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Schach

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[54] SOUND ATTENUATOR WITH FLUIDIC CONTROL

[72] Inventor: **Albert W. Schach**, Rockford, Ill.

[73] Assignee: **Barber-Colman Company**, Rockford, Ill.

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[58] **Field of Search** ..... 181/50, 56, 42, 60; 98/40 R, 98/40 A, 40 B, 40 C, 40 D, 41 R, 41 AV

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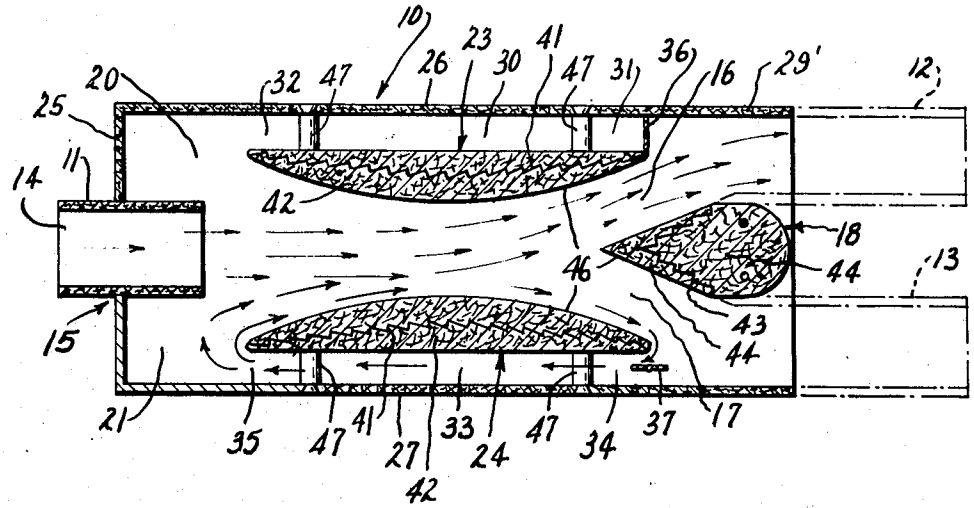
Primary Examiner—Robert S. Ward, Jr.

Attorney—Wolfe, Hubbard, Leydig, Voit & Osann Ltd.

[57] **ABSTRACT**

A main flow of air passes through an inlet into a unit which serves as a sound attenuator and which also acts as a fluidic control whereby the air is divided to be discharged through two outlets in unequal amounts or is discharged through only one outlet. Areas of low pressure are created around the inlet by the flow of air through the inlet and, by creating a pressure differential between the areas, the flow of air is deflected toward the outlet on the same side of the unit as the area of lowest pressure. To create the differential, two baffles are spaced from one another to form a channel for the main flow of air through the unit and are each spaced from opposed walls of the unit to form passages which empty into the areas of low pressure. A portion of the main flow of air may flow back through the passages and into the areas of low pressure. Dampers control the amount of flow through each passage so that the pressure in one area is raided a greater amount than the pressure in the other area thereby creating the pressure differential which controls the direction of airflow. To reduce the noise level in the unit and downstream thereof, each baffle comprises a zigzag-shaped sheet of lead positioned to reflect sound waves toward the other baffle and toward the inlet, a padding of fiber glass surrounding the sheet to dampen the sound waves, and a covering of perforated sheet metal to protect the fiber glass from the eroding effect of the flow of air. With this arrangement, the sound waves pass repeatedly back and forth within the unit until they are substantially dissipated.

16 Claims, 3 Drawing Figures



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Fig. 1.

