Dec. 9, 1969 A. H. SAWYER ET AL 3,482,505

AIR DISTRIBUTING ACOUSTICAL CEILING UNITS AND INSULATING BATTS THEREFOR

Filed April 10, 1968

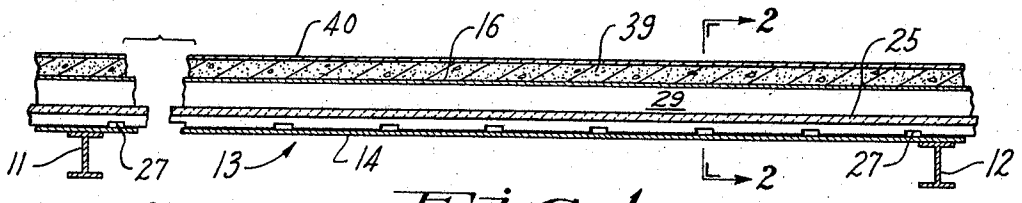


Fig. 1

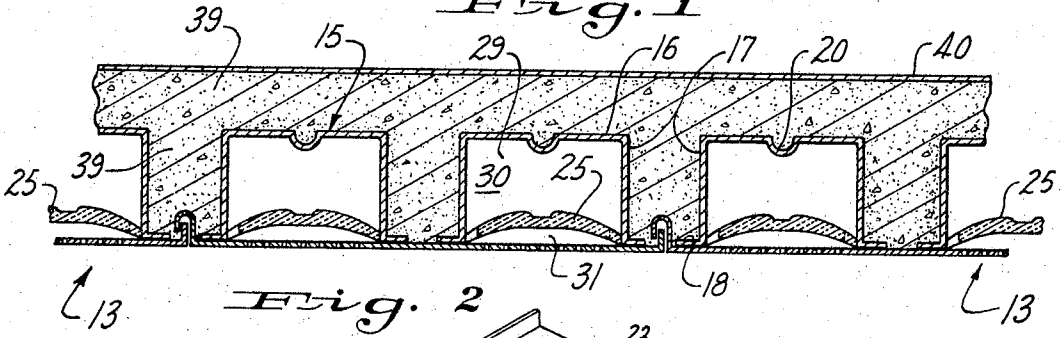


Fig. 2

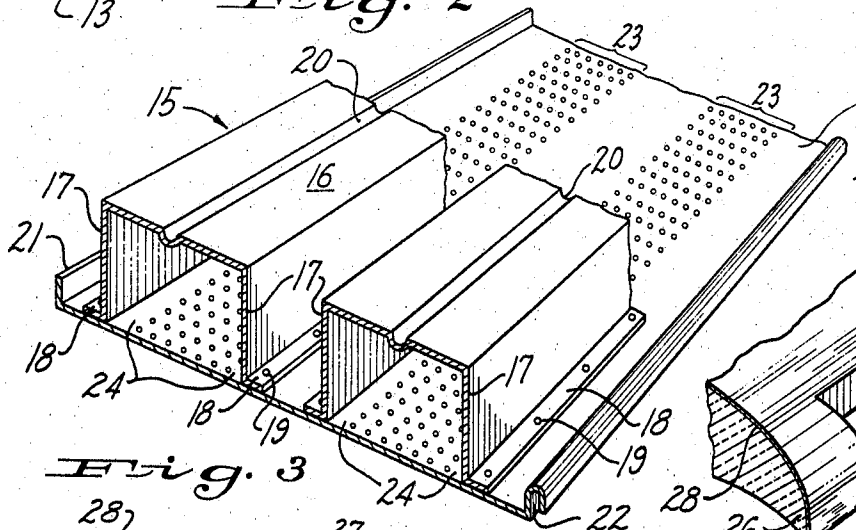


Fig. 3

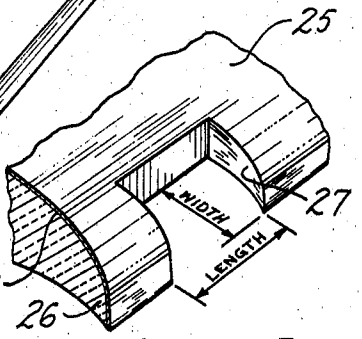


Fig. 7

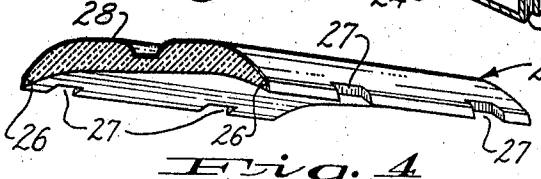


Fig. 4

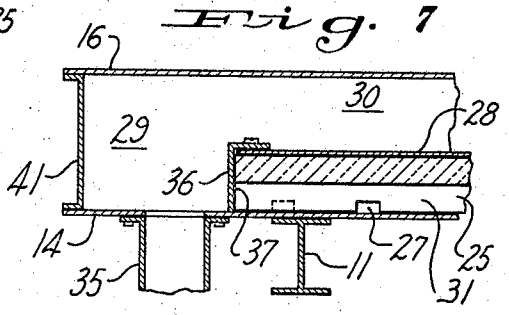


Fig. 6

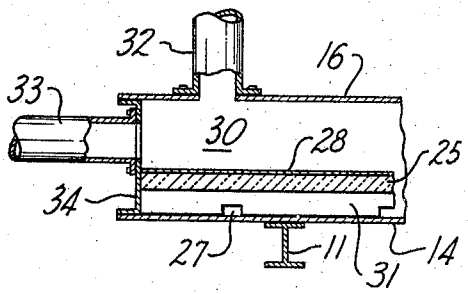


Fig. 5

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AIR DISTRIBUTING ACOUSTICAL CEILING UNITS AND INSULATING BATTS THEREFOR

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U.S. Cl. 98—40 6 Claims

ABSTRACT OF THE DISCLOSURE

An air distributing acoustical ceiling structure for a building and an acoustical batt utilized therein. Sheet metal ceiling units have essentially flat perforated bottom elements fastened to essentially imperforate hat section top elements cooperating to define lengthwise structural cells. Pre-formed batts of acoustical insulation material, arch-shaped in cross-section and having an air-impervious top coating, are installed within selected ones of the cells. Spaced notches are provided along at least one side edge of the pre-formed batts. Air is introduced into the structural cells above the batts and is delivered through the notches and through the perforated bottom element into the subjacent room.

BACKGROUND OF THE INVENTION

Field of the invention

This application relates to novel acoustical insulation batts and to improved structural ceiling units utilizing the same. The improved structural ceiling units are formed from channel-like upper elements and perforated sheet metal bottom elements which cooperate to define lengthwise cells. The cells contain acoustical insulating material which serves to divide the cells into an upper chamber and a bottom chamber. The acoustical insulating material is spaced above the perforations of the bottom element of the structural ceiling unit.

Description of the prior art

