June 17, 1958 H. J. SABINE 2,838,806

FIREPROOF ACOUSTICAL CORRECTION PANELS

Filed June 18, 1957 5 Sheets-Sheet 1

Fig. 1.

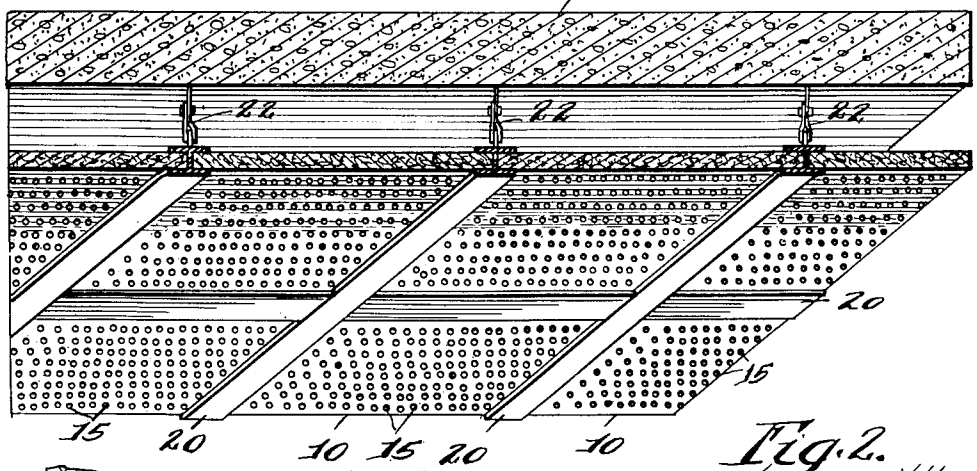


Fig. 2.

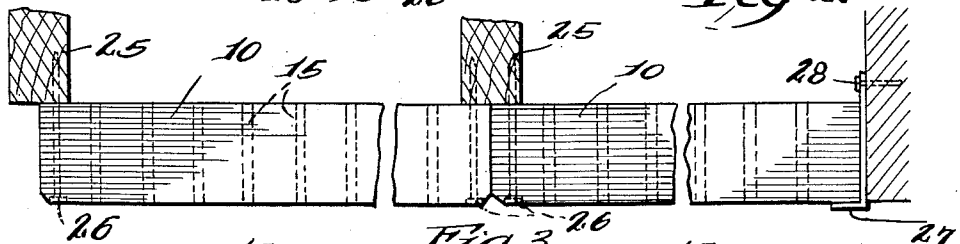


Fig. 3.

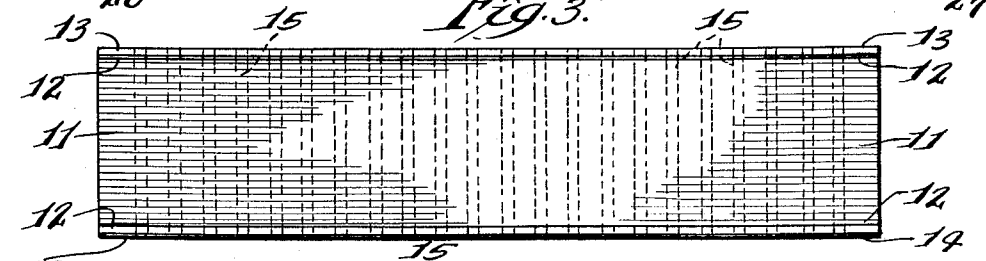
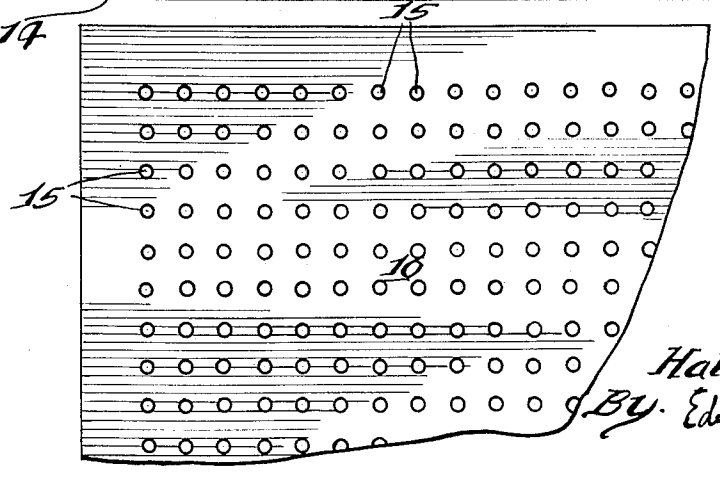


Fig. 4.



