passes;
   b. a plurality of vanes mounted rotatably in said shell;
   c. said vanes are rotatable, about axes which are slightly off set from vertical at a predetermined angle, between open positions where air can flow through said central opening and closed positions where air substantially cannot flow through said central opening.
2. The damper of claim one wherein at least some of said vanes rotates independently of at least some of the other vanes so that when in its open position each said blade is aligned with the localized direction of the air flowing over it.
3. The damper of claim 1 wherein said shell is rectilinear in cross section.
4. The damper of claim 1 wherein said shell is elliptical in cross section.
5. The damper of claim 1 wherein said shell is circular in cross section.
6. The damper of claim 1 wherein said vanes have leading edges and trailing edges, and said axes are proximate said leading edges.
7. The damper of claim 1 wherein said vanes have top ends and bottom ends and said axes are closer to said inlet at said top ends than at said bottom ends.
8. The damper of claim 1 wherein said shell has a vertical center line and said axes are closer to said vertical center line at said top ends than at said bottom ends.
9. The damper of claim 6 wherein said shell has a depth and said vanes have a width which is not greater than said depth.
10. The damper of claim 9 wherein said vanes are substantially located within said shell.
11. The damper of claim 1 wherein said shell has a vertical center line and a portion of said vanes located on one side of said vertical center line rotate clockwise when rotating toward their closed positions and a portion of said vanes located on the other side of said vertical center line rotate counterclockwise when rotating toward their closed positions.
12. The damper of claim 11 wherein there are an even number of vanes with one half of said vanes on one side of said vertical center line and the other half of said vanes on the other side of said vertical center line.
13. The damper of claim 1 wherein said vanes are symmetrical in cross section and have a shape which minimizes drag.
14. The damper of claim 1 wherein said predetermined angle is between 0.5 degrees and 45 degrees.
15. The damper of claim 1 wherein said predetermined angle is 1.6 degrees.
16. The damper of claim 1 wherein said predetermined angle is such that said vanes are free to start rotating towards said open positions when there is any airflow through said shell from said inlet to said outlet.
17. The damper of claim 1 wherein said predetermined angle is such that said vanes move to their closed positions when there is no airflow through said shell from said inlet toward said outlet.
18. The damper of claim 1 wherein said vanes have tops and bottoms and there is a bearing between the top of each vane and said shell and the bottom of each vane and said shell.
19. The damper of claim 18 wherein said bearing is a ball bearing.
20. The damper of claim 1 wherein said vanes have a thickness of between 0.250 inches and 0.400 inches at a leading edge thereof and of between 0.050 inches and 0.100 inches at a trailing edge of said vane.

21. The damper of claim 20 wherein said vanes have a thickness of 0.32 at said leading edge and a thickness of 0.086 at said trailing edge.

22. The damper of claim 1 wherein said vanes weight approximately 2 pounds.

23. The damper of claim 1 wherein said shell has a horizontal center line and a vertical center line and said axes are offset from vertical by positioning said shell such that said vertical center line is offset from vertical.

24. The damper of claim 1 wherein said shell has a horizontal center line and a vertical center line and said axes are offset from vertical by positioning said shell such that said horizontal center line is offset from horizontal.

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