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[54] **AIR DISTRIBUTION APPARATUS**

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[52] **U.S. Cl.** .... **181/50**, 181/68, 98/41 R

[51] **Int. Cl.** **F24f 13/10**, F16l 55/02

[58] **Field of Search** .... 181/42, 50, 46, 56, 181/68–70; 98/40 C, 40 D, 40 R, 41 R

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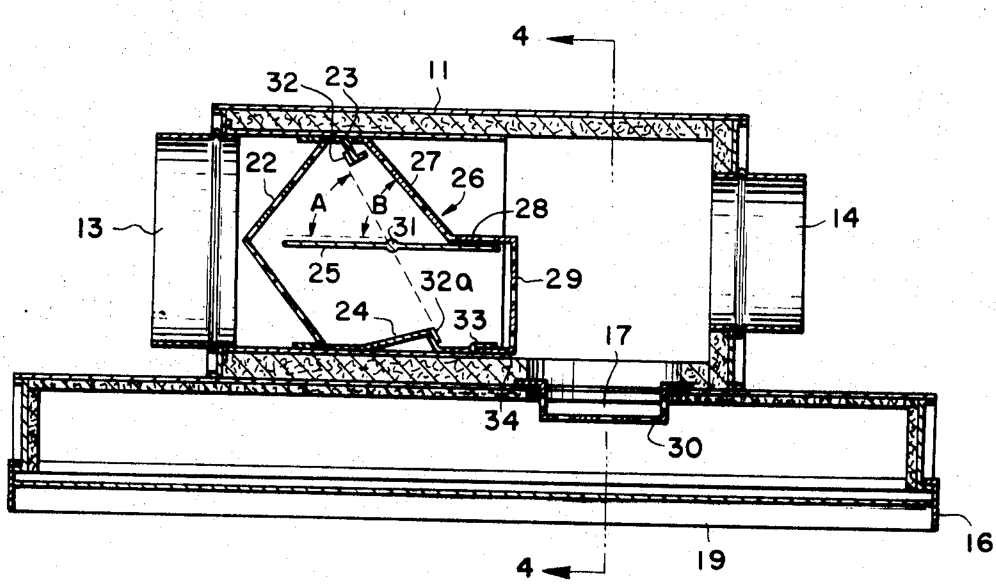
[57] **ABSTRACT**

Apparatus for controlling and distributing the flow of air to one or more zones. The apparatus includes a sound-dampening baffle to aid in delivering air with a minimum of perceptible noise.

13 Claims, 8 Drawing Figures



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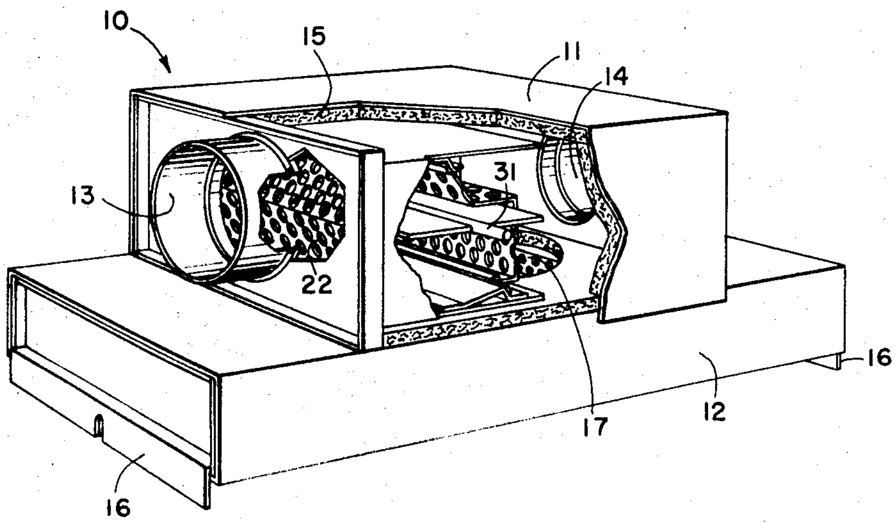