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FIREPROOF ACOUSTICAL CORRECTION PANELS

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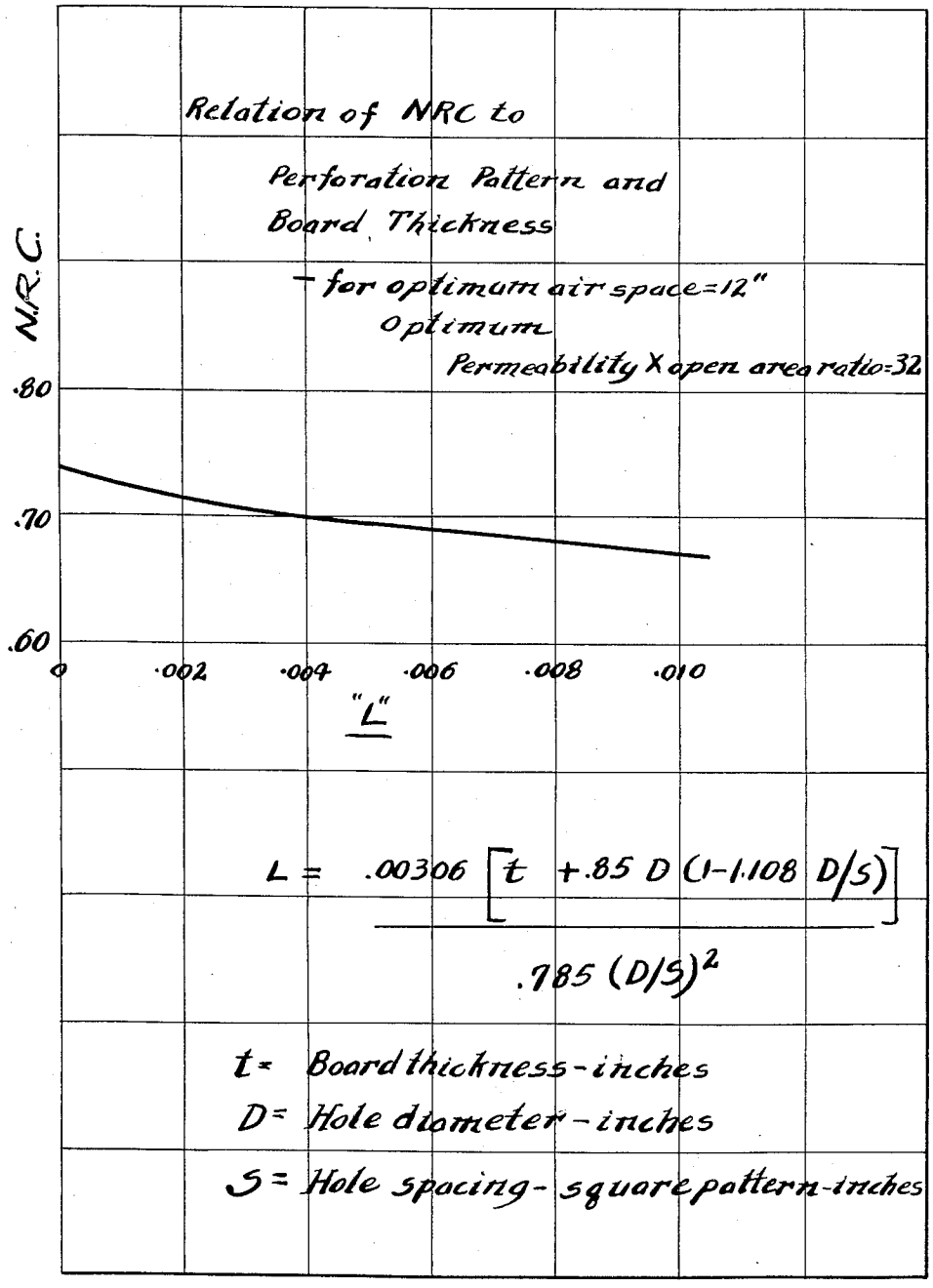


Fig. 5.

