A linear slot diffuser that includes a frame, at least one air channel incorporated into the frame, and at least one linear vane attached to the frame that controls the flow of air through the linear slot diffuser. The back of the vane is rounded to reduce air drag. The vane can include vane edges that are attached to the linear slot diffuser using tensioners. These tensioners can be positioned adjacent to the front of the vane.
LINEAR SLOT DIFFUSER

FIELD OF THE INVENTION

[0001] The subject matter described herein relates to an air distribution device. Specifically, the subject matter described herein relates to a linear slot diffuser for distributing air from a duct.

BACKGROUND

[0002] Air distribution devices, also referred to as diffusers, are the terminal units of air distribution systems. As such, they are typically set into the ceiling or walls in a room and receive air along its length from a supply duct. A front view of a typical linear slot diffuser as it is installed in a ceiling or wall is illustrated in FIG. 1. FIG. 1 has been substantially reproduced from U.S. Pat. No. 3,185,068, by Straub, entitled AIR DISTRIBUTION DEVICES.

[0003] As shown in FIG. 1, the typical linear slot diffuser includes a frame having narrow elongated slots for distributing air from a duct. In order to control and/or manipulate the flow of air out of the diffuser, the diffuser’s elongated slots typically include linear vanes. These linear vanes are used to direct and/or impede the flow of air coming into or going out of the diffuser. In most instances, the edges of the vanes are pivotally mounted to a support member of the diffuser so that their orientation may be adjusted to control the direction of the air flowing through the diffuser.

[0004] FIGS. 2A and 2B illustrate an example of a typical diffuser having pivotally mounted vane edges as found in the prior art. FIGS. 2A and 2B have been substantially reproduced from U.S. Pat. No. 3,412,669, by Averill, entitled SLOT DIFFUSERS WITH CLIP-IN PATTERN CONTROLLER. Referring now to FIG. 2A, it illustrates a front sectional view of a diffuser having a frame, the frame further including a support member. The support member is attached to a spring clip that pinches the ends of the vane edges against the support member, the spring clip being positioned on the back of the diffuser. In this configuration, the vane edges are allowed to pivot about their ends within the elongated slots of the diffuser to impede/control airflow (as shown in FIG. 2B).

[0005] Linear slot diffusers having the configuration illustrated in FIGS. 2A and 2B are prevalent in the prior art. Nevertheless, diffusers having this configuration are hindered by their inherent limitations. For example, the vane edges within the diffuser cannot easily be adjusted by the user without the use of additional tools. Moreover, a substantial amount of air friction is inherent to this design even when it is in its fully opened configuration. Accordingly, a long-felt, but unresolved need exists for an improved design for a linear slot diffuser.

SUMMARY

[0006] According to the embodiments of the present invention, an improved linear slot diffuser is provided that is more aerodynamic and easier to manipulate than its prior art predecessors.

[0007] The preferred embodiment of the present invention includes a frame having end plates and side walls that form a rectangular shell on the back side of the diffuser. In certain embodiments, a central side wall bisects the rectangular shell in order to form a pair of parallel air channels through which air can flow.

[0008] Located within the air channels are linear vanes that can be used to control the flow of air through the diffuser. In embodiments of the invention, these linear vanes each include a support rod that is immovably attached to the frame as well as vane edges that are pivotally attached to the support rods.

[0009] In certain embodiment of the present invention, the vane edges disclosed herein are pivotally attached to specially designed support rods through the use of tensioners. These tensioners are positioned proximal to the front of the diffuser, as opposed to the back of the diffuser as is typically done. By using front-loaded tensioners, the back section of the vanes can be rounded to reduce air drag within the diffuser. Placing the tensioners on the front of the vanes, away from the air source, also reduces air drag.

[0010] In certain embodiments, the vane edges are further equipped with ledges on their inner surfaces. These ledges allow a user to use his or her fingers to adjust the vane edges.