FIG. 1

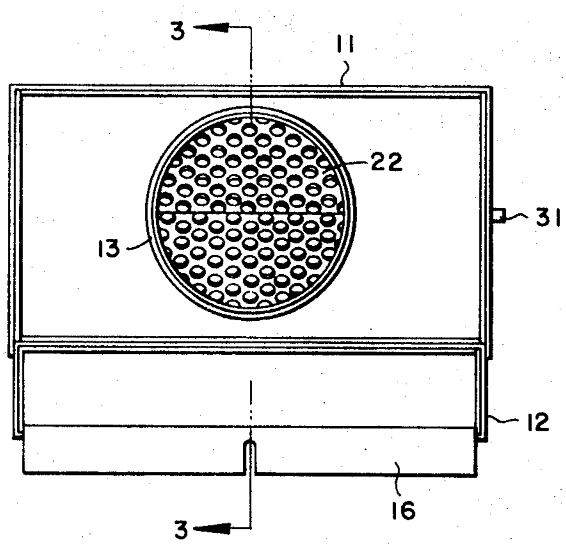

FIG. 2

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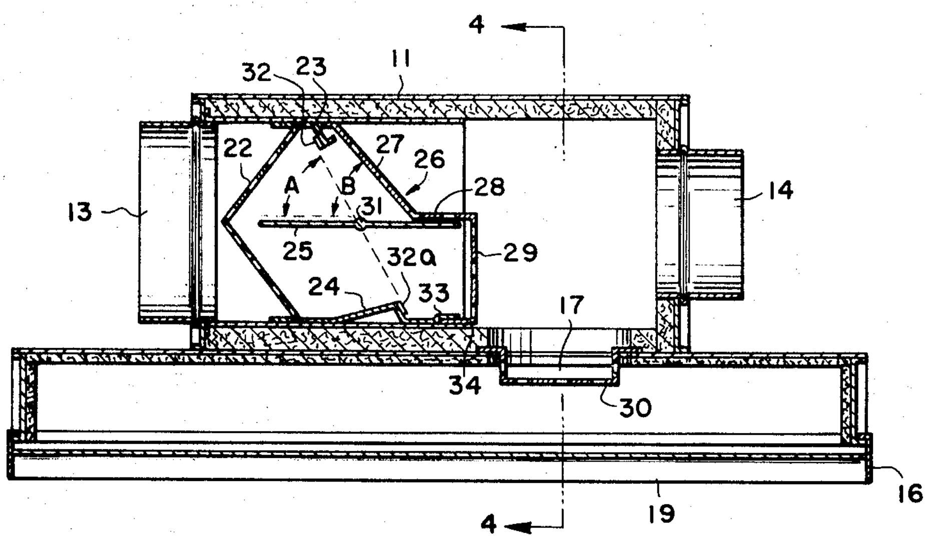

FIG. 3

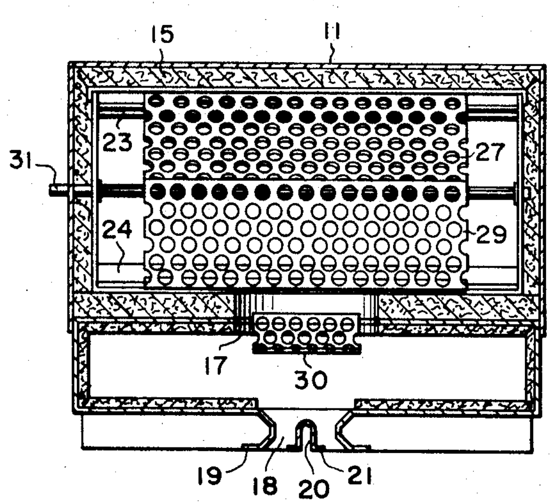

FIG. 4

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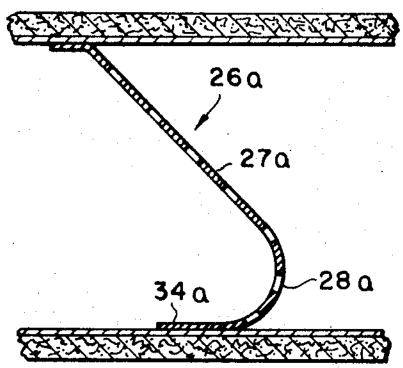