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FIREPROOF ACOUSTICAL CORRECTION PANELS

Filed June 18, 1957 5 Sheets-Sheet 3

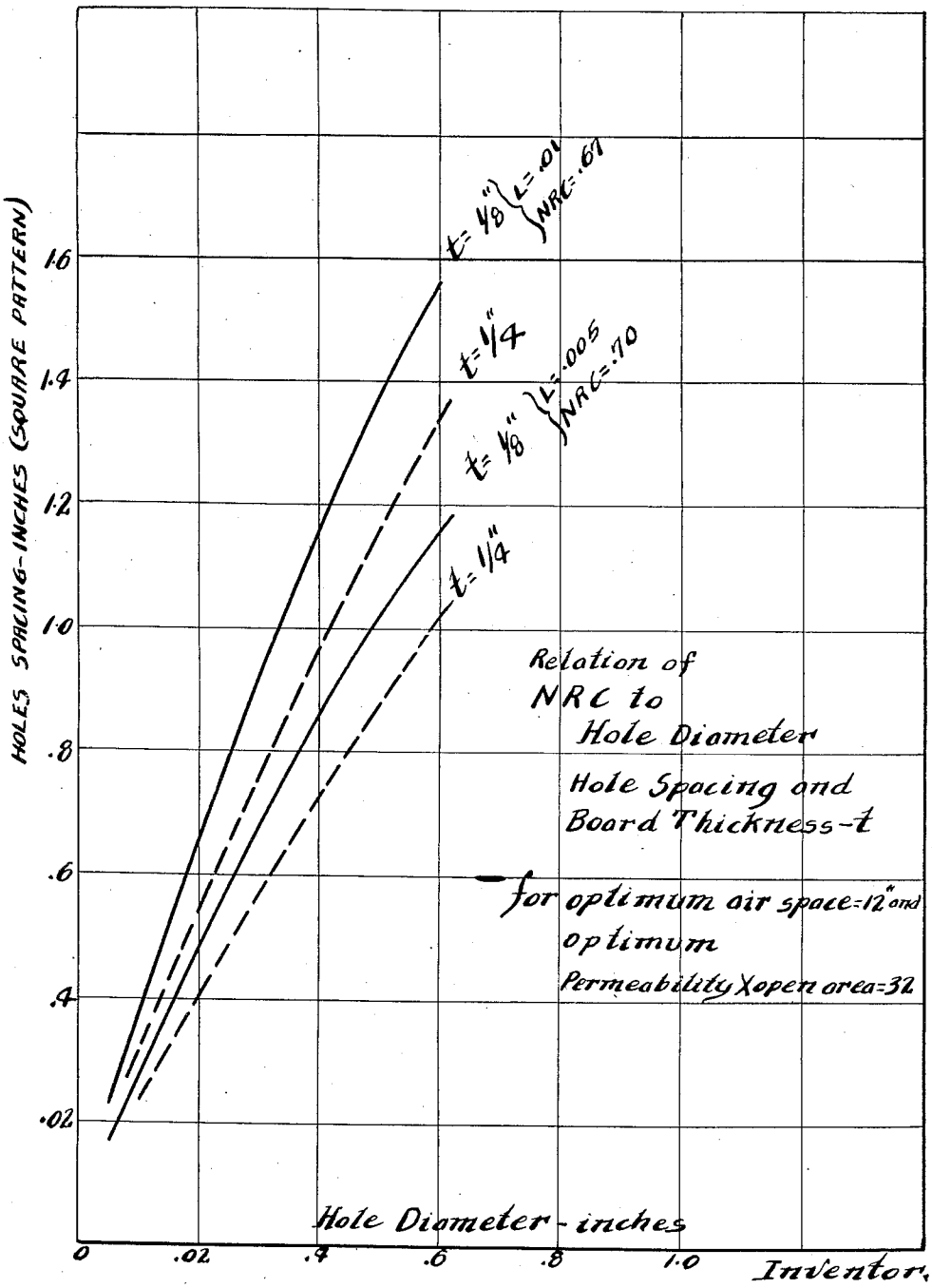


Fig. 6.