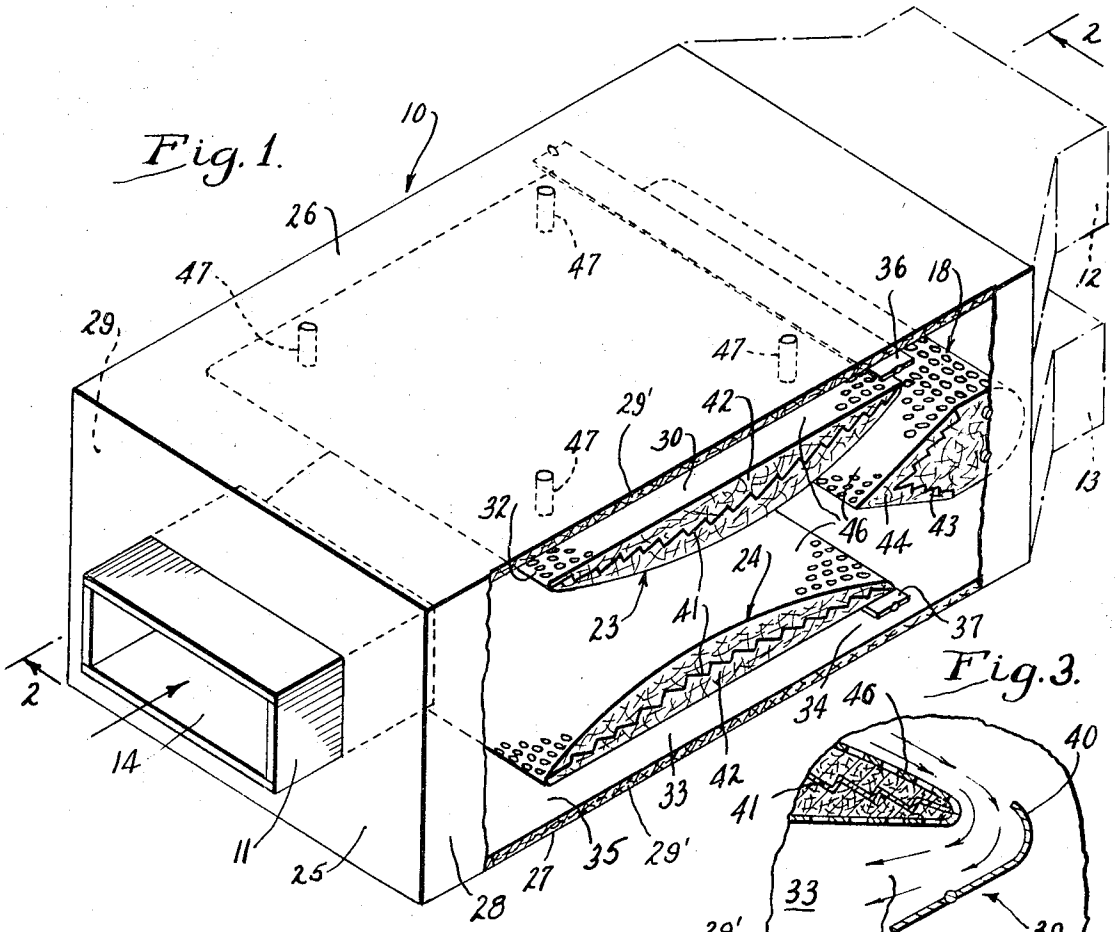
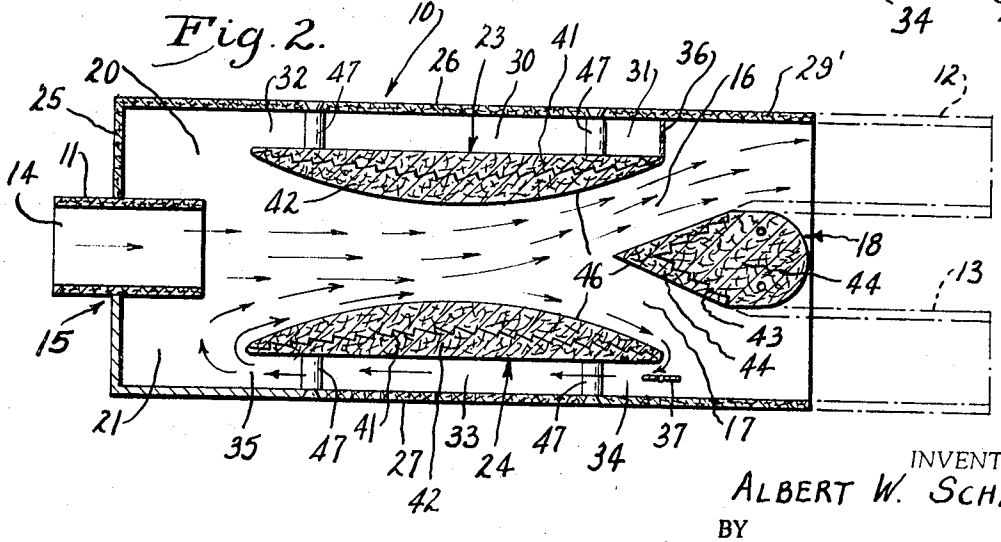