FIG. 5

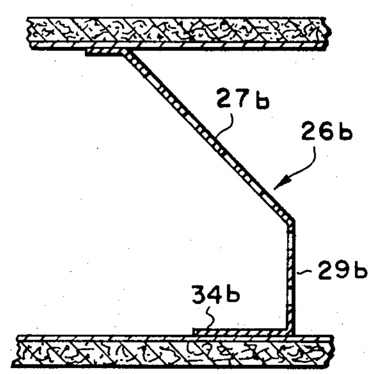

FIG. 6

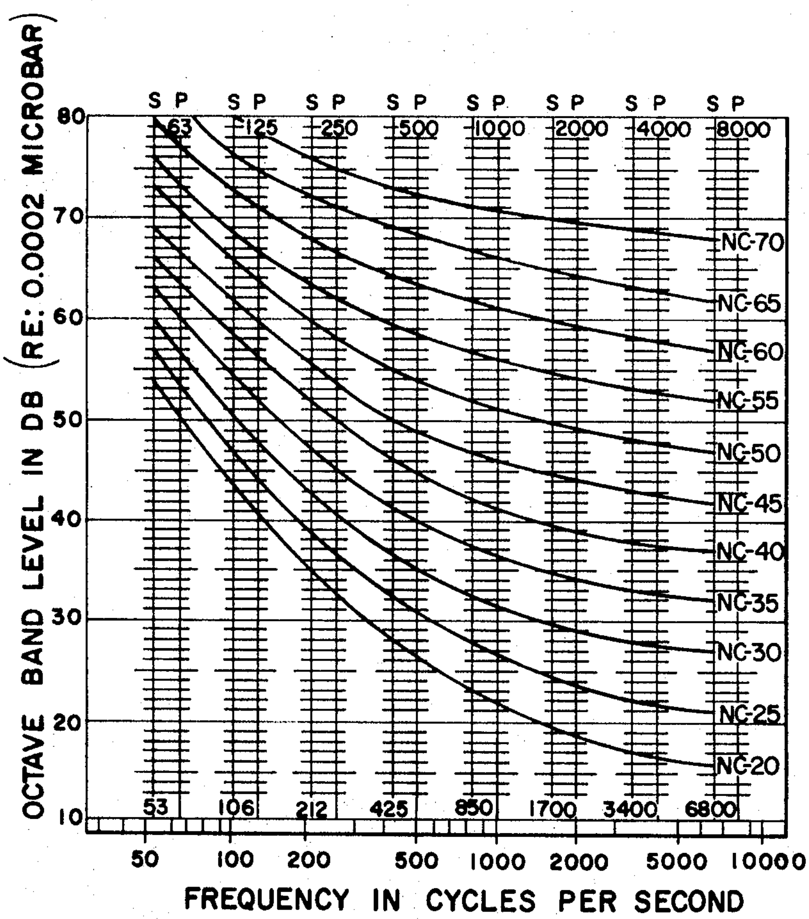

FIG. 7

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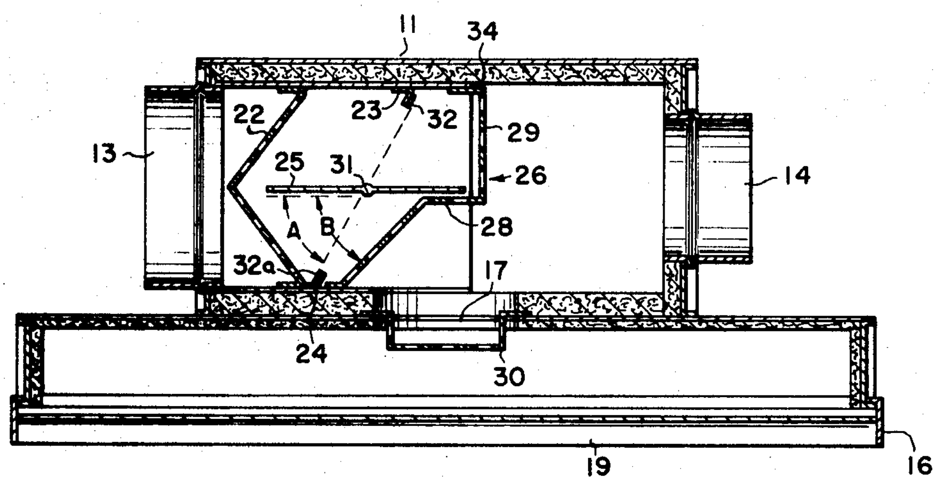

FIG. 8

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AIR DISTRIBUTION APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to air distribution systems generally, and particularly to apparatus for receiving conditioned air from a source and delivering the air to one or more spaces. For example, the invention deals with the distribution of air to offices within an office building, rooms within a school building, and the like.

Various apparatus and methods have been suggested in the art to accomplish the control and distribution of conditioned air to a plurality of spaces in a building. These devices seek to provide for efficient control of the air flow, uniform distribution of air in the spaces, and quiet operation. The present invention provides the aforementioned features in an improved manner which is relatively simple and economical in structure, and which is particularly effective in delivering air at relatively high velocities while maintaining the quiet operation which is particularly desirable.