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FIREPROOF ACOUSTICAL CORRECTION PANELS

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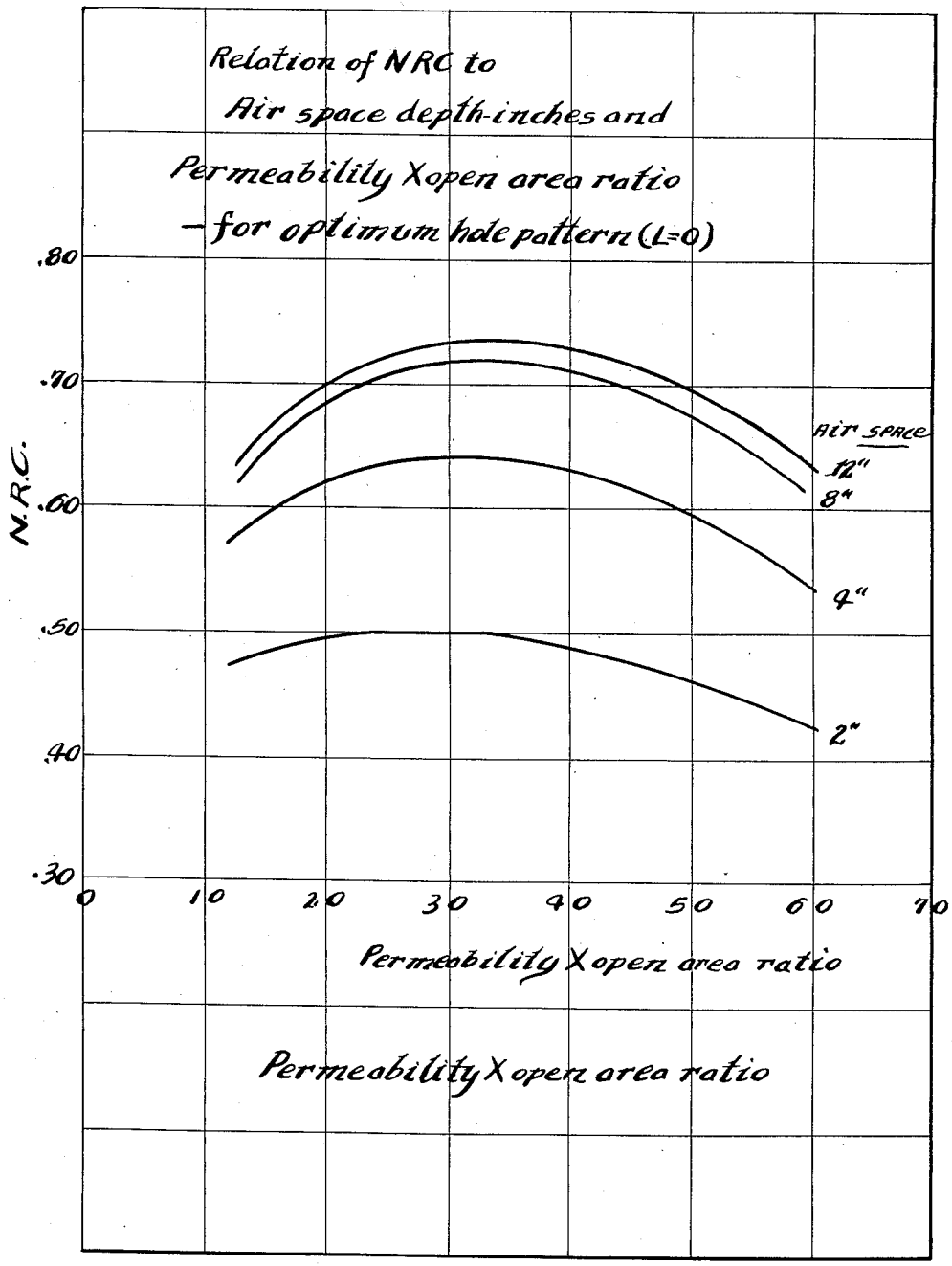


Fig. 7.

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June 17, 1958 H. J. SABINE 2,838,806

