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[73] Assignee **Carrier Corporation**  
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[56]

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[54] **AIR CONDITIONING TERMINAL**  
**4 Claims, 2 Drawing Figs.**

[52] U.S. Cl..... **98/40,**  
**98/41; 137/601; 181/50; 236/49; 251/5**

[51] Int. Cl..... **F24f 13/06**

[50] Field of Search..... **98/40, B, D,**  
**41; 236/49; 181/50; 137/601; 251/5**

**ABSTRACT:** A variable volume ceiling air-conditioning terminal having a diffuser construction to discharge air along the surface of the ceiling for attachment of the air stream thereon to evenly distribute the air within the area being conditioned.

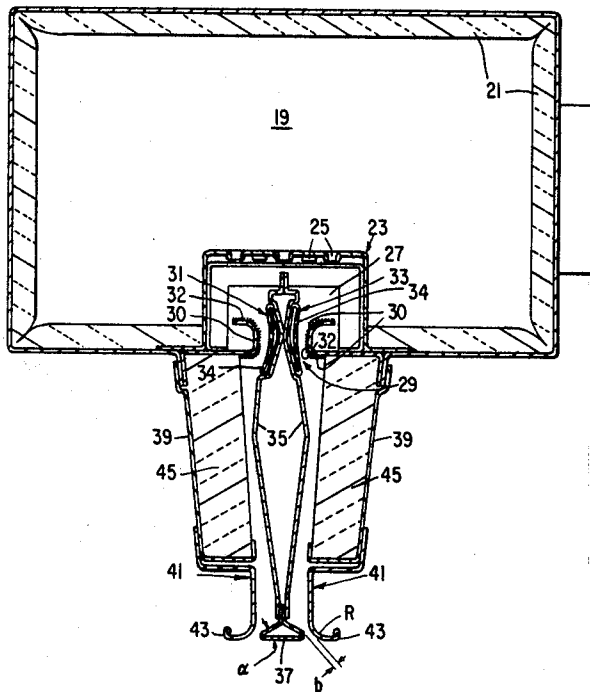
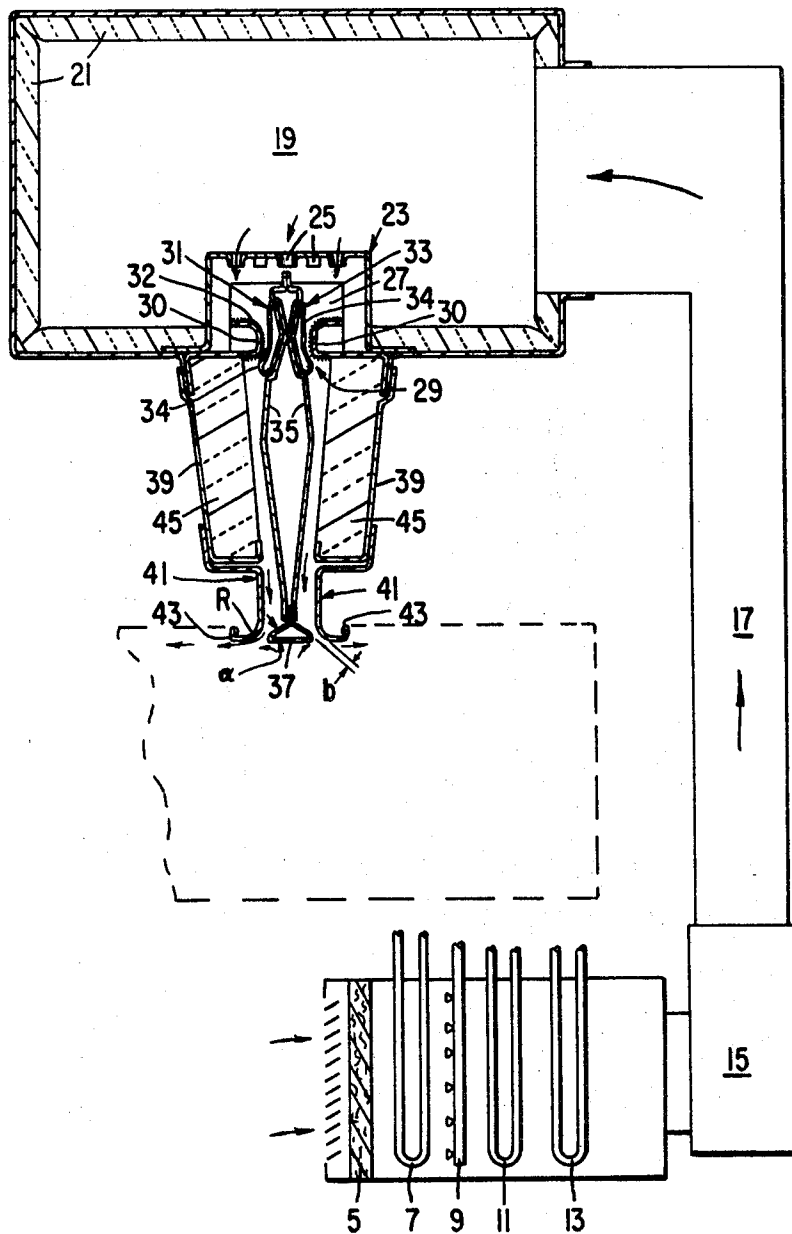


