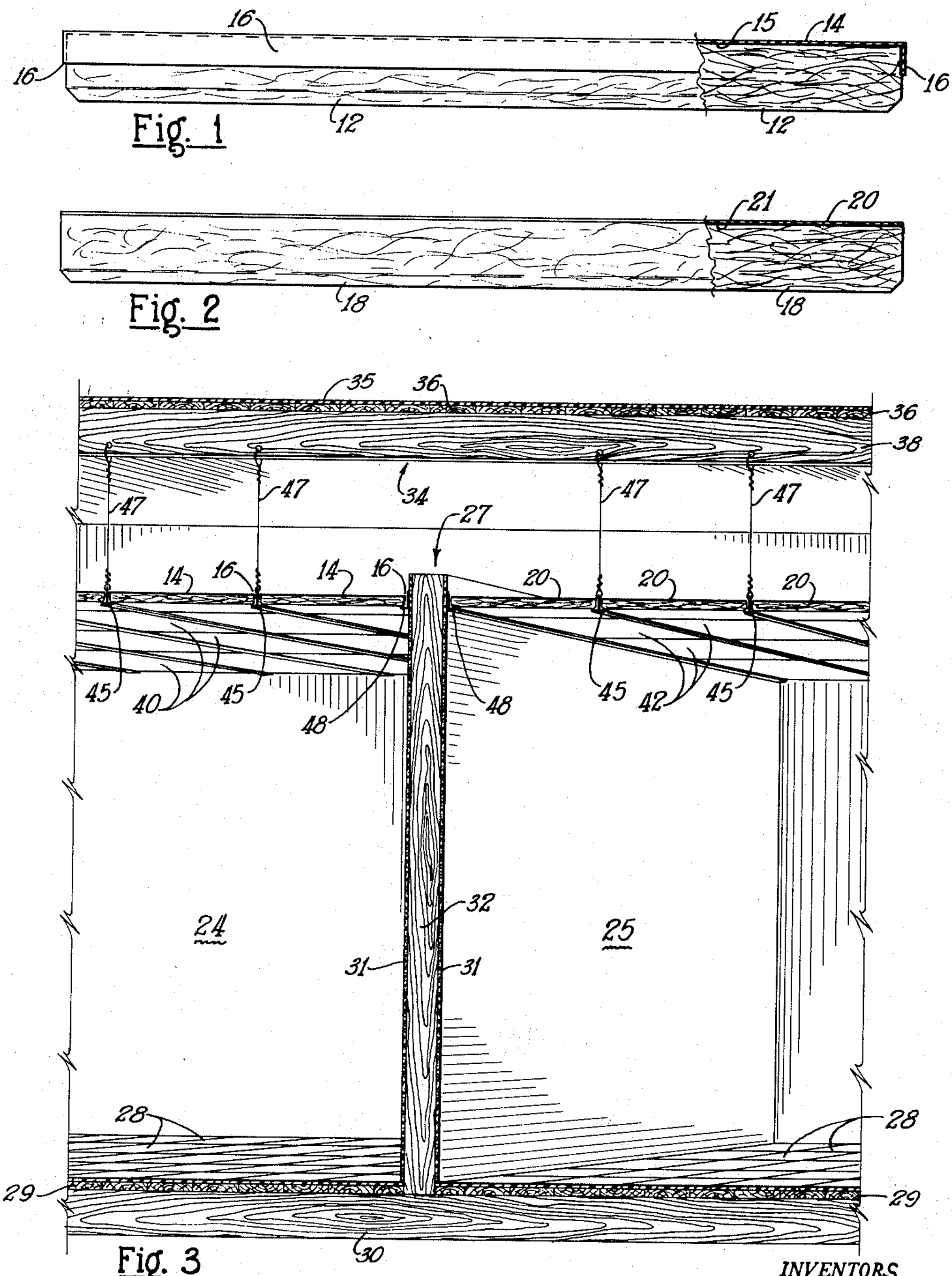
Feb. 25, 1964 R. W. BOLTZ ETAL 3,122,216

ACOUSTICAL CEILING PANELS

Filed March 21, 1960



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United States Patent Office

3,122,216
Patented Feb. 25, 1964

3,122,216
ACOUSTICAL CEILING PANELS

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Filed Mar. 21, 1960, Ser. No. 16,308
5 Claims. (Cl. 181—33)

The invention relates generally to sound absorbing panels or acoustical tiles for mounting upon walls or installed upon or to form ceiling structure. The invention pertains particularly to ceiling panels adapted for mechanical suspension as sound absorbing and transmission reducing media above adjacent rooms.