FIREPROOF ACOUSTICAL CORRECTION PANELS

Filed June 18, 1957 5 Sheets-Sheet 5

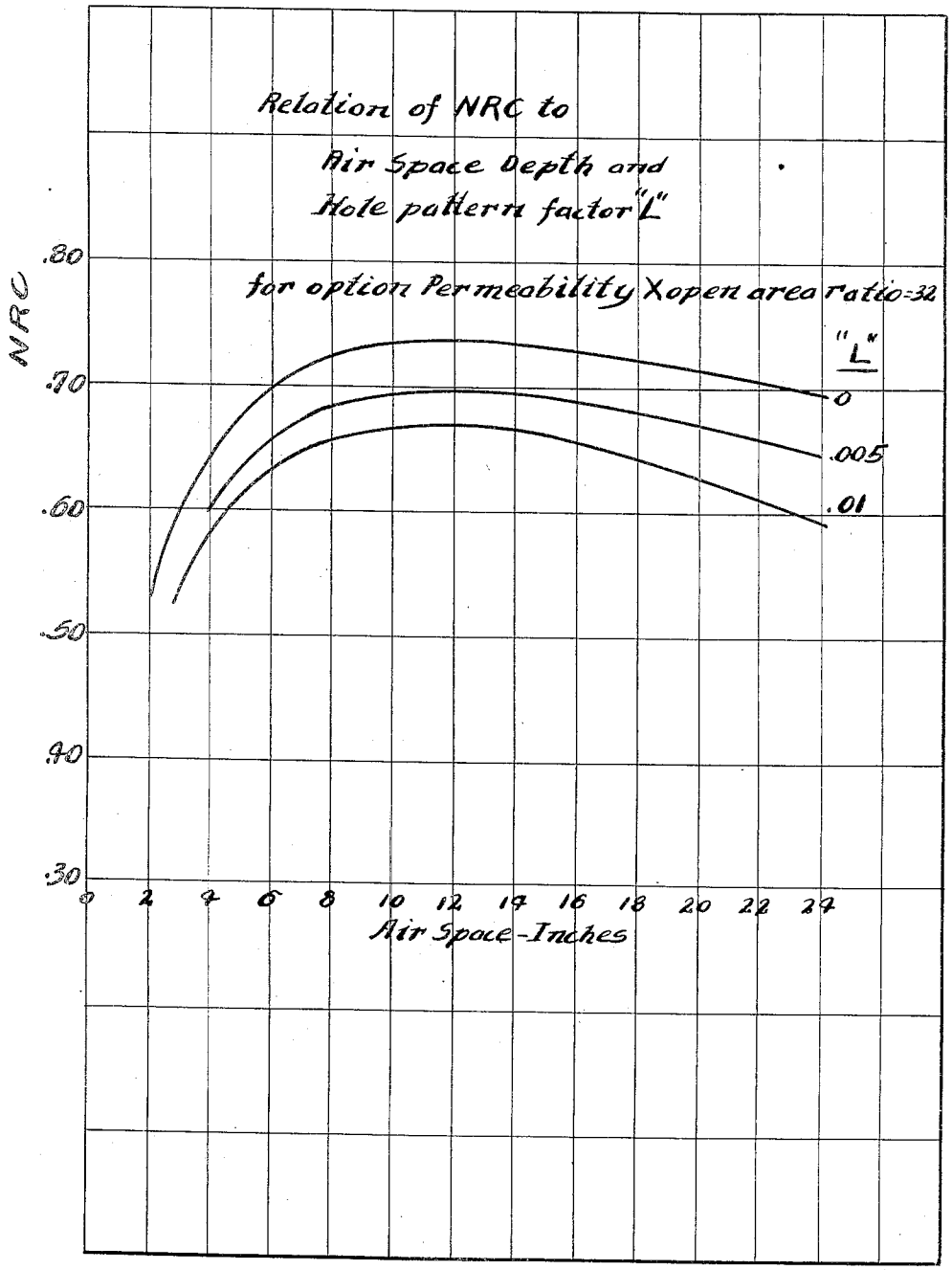


Fig. 8.

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United States Patent Office 2,838,806
Patented June 17, 1958

2,838,806

FIREPROOF ACOUSTICAL CORRECTION PANELS

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Application June 18, 1957, Serial No. 666,310

5 Claims. (Cl. 20—4)

The invention is with respect to a sound absorbing or acoustical correction product.

In particular the invention is directed to a non-combustible or fireproof acoustical correction product which it is believed has all the desired properties of the various fireproof acoustical products on the market.

Some of such products are comprised of several separate parts, such as a metal pan, a fiber pad to be inserted therein, and spacers. These components, separately, are quite bulky and for use involve their assembly on the job.

Fireproof felted mineral fiber products bonded with starch or protein or like binder are relatively heavy and rather fragile and are subject to marring and breakage in shipment to the extent that the packaging for such is quite costly.

There are types of such product which are quite light in weight. These are comprised of an air-laid glass fiber batt in which the fibers are bonded at least to a degree, at fiber to fiber contact points with a small amount of resin binder. Such product, however, while quite light in weight, is fragile due to having so little body. They have relatively little rigidity, are bulky, and are readily damaged in transit and during installation.