SUMMARY OF THE INVENTION

The present invention provides an air distribution apparatus including an air control section and at least one air diffuser section in fluid communication such that air flows from the control section to one or more diffuser sections. The control section includes a damper mechanism for throttling air flow through the control section, and at least one sound attenuating baffle which is effective in dampening annoying sounds with the damper mechanism in either an open or closed position, and wherein the baffle is effectively at relatively high air velocities. The air diffuser section is adapted to deliver air in a smooth pattern across the ceiling of the space to provide even, draft-free air distribution.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Certain preferred embodiments of the invention will be described with particular reference to the accompanying drawings, in which:

FIG. 1 is a perspective view, partially broken away, of an air distribution apparatus;

FIG. 2 is a front view in elevation of the apparatus of FIG. 1;

FIG. 3 is a section view taken along line 3—3 in FIG. 2;

FIG. 4 is a section view taken along line 4—4 of FIG. 3;

FIG. 5 is an enlarged section of one form of sound baffle;

FIG. 6 is an enlarged section of another form of sound baffle; and,

FIG. 7 is a chart of Noise Criteria curves.

FIG. 8 is a side view in cross-section showing a preferred arrangement of the apparatus.

In the drawings, an air distribution apparatus is shown generally at 10. The apparatus is made up of control section 11 and diffuser section 12. While the control section 11 and diffuser section 12 are shown to be contiguous, it will be understood that such is not necessary to the present invention, and that diffuser section 12 may be located at some distance remote from control section 11, the two sections in that instance being connected by suitable conduit or ductwork.

Control section 11 and diffuser section 12 are generally rectangular in cross section and are preferably constructed of metal such as galvanized or enameled steel. A layer of sound absorbing insulation 15 is attached to the interior walls of both sections.

Diffuser section 12 includes depending flanges 16 at each longitudinal end thereof which are useful in attaching the diffuser section to the ceiling supports, such as a T-bar, generally provided for installations of this type.

Control section 11 includes an air inlet 13 and air outlets 14 and 17. Outlet 14 may be used to connect control section 11 to an additional diffuser section remotely located from control section 11. Outlet 17 places control section 11 into fluid communication with diffuser section 12 whereby a portion of the air passing through control section 11 passes through outlet 17 into diffuser section 12.

Air passing into diffuser section 12 is distributed throughout the length of the section, and is then delivered to the space through slots 18. The air delivery slots are formed by depending flanges 19, which are preferably semi-octagonal in contour, with a center strip 20 disposed between flanges 19, the center strip 20 having projections 21 extending horizontally in the direction of the flanges. It has been found that the aforementioned configuration is beneficial in delivering the air substantially horizontally along and parallel to the ceiling in the space. Accordingly, the air tends to cling to the ceiling as it travels horizontally under the influence of Coanda effect, resulting in more uniform distribution of conditioned air in the space, whereby annoying drafts are avoided.

Air entering control section 11 through inlet 13 passes through a V-shaped perforated screen 22 which has been found to be useful in dampening the sound of the incoming air. Air flow through control section 11, and subsequently into and through diffuser section 12, is controlled by damper 25 rotatable about rod 31. It has been found that air flow can be effectively controlled when damper 25 is arranged to turn through an angle of about 60° from the fully open to the fully closed positions. To accomplish this, damper stops 23 and 24 are provided, fixed to the interior wall of control section 11, and including sound absorbing pads 32 and 32*a*.

Adjacent damper 25 and downstream thereof there is provided sound dampening baffle 26. Baffle 26 is in the general form of a perforated plate, and is of a particular configuration for best results. The baffle 26 includes an angled portion 27, a horizontal portion 28, and a vertical portion 29, as well as a horizontal projection 34 which is useful in holding the baffle in position as the portion 34 is captured by tab 33 on damper stop 24.

While the specific angle of angled portion 27 may be somewhat varied, it is preferred that this portion be at an angle which is about 0° to 15° from the horizontal less than the angle of damper 25 from the horizontal with the damper in the closed position. For example, if angle A in FIG. 3 is about 60°, it would be preferred that angle B be from about 45° to about 60°.

Inasmuch as portion 28 is substantially horizontal, it can be seen that it will be essentially parallel to damper 25 when the damper is in the open position. It is also preferred that portion 29 be substantially vertical.