Such acoustical panels are customarily compressed boards of wood fibers, shredded wood, wood pulp, cane fibers, cork granules, gypsum, rock wool or glass fibers. A popular size is twelve by twelve inches in broad dimensions and one-half inch thick. The panels are also available in thicknesses up to two inches and with planar dimensions in multiples of twelve inches.

Those of light weight when no larger than twelve inches square are most commonly attached directly to wall and ceiling surfaces by spots of adhesive. Staples and nails are frequently employed for securing in place the heavier and broader units to furring strips.

In ceiling treatment the acoustical panels may be installed upon a grid suspension system hung below the permanent ceiling structure. This arrangement may improve the dimensional proportions of a room as well as add to the attractiveness of the ceiling. The air space above the sub-ceiling of panels contributes to the sound absorbing properties of the installation.

In business offices, such a suspended acoustical ceiling is interrupted by partitions between rooms which extend up to but generally not above the level of the panels. For purposes of preserving the privacy of the individual office areas, the intervening partitions should be of a nature to reduce transmission therethrough preferably as much as thirty-five decibels. This rating indicates a loss in transmission sufficient to reduce the loudness level from one side to the other side of the wall the specified number of decibels.

Decibel units are conventionally used to roughly indicate the response by the ear to noise and are equal in number to ten times the logarithm of the ratio of the intensity of the sound in watts per square centimeter to the standard reference intensity of 10^{-16} watts per square centimeter at the low limit of human perception.

Of the various commercial acoustical products available, those of mineral fibers, particularly glass fibers are most highly regarded. Their sound absorption is very effective because of the porosity derived from the high number of communicating air cells in the maze of fibers. In contrast to panels of organic components, they are non-combustible and unaffected by moisture. They also have the advantage of being comparatively light in weight as well as having superior sound absorbing capacity.

When acoustical panels are applied to walls and directly upon a ceiling surface, the transmission of sound energy through the panels is ordinarily not of too serious a nature as the further travel of the sound is quite effectively curtailed by the mass of the structures upon which they are mounted.

However, where the panels are suspended below the regular ceiling, there is normally nothing to interfere with the continued upward movement of sound waves traveling through the panels. This piercing action may not be too serious with the more solid type of panels such as the more compacted organic products and those of gypsum as these panels are not so easily penetrated by waves.

Acoustical panels of bonded fibrous glass have noise absorbing coefficients as high as .99. This coefficient is the fraction of complete absorption of incident air-borne sound. Being highly porous, however, these panels allow a certain proportion of incident sound waves to pass therethrough. This permeable property may have objectionable consequences in false ceiling installations above adjoining rooms which are otherwise quite satisfactorily separated acoustically by partitions and by close fitting doors.

In such a situation, the sound waves emerging upwardly from the panels covering one room upon impinging against the surface of the permanent ceiling are reflected down and enter the adjacent room through the panels thereover. If of sufficient intensity, the overall transmitted sound may not only be annoying, but may also carry conversation of a confidential nature.

This problem may be minimized by backing the panels of glass fibers with other material such as gypsum or other heavy plaster boards. The sound movement is thus considerably reduced. However, the added cost of the extra material and labor is objectionable.

It is accordingly a prime object of this invention to provide a low cost, light weight acoustical panel of mineral fibers, and one preferably of glass fibers, adapted for mechanical suspension and which adequately deters the transmission of sound waves while retaining excellent properties of sound absorption.

More particularly, it is an object of this invention to provide a panel of mineral fibers which has on its rear face an integrated impervious membrane.

Another object of this invention is to provide ceiling treatment for adjoining rooms in which panels of mineral fibers, having a sealing membrane on their rear faces, are suspended below a common air space above such adjoining rooms.

It is a further object of the invention to provide an acoustical panel of bonded mineral fibers having an impervious membrane attached to its rear face and to the side edges thereof, the membrane being of a character to block the passage of sound waves therethrough and also from the edges thereof into adjoining panels.

Another object of the invention is to provide an acoustical panel for installation below an air plenum, said panel having a membrane on its rear face not only capable of blocking movement of sound waves therethrough, but also tightly impervious to air whereby the plenum may be used for a supply chamber or passage for air in a ventilating system.

The objects of this invention are primarily attained through the placing of a membrane on the back side of otherwise standard types of acoustical panels of bonded glass fibers. More specifically, the objects of the invention are secured by uniformly adhering an elastic and impervious membrane to the rear face and side edges of an acoustical panel.