The various types of such products, as above referred to, because of their deficiencies so far as is known are available only in sizes 12 inches by 12 inches, some 12 inches by 24 inches and one, it is believed, 18 inches by 18 inches. The necessity of installing these products in such small sizes results in high installation costs, particularly with respect to the suspension systems necessitated and the labor of installation.

The new acoustical correction product hereof is a fireproof product which lacks the various disadvantages of prior such products.

It is the principal object of this invention to provide a fireproof acoustical correction product. It is further the objective hereof to provide such product which does not have the deficiencies of various available products, that is, one which comprises the complete product as a unit, is rugged and stiff, and which, as a consequence of such properties, is shippable at a reasonable cost, as being sufficiently rugged as not to be liable to damage in transit and installation.

It is further an objective that the product having the physical properties referred to may be supplied and installed in relatively larger sizes with consequent saving in labor costs of erection.

Other and further objects of the invention will become apparent upon reading the following description of the invention when considered in connection with the accompanying drawings illustrating the invention:

In the accompanying drawings Fig. 1 is a worm's eye view of a portion of an installation of the sound absorbing material;

Fig. 2 is an elevation of an alternative installation;

Fig. 3 is an enlarged elevation of the sound absorbing material;

Fig. 4 is a top plan view of the sound absorbing material; and

Figs. 5 to 8 are graphs.

Fireproofness of a construction material is not merely dependent on whether the material does or does not have a combustible content. Actually, for construction materials, the term "fireproof" is used with the connotation of "fire safe" rather than that of "non-combustible."

Due to the many factors which enter into the rating of a construction material as "fireproof," technical test specifications have been set up for the determination of such ratings. The generally accepted test specification for the rating of acoustical materials as to fireproofness is that of the U. S. Bureau of Standards, Federal Specification SS-A-118*b*, Acoustical Units Prefabricated.

To meet the strict requirements as to Class "A" (fireproof) products under the above test specification, the acoustical product hereof is comprised of two parts; a base material and a surface coating thereon.

A unit **10** of the acoustical correction product comprises a sheet of gypsum board, the core of which is designated by numeral **11** which is provided with paper facings **12**. To the outer surface of one facing **12** of the core **11** there is adhered a layer of porous paper **13**, and a decorative coating of fire resistant paint **14** is applied to the outer face of the other facing sheet **12**.

The complete combination as above described will pass the requirements for classification as type "A" (fireproof) under Federal Specification SS-A-118*b*. The base member of the product without face coating **14** will not meet the requirements for such classification. Obviously, face coating **14** so modifies and coacts with the base member **11** that its character is altered to the extent that the requirements for classification as fireproof are imparted.

For this product the gypsum board base member is not an ordinary gypsum wallboard, although it is not different in appearance. The core portion **11** of the gypsum board is comprised of a special mixture imparting fire resistant properties thereto.

Core portion **11**, in addition to the usual gypsum wallboard core ingredients, contains Wollastonite finely divided, and relatively short mineral fibers. The gypsum board base member is prepared in the manner as disclosed in Patent 2,080,009 or 2,172,076 except that in the preparation of the core portion **11** there is incorporated in the mix, finely divided Wollastonite to the extent of ten percent by weight based on the weight of gypsum stucco. Additionally there is incorporated in the mix about one-half percent, or within the range of about one-quarter to one percent based on the weight of gypsum stucco of mineral fiber of about one-half inch in length. These mineral fibers, of course, cannot all be cut to accurate length, and it is to be expected that such of one-half inch nominal length will probably range in length of the various fibers within the range of one-quarter inch to one inch.

The Wollastonite is a natural mineral which is an article of commerce which, for the purposes hereof, is a pulverized material of between 20 to 300 mesh, of which preferably about 80% should be within the range of 20 to 35 mesh.

A typical formulation for the core **11** of the gypsum wallboard sheet, for 1000 square feet of nominal ⅜ inch thickness, is:

	Pounds
Gypsum stucco	1070
Wollastonite, pulverized, 20 to 30 mesh	107
Mineral fibers, nominal ½ inch	2
Core adhesive	9
Accelerator	2 to 4
Rosin soap	1.8

In the above formulation the rosin soap content represents foam formed therefrom and added to the mix to provide air cells in the formed gypsum board. Instead of the use of rosin soap foam for providing the cellularity, such effect can be obtained by foam produced from other sources, as, for example, by an equivalent amount of casein foam, albumen foam, etc., or the desired cells can be formed in the mix during the mixing by the use of a surface active agent. The Wolf patent, 2,172,076, discloses the use of surface active agents in the production of cellular gypsum board.