Fig. 3.

Fig. 2.



INVENTOR.
ALBERT W. SCHACH

BY

Wolfe, Hubbard, Leydig, Voit & Osann

ATTORNEYS

SOUND ATTENUATOR WITH FLUIDIC CONTROL

BACKGROUND OF THE INVENTION

This invention relates to an air distribution system with a unit which serves both as a sound attenuator and as a fluidic control operable either to divide a main flow of fluid into a plurality of flows as the fluid passes through the unit from an inlet to a plurality of outlets or to direct the fluid to only a selected one of the outlets. The unit dampens sounds generated upstream of the unit as well as within the unit itself. More particularly as regards the fluidic control, the main flow is deflected toward a selected one of the outlets to direct the larger portion of the fluid through the selected outlet, the amount of the flow going through the selected outlet depending on the amount the flow that is deflected toward the selected outlet. To deflect the flow, a pressure differential is created between areas on opposite sides of the flow as the latter enters the control unit, the flow being deflected toward the area of lowest pressure and thus toward the outlet corresponding to such area.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a unit which is simpler and easier to make and is less expensive to manufacture than similar control units heretofore available and which is a self-contained unit.

One object is to provide a control unit that discharges flows of fluid having lower noise levels than flows discharged by similar control units heretofore available.

Another object is to provide a control unit which is operable to self-induce a pressure differential between the areas and thus does not require the introduction of a high or low-pressure force into the unit from an outside source.

It is a more detailed object to take advantage of the natural laws of fluid flow not only to induce areas of low pressure within the unit but also to selectively raise the pressure in one area to create the pressure differential.

The invention also resides in the novel provision of a plurality of baffles with each baffle comprising a zigzag-shaped sheet of sound wave reflecting material surrounded by sound wave dampening material with the sheet being positioned to reflect the sound waves through the dampening material and upstream of the flow to help prevent the sound waves from being discharged through the outlets.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary, perspective view of a fluidic control unit embodying the novel features of the present invention and with parts broken away for clarity.

FIG. 2 is a cross section taken substantially along the line 2—2 in FIG. 1.

FIG. 3 is a fragmentary cross-sectional view of a second embodiment of a damper for use with one of the baffles.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawings for purposes of illustration, the invention is embodied in a unit **10** (FIG. 1) placed between an upstream fluid supply line **11** and a number, herein two, of downstream fluid distribution lines **12, 13** to dampen noise and to control the distribution with respect to the two distribution lines of a pressurized gas, such as air, flowing into the unit from the supply line, The air flows into the unit through an inlet **14** (FIG. 2) at one end of the unit (the left in FIG. 2) and is directed by the inlet toward the other end of the unit in which an upper outlet **16** joins the unit to one distribution line **12** and a lower outlet **17** joins the unit to the other distribution line **13**. Between the two outlets, a flow divider **18** with a generally triangular cross section extends generally horizontally across substantially the entire width of the unit and, when no other forces are acting on the flow of air, the divider splits the flow into two equal flows which pass through the two outlets.