The invention will be more fully understood and further objects and advantages thereof will become more apparent with reading of the detailed description which follows and referring to the accompanying drawings, in which:

FIGURE 1 is a side elevation, with a portion shown in vertical section, of an acoustical panel embodying this invention;

FIGURE 2 is a similar showing of an acoustical panel of a modified form embodying the invention; and

FIGURE 3 is a perspective view through a vertical section of two adjoining rooms over which panels of the invention have been suspended to form a sub-ceiling.

Referring to the drawings in more detail, the panel of FIGURE 1 has a main body portion 12 composed of bonded glass fibers. From the standpoint of lightness and acoustical effectiveness of the body portion 12, glass fibers of a diameter in the range between twelve and twenty-two hundred-thousandths of an inch serve most satisfactorily.

Fibers of still smaller diameters would enhance some properties of the product, while fibers of larger diameters, up to more than seventy hundred-thousandths, give quite adequate results and may be more practical for some commercial purposes.

The size of the fibers is determined by the type and control of the forming equipment utilized. Such apparatus ordinarily employs air, steam or combustion gases for attenuating molten threads of glass issuing from small orifices. The fibers are collected at the forming station in blanket form with an uncured binder component dispersed therethrough.

A resin combination of melamine and phenol formaldehydes, in a proportion of roughly one to two, constitutes a very satisfactory binder. The amount of binder may run between nine and twenty-six percent by weight of the finished panel, depending upon the balance desired between strength and fire protection in the product. Various other fibrous glass bonding agents are well known and would be quite equally effective. These include epoxy, urea, and polyester resins.

The density of the fibrous body portion of the panels generally runs between nine and fourteen pounds per cubic foot as compared with densities from fifteen to twenty-four pounds per cubic foot for the panels of compressed cellulosic fibers.

Upon the upper or back surface, and also upon the side edges of the panel shown in FIGURE 1, is a membrane 14 which is preferably an aluminum foil which is firmly attached to the main body 12 by an adhesive 15. The membrane tightly seals the rear face and edges of the panel.

For the purpose of this invention, the membrane 14 should be non-vibratile, of an elastic nature and thoroughly adhered to the panel. It should further be strong and fully impervious to air.

The membrane may be composed of a metal film such as an aluminum foil adhesively attached to the body of the panel. An aluminum foil with a thickness of about four ten-thousandths of an inch serves very satisfactorily. The adhesive providing such attachment may be separately applied or be a thermoplastic film such as polyethylene previously joined through tissue to the metal foil. This laminate may be attached to the panel by hot pressing.

Alternately, the membrane may be an elastic, synthetic plastic sheet of film, either self adhered through heat treatment or adhered with an intermediate adhesive. Plastic films which have the desired qualities of elasticity and strength include the non-rigid, vinyl chloride polymers and copolymers, vinyl chloride polymer-nitrile rubber blend, and polyethylene. Such films are preferably at least five thousandths of an inch in thickness.

An adhesive which functions well in this service is an elastomer cement type having a synthetic rubber base in a somewhat higher proportion of a ketone solvent. It has high strength and excellent adhesion and is resistant to vinyl plasticizers, oil and other aliphatic hydrocarbons. Various other thermoplastic, thermosetting and elastomeric adhesives would perform quite effectively and are available in liquid form permitting their application by spray or roller. Care should be taken to insure uniform attachment of the membrane to the panel.

The opposite or front face of the panel may be covered with a porous film of paint with decorative and light reflecting properties. This paint has little resin, latex or other binding components as those ingredients would tend to make the coating impervious to air. Porosity is required to permit the entry of sound waves into the absorbing panel of glass fibers.

The alternate form of panel shown in FIGURE 2 has a main body 18 and a back sealing membrane 20 shown adhered to the body 18 by an adhesive layer 21. This panel does not have the sound shielding extension 16 of the plastic film or metal foil on the side edges thereof as does the panel of FIGURE 1.

In FIGURE 3 is illustrated two adjacent rooms 24 and 25 separated by a partition 27. As shown each room has a tile flooring 28 laid upon a wood sub-flooring 29 supported upon joists 30. The partition 27 will be considered to have outer layers 31 composed of metal lath and lime plaster applied against wood studs 32.

The permanent ceiling 34 has an upper covering or roof 35 laid on planks 36, the latter being supported upon joists 38. A sub-ceiling utilizing panels of this invention is suspended above each of the rooms 24 and 25 below the top edge of partition 27.

The panels 40 installed in room 24 are of the type illustrated in FIGURE 1 having a back side and edge sealing membrane. The panels 42 mounted in room 25, for purposes of illustration, are of the design of the panels depicted in FIGURE 2.

The panels in both rooms are supported on inverted T-beams 45 which are held in place by wires 47 from the joists 38. The panels are supported along the partition by angled brackets 48.