[0011] In certain embodiment, the frame itself has an angled back surface to decrease air drag through the linear slot diffuser.

[0012] The linear slot diffuser, summarized above, and described in much greater detail below, is much more aerodynamic than the diffusers found in the prior art. As such, it reduces air friction inherent to linear slot diffusers, thereby reducing the amount of system pressure required to push air through the diffuser. The linear slot diffuser is also configured so that a user can easily adjust the vane edges without the use of any tools. These and other benefits of the present invention will be readily apparent from figures and detailed description of the invention provided herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, which are incorporated into and constitute a part of this specification, illustrate one or more embodiments, and together with the detailed description, serve to explain the principles and implementations of the invention. In the drawings:

[0014] FIG. 1 illustrates a front view of a linear slot diffuser.

[0015] FIG. 2A illustrates a front sectional view of a linear slot diffuser as found in the prior art.

[0016] FIG. 2B illustrates a front sectional view of a linear slot diffuser as found in the prior art.

[0017] FIG. 3A illustrates a front perspective view of a linear slot diffuser in accordance with an embodiment of the present invention.

[0018] FIG. 3B illustrates a back perspective view of a linear slot diffuser in accordance with an embodiment of the present invention.

[0019] FIG. 3C illustrates a side perspective view of a section of a linear slot diffuser in accordance with an embodiment of the present invention.

[0020] FIG. 4 illustrates a side sectional view of a linear slot diffuser in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

[0021] Embodiments are described herein in the context of an improved linear slot diffuser. Those of ordinary skill in the art will realize that the following detailed description is illustrative only and is not intended to be in any way limiting. Other embodiments of the present invention will readily suggest themselves to such skilled persons having the benefit of this disclosure. Reference will now be made in detail to
implementations of embodiments of the present invention as illustrated in the accompanying drawings. The same reference indicators will be used throughout the drawings and the following detailed description to refer to the same or like parts.

Definitions

[0022] To avoid confusion and maintain consistency throughout this application, the following basic definitions are provided as used in this application.

[0023] In this application, reference to the “back” of a diffuser, or the “back” of any part of the diffuser, refers to the duct-side of the diffuser. In other words, it refers to the side of the diffuser that is not exposed to the outside environment when the diffuser has been installed into a ceiling or a wall. For a specific section of the diffuser, it refers to the side of the specific section being referred to that is more distal to the front panel of the diffuser. Similarly, when referring to the “front” of a diffuser, or the “front” of any part of the diffuser, this is referring to the side of the diffuser that is visible from the room when the diffuser has been installed into a ceiling or a wall. For a specific section of the diffuser, it refers to the side of the specific section being referred to that is more proximal to the front panel of the diffuser.

[0024] The “closed” configuration of a diffuser refers to a configuration that does not allow air to flow through the diffuser. The “open” configuration of a diffuser refers to a configuration that does allow air to flow through the diffuser.

General Description of a Prior Art Design and its Inherent Limitations

[0025] As set forth above, FIGS. 2A and 2B illustrate an example of a typical diffuser having pivotally mounted vane edges as found in the prior art. Referring now to FIG. 2A, diffuser 200 can generally be seen as including a front panel 202 attached to side walls 204 connected by support member 206. Vane edges 208, 210 are pivotally attached to support member 206 through the use of tensioner 212 on the back of diffuser 200. When air is pushed through diffuser 200, it starts behind tensioner 212, and passes through opening 214 within front panel 202.

[0026] As air passes through diffuser 200, there are at least three different areas where substantial air friction can occur. The first area 216 is found directly behind tensioner 212. Since the back side of standard tensioner 212 includes a concave indentation, air tends to drag behind tensioner 212 as air is pushed through diffuser 200. The second area 218 where substantial air friction occurs is directly behind vane’s back surface. This area is substantially flat, which causes air to drag behind vanes edges 208, 210 along the entire length of diffuser 200. The third area 220 where air friction can occur is behind the back surfaces 222, 224, 226 of side walls 204. Once again, these surfaces 222, 224, 226 behind the side walls 204 causes air to drag as it is passed through diffuser 200.