FIG. 1



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## AIR CONDITIONING TERMINAL

## BACKGROUND OF THE INVENTION

In air-conditioning systems utilizing ceiling air terminals, a problem is encountered in evenly distributing the conditioned air throughout the area being conditioned. When cool air is being discharged from the terminal, there is a tendency for the air to drop rapidly before there is a complete mixture of the conditioned air with the room air. Further, to assure that conditioned air is provided to the portions of the area farthest from the terminal, the air may have to be discharged at a considerable velocity which can create excessive noise.

## SUMMARY OF THE INVENTION

This invention relates to a ceiling air terminal having a conduit section adapted for connection to a source of conditioned air. Opposed, parallel walls provide an air passage in communication with the conduit section. The walls have curved end portions with a radius  $R$  which forms an air discharge slot. A triangular diffuser is disposed in said slot having first and second upper walls disposed at an angle between  $0^\circ$  and  $45^\circ$  from horizontal. The diffuser walls are spaced a distance  $b$  from the curved end portions of the opposed walls to provide a  $b/R$  ratio in the range of .10 to .7.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic of a portion of an air-conditioning system illustrating the air terminal of the present invention in section; and

FIG. 2 is an enlarged sectional view of the terminal of FIG. 1.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to the drawings, there is illustrated a central air-conditioning apparatus including a filter 5, precooling coil 7, spray means 9, cooling coil 11, heating coil 13 and a fan 15, for heating, cooling, humidifying and filtering the air as desired, to provide conditioned air for passage to the area being conditioned.

A supply air duct 17 is illustrative of the plurality of ducts provided to supply conditioned air to ceiling air terminals throughout the building. The ceiling terminal includes a primary chamber 19 lined with a sound-absorbing material 21 such as glass-fiber blanket. The primary chamber is ordinarily open at both ends for connecting a series of terminals end to end to provide a complete air discharge system. Suitable end pieces, not shown, are utilized to cap the end terminals in the series. An air supply distribution plate 23 having a plurality of collared openings 25 therein is provided to evenly distribute the supply air from primary chamber 19 into the distribution chamber 27 which is defined by the top and sidewalls of distribution plate 23. To provide an optimum air discharge pattern, the air supplied to the distribution chamber from the primary chamber should have minimal nonvertical velocity components. Since the air supplied to the ceiling terminal is ordinarily introduced horizontally into the end or side of the terminal, there is a large horizontal velocity component to the air stream within the conduit section. The distribution plate employing a large number of collared openings is very effective in providing an efficient, nonturbulent vertical diversion of the air stream from primary chamber 19 into distribution chamber 27. This minimizes noise generation within the terminal. The collars divert the horizontal velocity component of the air stream so that the velocity components of the air stream within distribution chamber 27 are vertical. For an optimum air discharge pattern from the plate, the depth of the collar should approximate the diameter of the collared opening. The depth of each collar is constant throughout the entire circumference thereof to provide a discharge opening parallel to the plane of the distribution plate. In discharging air from an opening, the geometry of the opening itself may have a tendency to effect an attachment of the air stream to a portion of

the wall forming the opening. This attachment can cause the air stream to be diverted in a direction away from the axis of the opening. By providing a collar having a constant depth throughout its circumference, an abrupt detachment of the air stream therefrom is obtained which minimizes the tendency of the air stream to flow in a nonvertical direction within the distribution chamber.