As above referred to, the gypsum board base sheet is manufactured by well known procedures, as, for example, as disclosed in Roos 2,080,009. The formulation in any case will be basically that given above. It will, of course, be understood by those skilled in the art that gypsum board products are never manufactured strictly according to a formula. Normal manufacturing variation is, of course, contemplated, and of course is required as stucco quality may vary from time to time, or, for example, on substitution of one core additive for another. For example, practically speaking no two starch core adhesives are just alike in properties, and upon substitution appropriate adjustment of quantities is made. Also adjustment of accelerator is required to compensate for stucco quality or on change from one accelerator to another.

Gypsum board of the composition above given, after it is set and dried, is cut to suitable size which may, for example, be 24" x 24" and fabricated into units of sound absorbing material. These units are not limited to any specific size except by the physical properties of the board. Since a board 3/8" thick has ample strength for erection on a two foot span the units are usually made in such width, and preferably 4, 6 or even 8 feet in length, since the larger sizes of units result in simplification in erection, and particularly in lower erection cost due to the lesser cost of the suspending grid work and the labor in installing the suspended grid and in mounting the sound absorbing units therein. The sound absorbing units may, of course, be substantially of any width which may be suspended without excessive sag, so that the two foot width above referred to is merely suggestive of a convenient width of the units and is not to be taken as limiting the width of unit to such dimension.

If a quarter-inch base sheet is used, to avoid excessive sag, width would probably be limited to two feet. If 3/8" or 1/2" base sheet is used, width greater than two feet may, of course, be used, but a base sheet of 1/2" thickness results in units which are somewhat on the heavy side and some of the advantages of handleability and the like may be less than for the somewhat thinner units referred to. The units cut to size are perforated with an over-all pattern of perforations **15** extending through the thickness of the board. The preferred pattern of perforations is that of holes of 1/4" in diameter, spaced 17/32" on centers. This results in a field of 511 perforations per square foot in which the perforated area comprises about 17.4% of the total area.

The base sheet just above described is of preferred construction, all pertinent factors considered. So far as thickness is concerned, a base sheet of infinite thinness is preferred as such in the finished unit would result in the highest absorption. The base sheet, however, must have sufficient rigidity so as to have no apparent or non-excessive sag when installed, and therefore for general use a thickness for the base sheet of 3/8" has been selected as that which is preferred. Base sheet thickness of between that of 0 and 1/2" has relatively little effect on the sound absorption provided by the finished unit and therefore between such limits any thickness for the base sheet within such range as dictated by conditions of use are within the preferred range. While perforations **15** have been referred to as of 1/4" diameter, such may be square in cross section or of other geometrical configuration of substantially the cross section of a 1/4" circle.

Perforations of 1/4" diameter are preferred but they may vary in cross section from that of a circle of about 1/8" diameter to that of a circle of about 1/2" diameter.

The limitation of a cross sectional area of the perforations as above given is limited largely by practical consideration. If the perforations are smaller than 1/8" in diameter it will be substantially impossible to repaint the face of the unit without bridging or closing the holes. When the cross sectional area of the perforations is as great as that of a circle of 1/2" diameter, they become too noticeable and unsightly and are approaching such size that the efficiency of the over-all unit will be impaired. For the reasons stated, it is preferred that the cross section of the perforations be limited to an area of that of circles of from 1/8" to 1/2" diameter.

Spacing of the perforations **15** in the base sheet member is, of course, in view of the foregoing, determined by the cross sectional area of the perforations. Both for appearance and maximum sound absorption the perforations are substantially uniformly spaced and accordingly, for example, in a square foot of base sheet area, if the perforated portion is to be approximately 17.4%, as previously referred to, then 17.4% of a square foot divided by the area of an individual perforation will determine the number of perforations to be provided per square foot, and for substantially uniform spacing will be determinative of the spacings of the perforations **15**.