Sheet metal structural ceiling units having acoustical energy absorbing properties are well known in the building arts. Typical units include an air distributing variety as shown, for example, in the Meek et al. patent 3,202,078 which provides modifications of such prior art structural ceiling units peculiarly adapted to distributing ventilation air throughout the building in which such units are employed. The general use of perforated ceiling panels for ventilation is discussed by Koestel et al., ASHVE Report 1366, Air Streams From Perforated Panels (1949), ASHVE TRANS., vol. 55, pages 283–298 (1949).

Structural ceiling units without air distributing features are described in the Gruber et al., Patents 2,897,551, 2,924,857 and 3,049,199; and the Dobbins Patents 3,103,410 and 2,944,622. In all of these patents, a perforated bottom element is provided in a structural ceiling unit; a corrugated upper element is secured to the perforated bottom element to create lengthwise cells; acoustical insulation is provided within the cells.

The deficiencies of these two types of ceiling constructions are that the air distributing variety, e.g., Meek et al. Patent 3,202,078, cannot be provided with acosutical insulation for dampening the sounds originating beneath the ceiling in the occupied space of the room; the acoustically insulated ceiling of the type shown in the other references cannot deliver ventilation air into the building rooms.

SUMMARY OF THE INVENTION

According to the present invention, improved acoustical insulation batts are provided for use with structural ceiling units. The overall construction provides acoustical insulation for the subjacent room and also serves as a ventilation air distributing passageway to permit uniform ingress of ventilation air in a relatively quiet manner.

The principal object of this invention is to provide a ceiling construction and an improved acoustical insulation batt therefor which will serve as the structural ceiling or roof of a building, will provide acoustical insulation for the subjacent room and will provide means for ventilation air distribution from the ceiling into the room in a uniform pattern with relatively low noise.