To divide the flow of air unevenly between the two outlets **16, 17** or to direct the entire flow to one outlet, force is applied to the flow to deflect the latter toward one outlet or the other. Since the outlets are oriented one above the other in this instance, such a force acts to deflect the flow either upwardly or downwardly as the flow passes through the unit **10**. Herein, such a deflecting force is created by establishing a pressure differential between an area **20** above the flow as the latter enters the unit and an area **21** below the flow, the flow being deflected in the direction of the area of the lowest pressure.

In accordance with one aspect of the present invention, advantage is taken of the natural laws of fluid flow to use the flow of air through the unit to create a selected, self-induced, pressure differential between the upper and lower areas **20, 21** to deflect the flow of air toward one or the other outlet **16, 17**. For this purpose, the unit **10** is shaped so that the areas **20** and **21** become low pressure due to the air flowing through the inlet **14**, and two baffles **23** and **24** are positioned within the unit so that small amounts of airflow into the areas to raise the pressure in the areas. The amount of air directed to each area may be controlled so that different amounts flow into the areas to create a pressure differential between the areas. With this arrangement, the flow of air may be divided unevenly between the outlets or directed entirely through one outlet, and the unit utilizes the flow of air to create the pressure differential and thus the deflecting force to eliminate any need for an external deflecting force being introduced into the unit.

Herein, the unit **10** is in the shape of generally rectangular box formed with a flat end wall **25** (left end in FIG. 2), opposed top and bottom walls **26** and **27** and sidewalls **28** and **29** (FIG. 1). The walls may be made of sheet metal lined with sound dampening material **29'**. There is no end wall as such on the right end of the box because the upper outlet **16** and lower outlet **17** extend from sidewall to sidewall and are separated only by the flow divider **18**. From FIG. 1, it will be observed that the inlet **14** is centered in the end wall **25** and extends into the interior of the box to divide the left end of the box into the upper and lower areas **20** and **21**. The air passing from the supply line through the inlet and into the box is pressurized, and the resulting flow of air past the inner end of the inlet creates a low or negative pressure in the upper and lower areas in a manner well known in the art of fluid flow.

The baffles **23** and **24** are positioned to channel the flow of air toward the outlet end of the box **10** while directing small amounts of the air into the low-pressure areas **20** and **21** to raise the pressures in those areas. For this purpose, the upper baffle **23** is connected to and spaced from the upper wall **26** to form an upper passage **30** with an inlet end **31** adjacent the upper outlet **16** and with an outlet end **32** adjacent the upper area **20** while the other baffle **24** is connected to and spaced from the lower wall **27** to form a lower passage **33** with an inlet end **34** adjacent the lower outlet **17** and with an outlet end **35** adjacent the lower area **21**. As shown in FIG. 1, the baffles extend substantially from sidewall **28** to sidewall **29** so that the passages do likewise.

Due to the Coanda Effect, some of the air flowing between the baffles **23** and **24** will adhere to the outer surfaces of the baffles and will follow around the baffles and through the passages **30** and **33** and into the upper and lower low pressure areas **20** and **21** thus raising the pressure in these areas. The Coanda Effect generally is the principle that, when fluid is expelled under pressure into a chamber and contacts a surface therein, the fluid will adhere to that surface and move along the surface.

So that a pressure differential is created between the upper and lower low pressure areas **20** and **21**, the amount of air that is allowed to flow through each passage **30, 33** is controlled. For this purpose, dampers **36** and **37** are positioned at the inlet

