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# [54] CEILING AIR TERMINAL

[72] Inventors: **Darwin G. Traver**, De Witt; **Carl C. Herb**, Syracuse, both of N.Y.

[73] Assignee: **Carrier Corporation**, Syracuse, N.Y.

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

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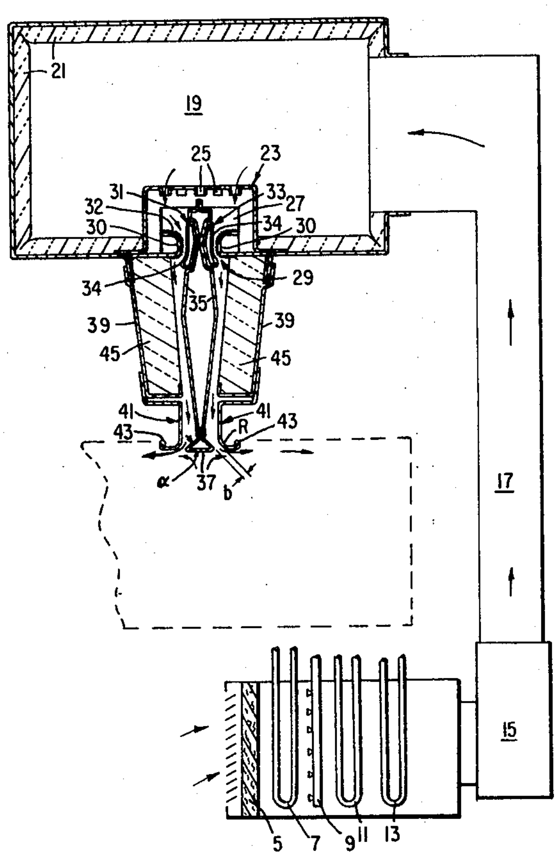
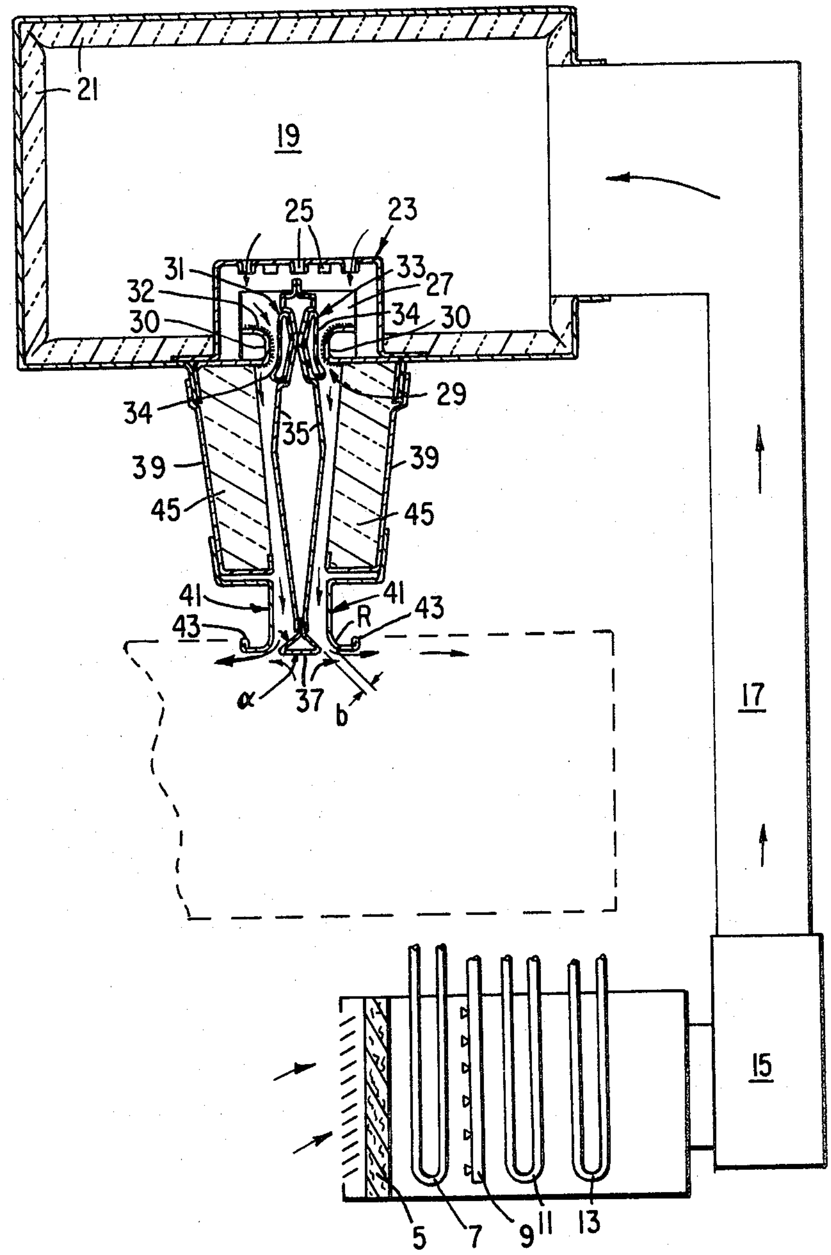
*Primary Examiner*—Albert W. Davis, Jr.
*Attorney*—Harry G. Martin, Jr. and Herman Seid