This object is accomplished by providing structural ceiling units having an essentially flat sheet metal bottom element to which one or more channel-like sheet metal upper elements is secured. The essentially flat bottom element is provided with plural perforations in the region beneath the upper element. The interior of the longitudinal cell formed by the bottom element and the upper element is provided with a pre-formed batt of acoustical insulation material which has an arch-shaped cross-section and an air-impervious top coat. The batt has opposed side edges which rest upon the bottom element. Spaced notches are provided along at least one side edge. The acoustical insulation batt divides the longitudinal cell into an upper chamber and a lower chamber. Ventilation air is introduced into the upper chamber of the longitudinal cell above the acoustical insulation. The ventilation air enters the bottom chamber by passing through the notches. The ventilation air leaves the bottom chamber and enters the subjacent room through the perforations of the bottom element.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a cross-section illustration of a sheet metal structural ceiling according to this invention;

FIGURE 2 is a cross-section illustration taken along the line 2—2 of FIGURE 1 showing the present structural ceiling units and acoustical insulation batts;

FIGURE 3 is a fragmentary view of a structural ceiling unit according to the present invention;

FIGURE 4 is a perspective illustration of the acoustical insulation batts which are employed in the preferred embodiment of this invention;

FIGURES 5 and 6 are alternative views of one end section of a ceiling unit illustrating ventilation air ingress; and

FIGURE 7 is a fragmentary illustration of an edge of the present acoustical insulation batt.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The sheet metal ceiling units of this invention are employed as a ceiling and roof component in a modern building, for example, a public auditorium, a gymnasium, school buildings, corridors, commercial stores, office buildings, hospitals, residential buildings such as apartments, display rooms, public rooms, meeting rooms and the like. The ceiling according to this invention is shown in FIGURES 1 and 2 to be spanning the space between structural support members such as horizontal beams **11, 12**. The structural ceiling units, identified by the numeral **13**, constitute hollow panels and include an essentially flat sheet metal bottom element **14** and at least one channel-like sheet metal upper element **15**. The upper element **15** has essentially flat crests **16**, vertical legs **17** and outwardly presented flanges **18** which are secured to the bottom element **14** preferably by spaced spot welds **19**. The upper and bottom elements **15, 14** cooperate to define longitu-

dinal cells **29** which extend over the length of the structural unit **13**. Preferably the crest **16** is rigidized with one or more lengthwise beads **20**. The bottom element **14** constitutes a lower wall and is equipped with connecting means such as a tongue **21** along one edge and a groove **22** along the other edge. The tongue **21** of one unit is adapted to engage groove **22** of the adjacent unit to permit assembly of the structural ceiling units **13** in side-by-side structural relationship. The primary function of the structural ceiling units **13** is to provide a roof or ceiling for the subjacent room or space. Customarily the assembled ceiling units are covered with a top covering **39** which may be foamed plastics materials, light-weight concrete, gravel, et cetera. A weather-resistant outer surface **40** normally is a built-up roofing of felts and bituminous coatings.

The bottom element **14** has a perforated region or band **23** disposed as a band along the length of the bottom element **14** in the region between the vertical legs **17** of the upper element **15**. The perforations in the perforated region or band **23** extend entirely through the bottom element **14** and preferably are disposed in a uniform pattern and are preferably of uniform size from about 0.05 to about 0.25 inch in diameter. It will be observed from FIGURE 3 that the perforated region or band **23** has a width which is less than the distance between the vertical legs **17**. Accordingly, there is provided in the flat bottom element **14**, for each cell **29**, between the vertical legs **17**, at least one imperforate strip **24**. There are two such imperforate strips **24**, for each cell **29**, shown in FIGURE 3, one adjacent to each of the vertical legs **17**. The imperforate strips **24** are presented within the cell **29** along the intersection of a vertical leg **17** with the bottom element **14**.

An arch-shaped, pre-formed acoustical insulating batt **25** is illustrated in FIGURE 4. This batt is a unitary elongated body similar to those described in the above-mentioned U.S. patents: 3,103,410; 3,049,199; 2,944,622; et cetera. These batts **25** preferably are fabricated from loosely aggregated fibers, especially inorganic fibers, and preferably glass fibers, which are lightly coated with a suitable binder, such as a phenolic resin, prior to molding and thereby held together in a form-sustaining relation. The pre-formed batts **25** preferably have leg members **26** along each side thereof. The upper surface of the batt **25** and the lower surface of the batt **25** extend downwardly along the sides from an intermediate or central portion **38** of the batt **25** to form the supporting leg portions. Preferably the density of the batt is greater in the leg members **26** than in the intermediate or central portion **38** of the batt **25**. The arch-shaped cross-section of the batts **25** assures that the central portion **38** is spaced above the perforated band **23**. The leg members **26** rest upon the imperforate strips.