The bottom of distribution chamber 27 includes aligned cutoff plates 29 which are provided with a curved surface 30 for engagement by bladders 31 and 33 to form a damper. The curved surfaces smooth the flow of air through the damper to minimize the pressure drop therethrough when the bladder is fully deflated and provide a low noise level over the entire operating range of the terminal as bladder inflation is varied between a fully deflated position and a fully inflated position. The surface 30 is covered with felt 32 to further minimize noise.

By varying the inflation of the bladders, the area of the openings between the bladders and the cutoff plates can be varied. This feature can be utilized to provide a variety of modes of terminal operation. If it is desired to maintain a constant discharge of air from the terminal, a pressure responsive control may be employed to inflate the bladders in response to supply air pressure to reduce the area between the bladders and cutoff plates as duct pressure increases and to increase the area therebetween as duct pressure decreases. If it is desired to control the terminal to provide a constant room temperature under varying cooling loads, the bladder inflation may be controlled by a thermostat responsive to room temperature to provide an increased quantity of air flow from the terminal as the cooling load increases and a decreased quantity of air flow from the terminal as cooling load decrease.

The bladders 31 and 33 are adhesively mounted on a central partition assembly comprised of opposed, generally convex plates 35 and diffuser triangle 37. The plates have a V-shaped recess therein so that the bladders are completely recessed within the plates when deflated. This provides a large area between the active walls 34 of the bladders and the cutoff plates for maximum air flow therebetween. Further, the recessed bladder provides a smooth surface along the plate 35 to minimize air turbulence.

By reference to the drawings, it can be seen that the walls 34 of the bladder are concave. When the bladders are fully deflated the active walls of the bladders are out of the air stream to minimize the possibility of bladder flutter. By recessing the bladder within the plate 35 and providing the bladder with concave wall 34, the distance between the cutoff plate and wall 34 of the bladder is increased. This provides a greater opening between the bladder and the cutoff plate when the bladder is fully deflated for maximum air flow therebetween. Further, a large movement of wall 34 from a concave to a convex position may be obtained without stretching the bladder material.

The damper mechanism is disposed a substantial distance upstream from the discharge openings in the terminal to provide sufficient space therebetween to absorb any noise generated by the damper mechanism. For maximum sound absorption, downwardly extending walls 39 which form air passages in conjunction with plates 35, are lined with a sound-absorbing material such as glass-fiber blankets 45. Outlet members 41 having outwardly flared lower portions 43 thereon are affixed, as by welding, to the walls 39.

The convex plates prevent direct, straight line passage of sound energy waves from the damper into the area being conditioned. The sound waves generated at the damper strike the sound-absorbing blankets 45 where they are absorbed, to prevent passage of noise from the terminal. The lower portion of the passageway formed between the plate 35 and the wall 39 has a constantly increasing cross-sectional area in the direction of air flow which also aids in the dissipation of sound energy.

For proper air distribution within conditioned area, the discharged air stream should attach and remain attached to

the ceiling to a location remote from the terminal before dropping into the area being conditioned. This assures a supply of conditioned air to areas remote from the terminal. Another advantage is that room air will be induced by the discharged air stream and will mix therewith to temper the stream so that the air stream temperature is not disproportionate to the room temperature, thereby providing even temperatures throughout the area being conditioned.

The ceiling terminal of the present invention is adapted for use in the center of an area being conditioned or for placement above a partition for air flow away from the partition in both directions. This creates a problem in that there is a tendency for the discharged air streams to attach to the partition rather than the ceiling. Since the terminal is adapted for discharging a variable quantity of air, there is also a tendency for the air stream to detach from the ceiling at low flow rates.