[57] **ABSTRACT**

A ceiling air terminal employing inflatable bladders for regulating the volume of conditioned air discharged therefrom into the area being conditioned.

**1 Claim, 1 Drawing Figure**






INVENTORS.
DARWIN G. TRAVER.
BY CARL C. HERB.
James E Schardt
ATTORNEY.

## CEILING AIR TERMINAL

### BACKGROUND OF THE INVENTION

In providing conditioned air to an area being conditioned, ceiling air terminals may be utilized which are supplied with air from a central source by ductwork which usually runs horizontally above the ceiling. The ductwork is connected to the terminal at the ends or sides thereof. To obtain the desired air discharge pattern from the terminal, the horizontal air stream should be diverted vertically within the terminal before it passes through the discharge portion of the terminal. It is desirable to divert the air as efficiently as possible to prevent noise generation and minimize fan power required at the central source.

Further, to obtain an accurate control of the temperature in the area being conditioned, a damper mechanism may be provided to regulate the quantity of conditioned air discharged from the unit. In throttling the air passing through the damper mechanism, a further problem with noise generation is encountered.

### SUMMARY OF THE INVENTION

This invention relates to a ceiling type air terminal. More particularly, this invention relates to a ceiling air terminal employing an air diversion plate having a plurality of small, circular collared openings to provide a substantially vertical flow of air to the diffuser portion of the terminal. A damper mechanism including inflatable bladders acting in conjunction with curved cut-off plates, provides smooth, quiet air flow through the terminal. An extended diffuser section downstream from the damper mechanism is lined with sound absorbing material to absorb a large portion of the sound energy waves generated in the terminal.

### BRIEF DESCRIPTION OF THE DRAWING

The drawing is a schematic of a portion of an air conditioning system illustrating the air terminal of the present invention in section.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to the drawing, 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 side walls 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 cut-off plates having substantially horizontal upper sections, substantially horizontal lower sections and substantially arcuate sections between the upper and lower sections, the lower portion **30** of said arcuate sections being adapted for engagement by bladders **31** and **33** to form a damper. The curved surfaces provide a smooth uninterrupted passage therebetween for non-turbulent 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 cut-off 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 cut-off 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 decreases.

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 cut-off 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 bladders 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 cut-off plate and wall **34** of the bladder is increased. This provides a greater opening between the bladder and the cut-off 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 the 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 area being conditioned. The angle $\alpha$ therefore should be within a range of 0° to 45° while the $b/R$ ratio should be within the range of 0.10 to 0.7.

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 for stable air flow decreases. For example, with an angle $\alpha$ of 45°, unstable air flow ordinarily is encountered if the $b/R$ ratio exceeds 0.25 while an angle $\alpha$ of 0°, while productive of excessive noise, will provide stable air flow as the $b/R$ ratio ranges from 0.10 to 0.7.

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 three-sixteenth inch and an angle $\alpha$ of 20°. This results in a $b/R$ ratio of 0.375.

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.** An air terminal comprising:

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

an air distribution chamber associated with said primary chamber;

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 air distribution chamber;

means associated with said distribution chamber for regulating the quantity of air discharged from said distribution chamber, said means including an inflatable bladder;

a cut-off plate disposed opposite said bladder for cooperation therewith, inflation of said bladder reducing the area between said bladder and said cut-off plate to reduce the quantity of air discharged from the terminal, said cut-off plate having a substantially horizontal upper section, a substantially horizontal lower section, and a substantially arcuate section between said upper and lower sections, said bladder cooperating with the lower portion of said arcuate section to reduce the pressure drop between said bladder and said cut-off plate and assure smooth, non-turbulent air flow therebetween for minimal noise generation;

diffuser means associated with the terminal to provide a substantially horizontal discharge of air from said terminal into the area being conditioned, said means for regulating the quantity of air discharged from the terminal being disposed a substantial distance upstream from said diffuser means;

opposed walls defining a space for passage of air from said regulating means to said diffuser means; and

sound absorbing means, affixed to the inner surfaces of said walls to absorb sound generated by said regulating means.

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