A plurality of notches **27** is provided at spaced intervals along at least one of the leg members **26** of the acoustical batts. The notches **27** are quite small in relation to the total width and length of the batt **25**. The notches are illustrated in FIGURE 7 as rectangular cross-section openings, which is preferred for convenience. The length can be from 0.2 to 2.0 inches and the width from 0.2 to 2.0 inches so long as the vertical projection of the notch in an operative assembly is entirely within an imperforate strip **24**. The notches may have other-than-rectangular cross-sections, of course. The cross-sectional area of each notch is from 0.2 to 2.0 square inches. Collectively the notches have a cumulative cross-sectional area which is less than the cumulative cross-sectional area of the perforations in thesaid perforated lower wall.

The fibrous acoustical batt **25** comprises essentially non-oriented, intermigled filaments and fibers which serve to dampen acoustical energy originating in the room beneath the ceiling. According to this invention, the top surfaces of the batt **25** are coated with an air-impervious film **28** to prevent the entry of air into the batt through the top surfaces. The air-impervious film **28** also minimizes erosion of the fibrous material, resulting from passage of air through the cell **29**. Aluminum foil, adhered to the top of the insulation batt **25**, is a preferred air-impervious coating. Other suitable coatings include foils of other materials; paints; plastic emulsions; plastic films, e.g., polyethylene, polyethylene terephthalate; coated or treated papers or fabrics; and the like.

When the present acoustical batts are installed in the ceiling units as shown in FIGURE 2, the batt **25** serves to divide the longitudinal cell **29** into an upper chamber **30** and a bottom chamber **31**.

The insulation batts **25** may be comprised of a single long length unit or a group of short units abutted end-to-end. Typically, the short units about two feet long are used. Mechanical clips are available in the prior art for connecting together the abutting ends of adjacent units. The impervious coating **28** of adjoining units can be connected by tape, paints, overlaps, adhesives or merely by abutting the unit ends.

In accordance with this invention, ventilation air is introduced into the upper chamber **30** in any convenient manner. As shown in FIGURE 5, the air may be introduced into the upper chamber **30** through a conduit **32** which penetrates the crest **16** or through a conduit **33** which penetrates an end wall closer element **34**. Alternatively, as shown in FIGURE 6, the air may be introduced through a conduit **35** into an opening in the bottom element **14** provided that a suitable closure member **36** is installed within the cell **29** to close off the end **37** of the acoustical insulation batt **25**.

Air introduced into the upper chamber **30** develops a static pressure which is greater than the static pressure in the subjacent room. The air passes from the upper chamber **30** through the plural notches **27** and thence into the bottom chamber **31**. The air passes from the bottom chamber **31** into the subjacent room through the perforations in the perforated region or band **23**.

EXAMPLE

In a typical installation, the side-to-side distance between the vertical legs **17** of the top elements **15** is 9 inches. The tip-to-tip distance between the bottoms of the legs **26** is 8.75 inches. Each of the individual notches **27** has a length (FIGURE 7) of 1-inch and a width of 0.5 inch The notches **27** are provided at 6-inch intervals along one leg **26** and also provided along 6-inch intervals along the other leg **26**. The notches **27** are provided in alternating relationship over the two legs **26**. The perforations in the bottom sheet are ⅛-inch diameter holes spaced 0.379 inch on center in parallel lines separated by 0.328 inch on center. The perforated band is about 7.75 inches wide.

A water-base latex paint coating is applied by roller to the top surface of the insulation batt **25** to serve the air-impervious coating **28**. The latex paint serves to prevent the transmission of air downwardly through the batt itself and also minimizes the erosion of the fibers resulting from the movement of air through the upper chamber 30.

A structural ceiling was assembled as shown in FIGURE 6. The unit was 20 feet long. Suitable end closures **41** were applied to the ends of a cell **29**. An air inlet opening 6-inches by 10-inches was cut into the bottom element **14** adjacent to one end of the unit in the manner shown in FIGURE 6. The perforated region or band **23** was 18-feet long.

Test #1.—Air was introduced into the upper chamber **30** at the rate of 54 cubic feet per minute, corresponding to a flow rate of 3-cubic feet per minute for each lineal foot of the effective structural ceiling. The static pressure in the upper chamber **30** was too small to be measured with the available instrumentation. The air discharge from the under side of the structural ceiling unit was measured with a thermal anemometer. The discharge velocity of the air varied from 1.5% above

average to 2.0% below average flow rate over the entire length of the perforated region or band.

Test #2.—Air was introduced into the upper chamber **30** at the rate of 180-cubic feet per minute corresponding to a flow rate of 10-cubic feet per minute for each lineal foot of the effective structural ceiling. The static pressure in the upper chamber **30** was measured as 0.02 to 0.04 inch (water). In this test, the variation of air discharge velocity through the perforations ranged from +9% to −6% deviation from the average flow rate.