ends 31 and 34 of the passages to regulate the airflow through the passages. As shown in FIGS. 1 and 2, each damper may be a sheet of metal extending from the sidewall 28 to the sidewall 29 and pivotally mounted between the sidewalls to turn about a generally horizontal and laterally extending axis at the center of the damper. Each damper may be turned about its axis and set in any selected position from horizontal to vertical. As shown in FIG. 2, the upper damper 36 is vertically positioned and completely closes the upper passage 30 while the lower damper is horizontally positioned and thus allows the maximum airflow through the lower passage 33. When the dampers are set as shown in FIG. 2, the greatest pressure differential is created between the upper and lower areas with the pressure in the upper area being the lowest since no air flows into the upper area. When the dampers are positioned in the above manner, the flow of air entering the box is deflected toward the upper outlet 16 to such an extent that substantially no air flows through the lower outlet 17. The flow of air can be divided unevenly between the two outlets by opening the upper damper less than the lower damper thus creating less of a pressure differential between the areas to deflect the flow of air only somewhat toward the upper outlet thus resulting in the larger portion of the flow going through the upper outlet or by opening the lower damper less than the upper damper to deflect the flow of air somewhat toward the lower outlet. If both dampers are horizontal or vertical, the pressures in the areas will be equal, and the flow will be evenly divided between the two outlets. Thus, by selectively setting the inclination of the dampers, the flow of air may be directed entirely through the upper outlet or the lower outlet or be divided in any proportions between the two outlets.

A modified damper 39, shown in FIG. 3, gives added assistance in guiding the air through the passages 30 and 33. Each damper (only one of which is shown in FIG. 3) is formed with a curved end portion 40 which, when the damper blocks its respective passage, overlaps its respective baffle 23, 25 and which, when the damper does not completely block the passage, tends to guide air around the end of the baffle and into the passage to aid the Coanda Effect.

Noises produced upstream of the box 10 and turbulence caused by the flow of air rushing into the box are objectionable if allowed to reach the area where the air is to be used. In accordance with another aspect of the invention, the baffles 23 and 24 are utilized to dissipate the sound waves in the box and reduce the sound traveling downstream with the air. For this purpose, the baffles 23 and 24 comprise cores 41 of sound wave reflecting material surrounded by paddings 42 of sound wave dampening material. Additionally, the flow divider 18 is formed by a core 43 of sound wave reflecting material covered by a padding 44 of sound wave dampening material and thus also serves as a baffle. With this arrangement, the sound waves pass through the paddings 42 and 44 and bounce off the cores 41 and 43 to pass repeatedly through the paddings until dampened and thus the noise levels in the distribution lines 12 and 13 are very low.

Each baffle core 41 is shaped to reflect the sound waves either toward the other baffle core or toward the inlet 14 so as to reduce the possibility of the sound waves progressing through the box 10 to the outlets 16 and 17. As best shown in FIG. 2, each core is formed with a zigzag surface comprised alternately of generally vertically inclined faces which face the inlet and generally horizontal faces which face the opposed baffle. Thus, sound waves bounce off the vertical faces toward the inlet and off the horizontal faces toward the other baffle. In either case the sound waves pass repeatedly through the paddings 42 until dampened. The core 43 of the flow divider 18 also is zigzag in shape but is bent into a V so that the sound waves are reflected back toward the inlet after passing through the padding 44. Lead is a satisfactory sound wave reflecting material and may be used to make the cores.

Paddings 42, 44 which are effective for the purpose usually are made of a material which may be easily worn away or eroded by the flow of air moving across the baffles 23 and 24 and the flow divider 18. Such a material which possesses the requisite sound wave dampening characteristics is fiber glass. To protect the paddings from the eroding effect of the moving air, protective coverings 46 encase each baffle and cover the flow divider. While burlap or cheesecloth might be used for this purpose, perforated sheet material is preferred, the perforations allowing the sound waves to penetrate into the paddings.

Advantageously, the baffles 23 and 24 are connected to and spaced from the upper and lower walls 26 and 27, respectively, so that sound wave vibrations are not transmitted from the baffles to the walls. For this purpose, each baffle is mounted on its wall by a set of vibration dampening posts 47, in this instance four. Hard rubber has been found to be a satisfactory material for the posts.