After the air has passed through baffle **26**, a portion of the flow will exit through outlet **14** to a satellite diffuser, and a portion of the flow will pass through outlet **17**, through perforated screen **30**, into diffuser section **12**, to be delivered to the space in the manner previously described hereinbefore.

As previously mentioned, it is preferred that sound dampening baffle **26** be of the particular configuration described, as that configuration has been found to be most effective in reducing the types of noise emissions most objectionable to most people. However, some beneficial results can be obtained with slightly different shaped baffles as will be more fully described with reference to FIGS. **5**, **6** and **7**.

An alternative shaped baffle **26*a*** is shown in FIG. **5**. Baffle **26*a*** includes angled portion **27*a***, curved portion **28*a***, and horizontal projection **34*a***. Yet another baffle shape is illustrated at **26*b*** of FIG. **6**, wherein baffle **26*b*** includes angled portion **27*b***, vertical portion **29*b***, and horizontal projection **34*b***.

FIG. **8** is illustrative of an alternative installation of baffle **26** and damper **25** within the air distribution apparatus **10**. In effect, the structure is essentially the same as that illustrated in FIG. **3**, for example, except that the damper mechanism and the sound baffle **26** have been inverted. It will be noted that the essential relationships between damper **25** and baffle **26** have been maintained in that the damper lies adjacent horizontal portion **28** when in the open position, and lies in angular disposition along and spaced from slanted portion **27** in the closed position. In this configuration, damper **25** rotates counter-clockwise from the open to the closed position, rather than clockwise as in the configuration shown in FIG. **3**, for example. Although the sound dampening characteristics of the structure of FIG. **8** are identical to the sound dampening characteristics of the structure of FIG. **3**, the apparatus of FIG. **8** covers an advantage in that outlet **17** can be shifted more toward the center of control section **11**, subjacent slanted portion **27**. The more central location of outlet **17** provides improved distribution to diffuser section **12**.

Various sound measurements were made to gauge the sound dampening effectiveness of various shaped baffles in an air distribution apparatus as illustrated in FIGS. **1–4**. Measurements were made with no baffle downstream of damper **25**, and with baffles of the configurations of baffle **26** in FIGS. **1–4** and FIG. **8**, baffle **26*a*** in FIG. **5**, and baffle **26*b*** in FIG. **6**. The sound measurements, expressed as Noise Criteria (NC) levels, effectively measured at a distance of 3.3 feet from the noise source in a free field over a reflective surface, are tabulated in Table I.

TABLE I

Air Flow Rate (CFM)	Noise Criteria Level (NC) No Baffle	Baffle 26	Baffle 26*a*	Baffle 26*b*
300	44	34	36	36
50	22	24	33	24

Within the science of acoustics, there have been numerous attempts at methods which might be useful to express sound in terms of its effect on people, however, no single method has gained universal acceptance. Within the air handling and distribution industry, the NC level has gained wide recognition, and is an ac-

cepted standard of the American Society of Heating, Refrigeration and Air Conditioning Engineers.

Noise criteria have been developed from detailed studies and engineering experience in a number of architectural spaces. Two of the principal factors which are considered are Speech Interference Levels (S1L) and loudness level (L_n). The S1L is a single number derived by taking the arithmetic average of sound pressure levels in the three octave frequency bands 600–1,200, 1,200–2,400, and 2,400–4,800 cycles per second. L_n, in phons, is obtained by measuring the sound pressure in each of eight octave bands, converting each to loudness in sones, and summing these to obtain a loudness in sones. This can then be converted to loudness in phons, or L_n, by the formula:

$$L_n = 33 \log_{10} N + 40 \text{ phons}$$

where N is the sum of the loudnesses in sones.

The above mentioned factors, and subjective studies of the annoyance level produced by sounds of particular frequency at particular loudness levels, have been combined to produce the NC curves depicted in FIG. **7**. The NC curves are plotted over a graph showing octave band level in decibels on the vertical axis, and sound frequency in cycle per second along the horizontal axis.

As has been indicated, NC levels are, in essence, an objective or empirical expression of a subjective matter. That is, NC levels seek to express the effect on humans of sounds of particular groups of frequencies and loudness levels. In general, the lower the NC level the less noticeable and less annoying the sound represented; the higher NC levels indicating more noticeable and more annoying sounds. Accordingly, with reference to FIG. **7**, it can be seen that for two sounds of equal loudness, the noise criteria level increases with the frequency of the sound. For example, at a level of 40 decibels, a sound at a frequency of 125 cps would have an NC level of about 20 whereas a sound of 4,000 cps would have an NC level of about 42. That is, the latter sound would be approximately twice as noticeable and annoying as the former in the same environment.