A definite relationship between the radius  $R$  of the flared portions 43, the spacing  $b$  between the portions 43 and the diffuser triangle 37, and the angle  $\alpha$  of the upper walls of the diffuser triangle must be maintained to assure that the discharged air stream attaches to the ceiling for proper distribution of air within the air being conditioned. The angle  $\alpha$  therefore should be within a range of  $0^\circ$  to  $45^\circ$  while the  $b/R$  ratio should be within the range of .10 to .7.

For quiet operation of the unit, it is desirable to utilize a diffuser triangle having a large angle  $\alpha$ . However, as angle  $\alpha$  increases, the range of the  $b/R$  ratio to assure attachment of the air stream to the ceiling decreases. For example, with an angle  $\alpha$  of  $45^\circ$ , detachment of the air stream from the ceiling ordinarily is encountered if the  $b/R$  ratio exceeds .25 while an angle  $\alpha$  of  $0^\circ$  while productive of excessive noise, will provide attachment of the air stream to the ceiling as the  $b/R$  ratio ranges from .10 to .7.

In order to provide a unit that is as unobtrusive as possible, and within acceptable noise levels, the preferred embodiment illustrated has a radius  $R$  of one-half inch, a distance  $b$  of 3/16 inch and an angle  $\alpha$  of  $20^\circ$ . This results in a  $b/R$  ratio of .375.

The described ceiling air terminal is capable of efficiently discharging a large quantity of conditioned air at low noise levels with minimal temperature variations within the area being conditioned.

While we have described a preferred embodiment of our invention, it is to be understood that the invention is not limited

thereto, but may be otherwise embodied within the scope of the following claims.

We claim:

1. A ceiling air terminal for use in an air-conditioning and distributing system for discharging air into a space to be conditioned comprising:

a primary chamber adapted for connection to a source of conditioned air;

opposed, parallel walls, associated with said primary chamber to form an air discharge slot, each of said walls having a curved end portion having a radius  $R$ ;

diffuser means disposed within said slot and held in fixed relation to said curved end portion of each of said walls to produce two discharge air streams which will attach to the ceiling adjacent said terminal, said diffuser means having first and second upper walls disposed at an angle in the range  $0^\circ$  to  $45^\circ$  from horizontal, said walls being spaced a distance  $b$  from the curved end portions of said opposed walls to provide a  $b/R$  ratio having a lower limit of .10, the upper limit of the  $b/R$  ratio varying inversely from .70 to .25 as the diffuser wall angle varies from  $0^\circ$  to  $45^\circ$ .

2. An air terminal according to claim 1 including an air distribution chamber associated with said primary chamber; and a distribution plate disposed between said primary chamber and said distribution chamber, said distribution plate having a plurality of openings formed therein for passage of conditioned air from said primary chamber into said distribution chamber.

3. An air terminal according to claim 2 further including means associated with said distribution chamber for regulating the quantity of air discharged from said distribution chamber, said means including an inflatable bladder; and a cutoff plate disposed opposite said bladder for cooperation therewith, inflation of said bladder reducing the area between said bladder and said cutoff plate to reduce the quantity of air discharged from the terminal.

4. An air terminal according to claim 1 wherein said diffuser means is triangularly shaped, the upper walls of said diffuser means is triangle being disposed at an angle of  $20^\circ$  from the base of said triangle, said triangular walls being spaced a distance  $b$  from the curved end portions of said opposed walls to provide a  $b/R$  ratio of .375.

**UNITED STATES PATENT OFFICE**  
**CERTIFICATE OF CORRECTION**

Patent No. 3,554,111 Dated January 12, 1971

Inventor(s) DARWIN G. TRAVER & FRED V. HONNOLD, JR.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 33, "decrease" should read --decreases--

Column 2, line 44, "bladder" should read --bladders--

Column 4, lines 39, 40, Claim 4, "diffuser means is"  
should read --triangle being disposed--

Signed and sealed this 28th day of March 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.  
Attesting Officer

ROBERT GOTTSCHALK  
Commissioner of Patents