Spacing of the baffles 23 and 24 from the walls 26 and 27 to permit the flow of some air back into the areas 20 and 21 also has the effect of reducing noise which would result from the otherwise low pressure in these areas. Thus, the unit 10 may be used simply as a sound attenuator without producing fluidic action. In such a case, both dampers 36 and 37 are placed in the open position or are eliminated completely and the air from the outlets 16 and 17 may flow into a common conduit instead of the distribution lines 12 and 13 shown in the drawings.

It will be observed that the provision of the baffles 23 and 24 spaced from the upper and lower walls 26 and 27 of the box 10 to create the passages 30 and 33 which are controlled by the dampers 36 and 37 is a particularly advantageous arrangement for controlling the flow of air through the box. With this arrangement, air may be diverted from the main flow and directed into one or the other or both of the upper and lower low-pressure areas 20 and 21 to create a pressure differential between the areas thus exerting a force on the flow of air into the box to deflect such flow toward the outlet associated with the area of lowest pressure. Also of particular advantage is the construction of the baffles 23 and 24 so that they prevent the passage of most of the sound waves into the distribution lines. More particularly, the zigzag-shaped cores 41 repeatedly reflect the sound waves through the sound wave dampening paddings 42.

I claim as my invention:

1. For use in an air distribution system, a unit comprising in combination, a generally rectangular box having an end wall, sidewalls, and opposed upper and lower walls, an inlet positioned in said end wall for directing a main flow of fluid toward the other end of said box and thus tending to create upper and lower areas of low pressure in the end portion of said box above and below said inlet, outlet means in the other end of said box, an upper baffle connected to said upper wall and extending generally from one sidewall to the other, and a lower baffle connected to said lower wall and extending generally from one sidewall to the other, said baffles being spaced apart to define between themselves a central channel for the flow of fluid from said inlet toward said outlet means, said upper baffle being spaced from said upper wall to define an upper passage communicating between said upper low-pressure area and the other end of said box, said lower baffle being spaced from said lower wall to define a lower passage communicating between said lower low-pressure area and the other end of said box, a portion of said fluid at said other end being drawn through said passages and into said low-pressure areas to increase fluid pressure in said low-pressure areas to reduce the turbulent flow of fluid into the box through the inlet and, thereby, reduce noise normally produced by said turbulent flow.

2. The unit of claim 1 in which each said baffle comprises a body formed of sound wave dampening material to dampen sound waves in the fluid flowing through said box whereby the noise level of the flow of fluid through said outlet means is kept low.

3. The unit of claim 2 in which each baffle further comprises a zigzag-shaped sheet of sound-reflecting material embedded

within said sound wave dampening material, the sheets generally opposing one another to reflect sound wave through said dampening material and away from said outlet means.

4. The unit of claim 3 in which each said baffle further includes a perforated casing of wear-resistant material around said dampening material thus protecting such material from the eroding effects of the flow of fluid past said baffles.

5. The unit of claim 1 further including supports extending through said upper and lower passages to connect said upper and lower baffles to said upper and lower walls respectively while spacing said baffles from said walls, and said supports being made of material which is a poor conductor of sound waves.

6. The unit of claim 2 in which said outlet means comprises upper and lower outlets and further including a third baffle adjacent said other end and between said outlets and being made of a sound-dampening material.

7. The unit of claim 6 in which each of said three baffles includes a zigzag-shaped sheet of sound-reflecting material embedded within said sound-dampening material.

8. The unit of claim 1 in which said outlet means comprises upper and lower outlets and further including means for selectively controlling the flow of fluid through said passages whereby a greater amount of fluid may be allowed to flow through one of said passages to raise the pressure in the corresponding area of low pressure to create a differential in pressure between the two areas and thus deflect the main flow of fluid in the direction of the area of lower pressure.