It will be presumed that the partition 27 is in itself a satisfactory sound barrier between the rooms 24 and 25. As constructed with wood studs and with metal lath and lime plaster, this wall may have a transmission loss in the region of thirty-five decibels. This curtailment of sound travel is sufficient to reduce the noise level of loud conversation to that of quiet whispering. It would also be the equivalent to the difference between the level of an office with typewriters and that of a quiet living room.

Since the partition 27 does not extend up to and join the standard ceiling 34, sound would travel between the rooms above the partition unless this transmission path is otherwise blocked.

As previously stated conventional acoustical panels of mineral fibers are not effective as a barrier for this purpose. However, with the panels 40 and 42 constructed according to this invention installed in the suspended ceiling, a sound transmission loss approaching that provided by panels two or three times as heavy may be attained in this area without impairing the function of the fibrous glass panels in serving as excellent sound absorbing media.

It should be considered, however, that there are two separate ceilings of the suspended back-sealed panels through which sound must pass in either direction and that their suppression action is additive with each contributing an important part.

Either with or without the back sealing layers upon the panels, the transmission loss would vary depending upon the size of the upper air space and the nature of materials of the standard ceiling, but without the back sealing layers the loss might be no more than fourteen decibels.

It may be concluded therefore that the addition of the sealing membrane may be employed to increase the sound transmission loss through this overhead path as much as two or three hundred percent. This transmission loss is superior to that accompanying the use of the ordinary, less absorbent panels of organic fibers. At the same time the sealed panels of mineral fibers retain their original light weight, and their superior sound absorbing performance is affected, at most, to only a slight degree.

It is natural that better noise isolation is secured with acoustical panels back-sealed according to this invention with base panels of increased thickness. This is due to the greater absorption provided by the extra depth. Also, heavier sealing membranes slightly improve the sound shielding action of the panels because of the added mass.

Experience has shown that reduction of sound transmission is obtained by increasing the mass per unit area of a partition, by constructing the partition of material having a large resistance to bending, or by the use of double partitions, vibrationally isolated.

The addition of mass to the sealing layers of the panels of this invention has, of course, limited possibilities. Reliance on effective performance has been placed principally on constructing the sealing membranes with low vibratile properties. Also it is concluded that the two separate ceilings of the back sealed panels contribute to transmission reduction by acting as double partitions, vibrationally isolated.

The side edge coverings 16 reduce direct sound transmission and make the panel installation more impervious to air movement. This is particularly advantageous if the space above the panels is used as a chamber or passage for ventilating air. Should the space be employed as a path for heated or cooled air, the reflective heat insulating properties of the metal foil backing is of value. Besides their acoustical and thermal properties, the membranes prevent the settling of dust through the panels.

As previously set forth herein, the membranes must be impervious and be as non-vibratile as possible in order not to transmit sound energy. Both the metal foil and plastic films have negligible gas permeability. The plastic membranes are generally of an elastic nature which opposes vibration in response to sound pulsations while the metal foil is held against vibration by the polyethylene film or other elastic adhesive by which it is uniformly secured to the panel. The adhesives which may be used with the plastic films also may contribute to their resistance to vibrational forces.

While the invention has been described in connection with panels having a porous, decorative coating of paint deposited on the outer facing, it is also quite equally suitable for panels having a tight, washable outer coating of paint with spaced holes, through which sound waves are admitted. Likewise, the rear sealing membrane may be applied to panels faced with an unattached film which transmits sound by vibration to a panel interior as well as to panels with the outer facing left unfinished.

Having described the invention in detail and with reference to particular materials, it will be understood that such specifications are given for the sake of explanation and various modifications and substitutions other than those cited may be made without departing from the scope of the invention as defined in the following claims.

We claim:

1. An acoustical panel adapted for installation in closely abutting relation having a main, generally rigid and self-sustaining, porous body of mineral fibers integrated by a hard, non-elastic resinous binder, a sound admitting surface on the front planar side of the body and an air impervious, non-vibratile, sound backing membrane continuously and elastically attached to the rear planar side of the main body of mineral fibers.

2. An acoustical panel according to claim 1 in which the membrane is composed of an elastic, polymerized resin material.

3. An acoustical panel according to claim 1 in which the membrane extends down and is continuously attached to the side edges of the body.

4. An acoustical panel according to claim 1 in which the membrane is attached to the body by an elastic synthetic resin, distinct from the resinous binder by which the main porous body is integrated.

5. An acoustical panel according to claim 4 in which the membrane is an aluminum foil less than one mil in thickness.

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