[0027] Referring now to FIG. 2B, vane edge 210 has been positioned in its closed configuration. To do this, the user can simply use his or her finger to swing vane edge 210 back towards its nearest sidewalk 204. The problem, however, comes when trying to move vane edge 210 back into its open configuration. Since end 222 of vane edge 210 is adjacent to side wall 204, and since front panel 202 is directly in front of end 222 of vane edge 210, as a practical matter, it is almost impossible for a user to easily reach end 222 of vane edge 210 with his or her finger to pull it back to the diffuser’s 200 fully opened configuration. Accordingly, the user usually needs to use a tool to move vane edge 210 from its closed configuration to its open configuration.

General Structure for Linear Slot Diffuser

[0028] Referring now to FIG. 3A, a front perspective view of an embodiment of linear slot diffuser 300 is illustrated. As shown in FIG. 3A, diffuser 300 can be seen as including diffuser frame 302 and linear vane assemblies 304, 306.

[0029] In this embodiment, frame 302 includes front panel 308 having linear slots 310, 312. The front side of front panel 308 is substantially flat and represents the front face of diffuser 300 that remains visible once diffuser 300 is installed into a ceiling or wall. Slots 310, 312 allow air to flow through front panel 308 when diffuser 300 is in use. Slots 310, 312 can be seen as being positioned parallel to one another, and they are configured within front panel 308 to run along the length of diffuser 300. In this embodiment, two slots are illustrated. It is to be understood, however, that diffuser 300 may have any number of slots (e.g., 1 slot to 10 slots) and still fall within the scope of the invention.

[0030] Referring now to FIG. 3B, a back perspective view of an embodiment of linear slot diffuser 300 is illustrated. As shown in FIG. 3B, frame 302 can be seen as including end plates 314, 316, side walls 318, 320, central side wall 322, and intermediate support plates 324, 326, 328, 330.

[0031] End plates 314, 316 and side walls 318, 320 extend away from the back of front panel 308 perpendicular to front panel 308. End plates 314, 316 are positioned parallel to one another proximal to opposing ends 332, 334 of diffuser 300. Side walls 318, 320 are positioned parallel to one another proximal to the top 336 and bottom 338 of diffuser 300. Overall, the side edges of end plates 314, 316 and side walls 318, 320 are attached to one another to form a rectangular shell through which air can flow on the back of diffuser 300. In an embodiment, end plates 314, 316 and side walls 318, 320 are extruded metal panels that are formed behind front panel 308. In other words, front panel 308, end plates 314, 316 and side walls 318, 320 form one extruded piece. In use, the rectangular shell that is formed by end plates 314, 316 and side walls 318, 320 can be positioned within a duct opening in a ceiling or wall.

[0032] In an embodiment, central side wall 322 is positioned in between side walls 318, 320, parallel to side walls 318, 320 on the back surface of the front panel 308. Central side wall 322 extends away from the central portion of front panel 308, in between slots 310, 312, perpendicular to front panel 308. Like side walls 318, 320, central side wall 322 extends from end plate 314 to end plate 316. In this configuration, parallel air channels 340, 342 are formed between side walls 318, 320 and central side wall 322 through which air can flow.