SUMMARY

With the construction herein described, a building can be provided with an acoustical-absorbing ceiling through which ventilation air can be introduced. It should be observed that not everyone of the structural ceiling cells must be equipped as a ventilation air inlet device. Instead, it is contemplated that perhaps only one-tenth to one-third of the structural ceiling cells will be employed as a ventilation air distributing device. In a typical building, one ceiling cell out of every five in the building is equipped as an air inlet unit. The remaining four cells out of five cells are merely acoustic-absorbing units similar to those shown in the aforementioned U.S. patents: 3,103,410; 3,049,199; 2,944,622; 2,924,857; 2,897,551.

In the preferred embodiment of this invention, the imperforate strips **24** are provided on each side of each of the perforated regions or bands **23** whereby each of the legs **27** of the acoustical insulation batt **25** rests directly upon an imperforate strip **24**. Accordingly, the present notches **27** can be, and preferably are, provided in both of the legs **26** as described. It should be apparent, however, that all of the notches **27** could be provided in a single one of the legs **26** which can be identified as a "first leg." In this situation, the "first leg" rests on an imperforate strip **24**. The other leg **26**, identified as the "second leg," would not require an imperforate strip **24** and, accordingly, only a single imperforate strip **24** would be needed. Two imperforate strips **24**, of course, may be provided as is shown in FIGURE 3. The notches **27** should be disposed directly above one of the imperforate strips **24**. Otherwise, the velocity component of the ventilation air passing downwardly through the notches **27** will allow the air to be discharged directly through aligned perforations and the desired uniform distribution of ventilation air along the length of the structural ceiling unit will not be achieved. The imperforate strips **24** avoid the objectionable aligned perforations.

We claim:

1. A structural ceiling construction including acoustical absorption features and ventilation air distributing features comprising:

spaced horizontal supports;

a plurality of structural ceiling units assembled in side-by-side relation upon said horizontal supports;

each of said structural ceiling units comprising:

an essentially flat sheet metal bottom element;

lengthwise connecting members along opposed sides thereof;

at least one channel-like sheet metal upper element having an essentially horizontal crest, vertical legs and horizontal flanges, said horizontal flanges being secured to the said bottom element whereby each of the said structural ceiling units includes a lengthwise longitudinal cell for each of said upper elements;

the area of said bottom element between the said vertical legs, including a perforated band, comprising plural perforations extended through the said bottom element and also including at least one imperforate strip which is located between an edge of the said perforated band and a said vertical leg;

an acoustical insulation batt disposed within said structural cell and having a central portion and a lateral depending first leg portion along one side thereof and a laterally depending second leg portion along the other side thereof, the said leg portions resing upon the said bottom element with the said first leg portion resting upon a said imperforate strip, a plurality of spaced-apart notches in said first leg portion;

the top surface of said batt being coated with a gas-impervious coating; and

means for introducing air under pressure into the enclosed space between the said batt and the said upper element.

2. The structural ceiling construction of claim **1** wherein the said notches are provided in both of said leg portions and a said imperforate strip is provided adjacent to each of said vertical legs for supporting the said leg portions.

3. The structural ceiling construction of claim **1** wherein the cumulative cross-sectional area of the said spaced-apart notches of the acoustical insulation batt is less than the cumulative cross-sectional area of the perforations in the subjacent perforated band of the said bottom element.

4. In an acoustical insulation batt for use in a hollow panel having a perforated lower wall, said batt being a unitary elongated body composed of loosely aggregated fibers lightly held together in a form-sustaining relation, the upper and lower surfaces of said body along the edge portions thereof extending downwardly from an intermediate portion of said body and forming supporting leg portions for said member, said downwardly extending leg portions having substantially greater density than the density of the intermediate portion of the member between the said legs, the improvement comprising:

a plurality of spaced-apart notches in the bottom ends of the said leg portions, the said notches individually having a cross-sectional area of 0.2 to 2.0 square inches and collectively having a cumulative cross-sectional area which is less than the cross-sectional area of the perforations in the said perforated lower wall; and

an air-impervious coating covering the upper surface of the said acoustical insulation batt.

5. The improvement of claim **4** wherein the said air-impervious coating is a metal foil.

6. The improvement of claim **4** wherein the said air-impervious coating is a coating of paint.

References Cited

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3,074,339	1/1963	Pennati	52—145 X
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JOHN E. MURTAGH, Primary Examiner

U.S. Cl. X.R.

52—145; 161—119; 181—33