Acceptable NC levels for air delivery equipment for different types of environments have been suggested in the industry as general design guidelines. For example, a concert hall--NC **22**, private hospital room--NC **30**, school classroom--NC **35**, general office space--NC **40**, cafeteria--NC **45**, and factory--NC **65**. Viewing Table I, it can be seen without a sound dampening baffle such as baffles **26**, **26*a***, and **26*b***, the NC level at 300 CFM (damper **25** in the open position) was too high for most air conditioning applications. However, with baffle **26**, **26*a***, or **26*b*** installed, the NC level has been brought within acceptable ranges, although some increases were noted at 50 CFM (danper **25** nearly closed).

Thus, the apparatus of the present invention provides for the control and delivery of conditioned air to a space or plurality of spaces in a manner that insures the comfort of the occupants of the space from both a phsyiological and psychological view point by providing for air delivery which is relatively draft-free and does not create annoying background noise.

While in the foregoing specification, the present invention has been described in considerable detail, it will be understood that such detail is for the purpose of illustration and is not intended to limit the scope of the invention, which is defined in the appended claims.

I claim:

1. An air distribution apparatus for providing conditioned air to at least one space, said apparatus comprising:

an air receiving portion having an air inlet and a plurality of air outlets;

damper means disposed in said air receiving portion to vary the volume of air passing through said portion;

a first perforated baffle disposed between said air inlet and said damper means;

a second perforated baffle disposed between said damper means and said air outlets;

and a plurality of air diffuser portions each in fluid communication with one of said air outlets, said diffuser portions including slot means for discharging air therefrom in a flow generally along the ceiling of said space.

2. The apparatus of claim 1 wherein said air receiving portion includes top and bottom walls, and wherein said second baffle slants downwardly and rearwardly from said top wall, thereafter extends substantially horizontally and rearwardly, and thereafter extends substantially vertically downwardly into contact with said bottom wall.

3. The apparatus of claim 1 wherein said second baffle includes a slanted portion, said slanted portion disposed at an angle measured from the horizontal which is from about 0° to about 20° less than the angle at which said damper means is disposed from the horizontal when said damper means is in the closed position.

4. The apparatus of claim 3 wherein said angle of said slanted portion is about 15° less than said angle of said damper means in the closed position.

5. The apparatus of claim 1 wherein said air receiving portion includes top and bottom walls; and wherein said second baffle slants downwardly and rearwardly from said top wall and thereafter smoothly curves downwardly and forwardly into contact with said bottom wall.

6. The apparatus of claim 1 wherein said air receiving portion includes top and bottom walls, and wherein said second baffle slants downwardly and rearwardly from said top wall and thereafter extends substantially vertically downwardly into contact with said bottom wall.

7. The apparatus of claim 1 wherein said air receiving portion includes top and bottom walls, and wherein said second baffle extends substantially vertically downwardly from said top wall to a point about midway between said top and bottom walls, thereafter extends substantially horizontally and forwardly toward said damper means, and thereafter slants downwardly and forwardly into contact with said bottom wall.

8. The apparatus of claim 1 wherein said first perforated baffle comprises a substantially V-shaped perforated plate between said damper means and said air inlet, said first baffle extending substantially across the area of said air inlet.

9. The apparatus of claim 1 wherein said slot means includes a semi-octagonal side and an L-shaped side facing said semi-octagonal side, whereby air passing through said slot means flows along the ceiling of said space.

10. The apparatus of claim 1 wherein said slot means includes two spaced apart semi-octagonal sides and an inverted U-shaped member disposed between said semi-octagonal sides, said U-shaped member having horizontal projections at each tip thereof facing toward a respective semi-octagonal side, whereby air passing through said slot flows along the ceiling of said space in two oppositely directed streams.

11. The apparatus of claim 1 wherein each of said diffuser portions includes a third perforated baffle disposed in the fluid passageways between said air outlets and each of said diffuser portions.

12. The apparatus of claim 1, said second perforated baffle including a slanted portion, a horizontal portion, and a vertical portion, and said damper means including a rotatable damper blade, wherein said slanted portion is disposed at an angle measured from the horizontal which is about 0° to 20° less than the angle at which said damper blade is disposed from the horizontal when said damper blade is in the closed position.

13. The apparatus of claim 12 wherein said angle of said slanted portion is about 15° less than said angle of said damper blade in the closed position.

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