[0033] In an embodiment, frame 302 includes intermediate support plates 324, 326, 328, 330 that are attached to side walls 318, 320 and central side wall 322. Specifically, support plates 324, 326, 328, 330 are attached to the back ends of side walls 318, 320 and central side wall 322. Support plates 324, 326, 328, 330 are positioned parallel to one another and perpendicular to side walls 318, 320 and central side wall 322. In an embodiment, the back surfaces of support plates 324, 326, 328, 330 are substantially flat. Support plates 324, 326, 328, 330 can further include centralized apertures for accepting a screw or bolt.
Still referring to FIG. 3B, linear vane assemblies 304, 306 can be secured to frame 302 by attaching linear vane assemblies 304, 306 to support plates 324, 326, 328, 330. Vane assemblies 304, 306 can be attached to support plates 324, 326, 328, 330 using any means for attachment as would be envisioned by one having ordinary skill in the art. In the embodiment illustrated in FIG. 3B, vane assemblies 304, 306 have been screwed onto support plates 324, 326, 328, 330.

Referring now to FIG. 3C, another perspective view of diffuser 300 is illustrated. In this view, end plate 316 as well as vane assembly 304 are not shown in an effort to provide more clarity as to diffuser 300's specific components.

In the configuration described above, and as shown in FIGS. 3A, 3B and 3C, air can flow from the back of diffuser 300, through air channels 340, 342, around vane assemblies 304, 306, through slots 310, 312, and out of the front of diffuser 300.

Embodiment of the present invention are not limited to any particular size. Accordingly, in certain embodiments, the length of the linear diffuser can range from 1 foot to 10 feet. Further, in certain embodiment, the linear slots can have any width, including, but not limited to 1 inch, ¼ inch, ½ inch, ¾ inch, and 1 inch.

Vane Embodiments

Referring now to FIG. 4, a side cross-sectional view of an embodiment of linear slot diffuser 300 is illustrated. As shown in FIG. 4, frame 302 is the same as frame 302 illustrated in FIGS. 3A and 3B. Vanes assemblies 304, 306, however, can now be seen as including vane support rods 400, 402 and vane edges 404, 406, 408, 410.

In this embodiment, vane support rods 400, 402 have semicircular cross-sectional shapes. The rounded edges of support rods 400, 402 are positioned adjacent to support plates 324, 326. Furthermore, rods 400, 402 can include threaded apertures 412, 414 for receiving screws 416, 418. The threaded apertures 412, 414 can be positioned at a location central to the rounded edges of support rods 400, 402.

Vane support rods 400, 402 also include slots 420, 422, 424, 426 that extend into the interior of vane support rods 400, 402 from the flat top surfaces of vane support rods 400, 402. Slots 420, 422, 424, 426 run the entire length of vane support rods 400, 402, and are designed to accept the ends of vane edges 404, 406, 408, 410 as well as the ends of tensioners 428, 430.

In the embodiment of the invention illustrated in FIG. 4, slots 420, 422, 424, 426 generally have a C-shape, wherein the ends of the “C-shape” point away from the center of vane support rods 400, 402. The ends of vane edges 404, 406, 408, 410 also have an opposing “C-shape” in order to conform to the shape of the slots 420, 422, 424, 426 of support rods 400, 402. In this configuration, the ends of vane edges 404, 406, 408, 410 can swivel within support rods 400, 402.

In this embodiment, tensioners 428, 430 are used to hold vane edges 404, 406, 408, 410 in place within the slots 420, 422, 424, 426 of support rods 400, 402. Specifically, the ends of tensioners 428, 430 are designed to exert an outward force against an object. Accordingly, vane edges 404, 406, 408, 410 can be held in place by tensioners 428, 430 within slots 420, 422, 424, 426 since the ends of tensioners 428, 430 push the ends of vane edges 404, 406, 408, 410 against the support rods 400, 402 within slots 420, 422, 424, 426. In this configuration, vane edges 404, 406, 408, 410 can be pivotally attached to support rods 400, 402.

Still referring to FIG. 4, vane edges 404, 406, 408, 410 can further be seen as including ledges 432, 434, 436, 438. These ledges 432, 434, 436, 438 can be used by an individual to move vane edges 404, 406, 408, 410 to their open configurations. Using vane edge 404 as an example, FIG. 4 illustrates vane edge 404 in a closed configuration. In other words, vane edge 404 blocks the flow of air through diffuser 300 since it has been pivoted to lie adjacent to side wall 318. To adjust vane edge 404 to be in its open configuration, a user can insert his or her finger into slot 310 and pull back on ledge 432 to pivot vane edge 404 and place vane edge 404 in its open configuration.