9. A fluidic control comprising a box having an inlet and a pair of outlets for moving a flow of fluid through said box, and means in said box for selectively apportioning the flow of fluid between said outlets by creating selected pressure differentials in areas adjacent the sides of the inlet so as to deflect a portion of the flow toward the outlet on the same side of the box as the lower low-pressure area and away from the outlet on the same side of the box as the higher low-pressure area, said means including a baffle positioned adjacent the flow of fluid, said baffle comprising sound wave dampening material so that a large portion of the sound waves in said flow of fluid is dampened as the flow of fluid passes said baffle.

10. A fluidic control comprising, a box having an inlet for directing a flow of fluid into said box and having a plurality of outlets spaced from said inlet for conducting said flow out of said box and means in said box for apportioning said flow and directing the latter to said outlets, said means including two opposed baffles spaced apart to define between themselves a central channel for the flow, each said baffle comprising a zigzag-shaped sheet of sound wave reflecting material, and sound wave dampening material surrounding said sheet, said sheets being positioned to reflect sound waves toward said inlet and toward one another so that sound waves from the flow are passed through said sound wave dampening material until dissipated to provide a quite flow of fluid beyond said outlets.

11. The fluidic control of claim 10 in which said box has first and second opposed sidewalls, a first support connecting one of said baffles to said first wall while spacing said baffle from said first wall, and a second support connecting the other said baffle to said second wall while spacing said other baffle from said second wall, said supports being made of material which is a nonconductor of sound waves whereby sound waves are not transmitted from said baffles to the walls of said box.

12. The fluidic control of claim 10 in which each said baffle further includes a covering of wear resistant material to help protect said dampening material from the eroding effects of the flow of fluid.

13. For use in an air distribution system, a unit comprising in combination, a box having two ends and first and second opposed walls extending between said ends, an inlet positioned in said one of said ends between said walls for directing a main flow of fluid toward said other end and thus tending to create first and second areas of low pressure in the end portion of said box adjacent said inlet, a first outlet disposed in the other said end adjacent said first wall, a second outlet disposed in said other end adjacent said second wall, a first baffle connected to said first wall, a second baffle connected to said second wall, said baffles being spaced apart to define between themselves a main channel for the flow of fluid from said inlet toward said outlets, said first baffle being spaced from said first wall to define a first passage beginning adjacent said first outlet and ending adjacent said first area of low pressure for the flow of fluid around said first baffle toward said first area of low pressure, said second baffle being spaced from said second wall to define a second passage beginning adjacent said second outlet and ending adjacent said second area of low pressure for the flow of fluid around said second baffle toward said second area of low pressure, said baffles having opposed surfaces curved away from each other and toward the beginning of said passages to help guide a portion of said flow of fluid into said passages, and means for selectively controlling the flow of fluid through said passages to allow a greater amount of flow through one of said passages to raise the pressure in the corresponding area of low pressure thereby creating a differential in pressure between the two areas thus deflecting the main flow of fluid in the direction of lower pressure.

14. The unit of claim 13 in which said controlling means comprises dampers positioned adjacent said baffles and each mounted for selective movement to block or partially block said passages. baffles

15. The unit of claim 14 in which each said damper comprises a body with a curved edge portion said edge portion being positioned to guide fluid into a respective passage when said damper is positioned to partially block said respective passage.

16. A fluidic control comprising in combination, a box having two ends and opposed sidewalls extending between said ends, an inlet positioned in one of said ends between said walls for directing a main flow of fluid toward said other end and thus tending to create first and second areas of low pressure in the end portion of said box adjacent said inlet, a plurality of outlets disposed in the other said end, means contained within said box for creating a pressure differential between said areas whereby the flow of fluid is deflected toward one of said outlets said means comprising two opposed baffles spaced apart to define a central channel for the flow of fluid from said inlet toward said outlets each said baffle being spaced from a sidewall to create a passage having one end adjacent and communicating with one of said areas of low pressure and one end adjacent an outlet so that fluid may pass through each passage and into the area of low pressure to raise the pressure in that area, and control means for regulating the amount of fluid passing through each passage so that more fluid is directed to a selected one of said areas to create a pressure differential between the areas to deflect the flow of fluid.

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