Aerodynamic Qualities of Linear Slot Diffuser as Compared to Prior Art Designs

There are at least three ways that diffuser 300 is aerodynamically superior to its prior art predecessors.

First, vane support rods 400, 402 have rounded back edges to minimize the amount of air drag that is present along diffuser 300. In contrast, prior art vanes typically have flat back edges, which increases the amount of air drag that is caused by the vanes themselves. This occurs even when the prior art vanes are in their fully opened configuration.

The reason that most prior art vanes have flat back surfaces is because they are designed to accommodate tensioners that are attached to the vanes proximal to the back of the diffuser (as shown in FIGS. 2A and 2B). This occurs since prior art diffusers are designed to employ tensioners that exert an inward force against the vane edges, thereby compressing the vane edges together about a central support structure. But exerting an inward force around a round object is difficult. By way of analogy, it would be like squeezing the back of a slippery ball with two fingers, where increasing the pressure exerted on the ball would likely cause the ball to slip away. Accordingly, most prior art vanes have squared-off back edges.

With diffuser 300, since tensioner 428, 430 exert an outward force against vane edges 404, 406, 408, 410 within slots 420, 422, 424, 426, the back surfaces of support rods 400, 402 can be rounded without affecting the diffuser's functionality.

Second, the tensioners used with diffusers can themselves contribute to air drag within a diffuser. Accordingly, by placing tensioners 428, 430 on the front side of vane assemblies 304, 306, as opposed to the back sides of the vanes as found in the prior art, an additional source of air drag is eliminated.

Third, with prior art diffusers, the side walls of the frames can have flat back surfaces 224, 226 that contribute to air drag (as shown in FIG. 2A). Accordingly, in an embodiment of the invention, the back surfaces 440, 442, 444 of side walls 318, 320 and central side wall 322 have been angled to reduce air drag. In an embodiment, by angling side walls 318, 320 toward support plates 324, 326, 328, 330, the bent or angled portion of the side wall 318, 320 can also function to hold support plates 324, 326, 328, 330 in place to help stabilize the entire assembly.

The foregoing description of preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many embodiments were chosen and described in order to best explain the principles of the invention and its practical application, thereby enabling others skilled in the art
to understand the invention for various embodiments and with various modifications that are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims and their equivalents.

1. A linear slot diffuser, comprising:
a frame comprising at least one air channel;
at least one vane attached to said frame within the at least one air channel; and
wherein the at least one vane comprises a rounded back surface.

2. The linear slot diffuser of claim 1 wherein each vane is comprised of a support rod and a pair of vane edges, wherein the vane edges are pivotally attached to said support rod using a tensioner, wherein said tensioner is attached to said support rod proximal to the front face of the support rod.

3. The linear slot diffuser of claim 2 wherein the support rod includes slots on the support rod’s front surface for accepting the vane edges and the tensioner.

4. The linear slot diffuser of claim 3 wherein the slots are substantially C-shaped.

5. The linear slot diffuser of claim 2 wherein the tensioner exerts an outward force against the support rod.

6. The linear slot diffuser of claim 1 wherein the back surfaces of the frame are angled.

7. A linear slot diffuser of claim 1, comprising:
a frame comprising at least one air channel;
at least one vane attached to said frame with at least one air channel;
wherein the at least one vane comprises a rounded back surface; and
wherein each vane is comprised of a support rod and a pair of vane edges, wherein the vane edges are pivotally attached to said support rod using a tensioner, wherein said tensioner is attached to said support rod proximal to the front face of the support rod, wherein the tensioner exerts an outward force against the support rod.

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