Subsequent to the step of providing perforations **15** in the base sheet there is applied to one face thereof a fabric sheet **13**, such term "fabric" being used in a very broad and generic sense. The essential of sheet **13** is that it shall have porosity to air within definite limits and thus it will be evident that the sheet **13** may be a felt or paper sheet formed of wood, glass, asbestos, rayon, or other synthetic fibers, or of hair, fur, or other fibrous material which may be felted to sheet form. Another alternative of the sheet **13** is a thin continuous sheet, such as a sheet of cellophane, saran, or the like, which is very finely perforated to provide the requisite porosity. Also it is to be understood that a felt or woven fabric or paper sheet or the like not originally having the requisite porosity may be suitably perforated with fine perforations, or otherwise made porous to the requisite degree. Accordingly, it is to be understood that the sheet **13**, in accordance with the explanation just given, may be of almost any material or type of material which may be sheeted in relatively thin sheets, and might even be of metal, as, for example, of aluminum foil pierced with fine perforations to provide the requisite porosity.

The fabric sheet **13** is adhered to the outer face of the paper facing **12** by suitable adhesive. Preferably, fabric sheet **13** is adhered to facing sheet **12** by adhesive applied to the outer face of the facing sheet **12**. By such technique the fabric sheet **13** may be firmly and continuously adhered to facing sheet **12** without the adhesive getting on to those portions of fabric sheet **13** overlying perforations **15**. The fabric sheet **13** must be firmly adhered to facing sheet **12** around the periphery of perforations **15**, but porosity to air of those areas of the sheet overlying the ends of perforations **15** must be retained.

It is not impossible to adhere fabric sheet **13** by adhesive applied directly to the fabric sheet **13** by an operation akin to printing or by stenciling, or the like, such being carried out in a manner so that the adhesive is not applied to the areas which will overlay the perforations **15**. The difficulty of registration, however, in applying the fabric sheet to the facing sheet in such manner, substantially renders the such procedure quite impractical for commercial production, but such would not be applicable if an apparatus is developed for applying the sheet **13** in registry, such being well within the realms of probability, and accordingly such method

of application is not at all ruled out, and at least such operation could be accomplished by manual procedure.

In the application of the fabric sheet **13** it is critical that the material be firmly mounted to the rear surface of the board extending over the perforations **15** and secured around the periphery of the perforations. The specific manner of arriving at such results is relatively unimportant. The fabric **13**, for example, might be in the form of small circles, or of other geometrical form, individually applied at each perforation **15** and each firmly secured around the periphery of the perforation. Best absorption would be provided by fabric sheet **13** alone, if it could be suitably mounted.

To secure the maximum absorption effect, which is the true basis of this invention, it is necessary that the fabric sheet be sufficiently stiff that in effect it is non-vibratable on impact of the sound waves thereon so that the sheet, when impacted by the sound waves, at least does not appreciably vibrate. The porous sheet having effective stiffness, mounted so as to be non-vibrating, provides an air-permeable barrier to the free flow of the air pulses comprising the sound waves, and as a consequence the pulsing of the sound waves through the porous sheet converts and dissipates a portion of the energy of the sound waves to provide acoustical correction.

Due to the fact that practically, as a ceiling, the required porous sheet cannot be mounted so as to have the required stiffness, it results that resort must be had to the construction of this invention. By exposing independent, relatively small areas of the porous sheet material **13** to the impact of the sound waves, each such area firmly secured around the periphery of its exposed portion, the portion overlying a perforation **15**, the necessary effective stiffness of the porous sheet **13** is achieved.

The product so far described, because of the paper facings thereon, will not, of course, pass the Class "A" fireproof rating of Federal Specification SS–A–118*b*. To enable the product to obtain the rating it is necessary to alter and protect the character of the facing sheet on the side of the unit from which the test procedure is applied. The requisite alteration or modification of the character of the facing sheet and provision of the necessary protection thereof is accomplished as follows:

The modification of the facing sheet and protection thereof is accomplished by a three-step application of coating. The three steps of such coating comprise the application of a first or base coat, the principal function of which is that of imparting flame resistance to the paper facing, and over which there is applied a second coat, the principal function of which is that of a protective coating, and finally a third coat, the principal function of which is to harden and consolidate the previously applied coatings so that the composite coating is integrated of itself and with the paper face sheet **12**. This coating applied to a face sheet **12** is identified on the drawing by numeral **14**.

The first or base coat of coating **14** is comprised of components which are listed below under two categories; one, "Pigment," and the other, "Binder":

Pigment:		
Asbestos	lbs.	15
Aquasol	gal.	2.5
Ti Pure FF	lbs.	25
Hi White china clay	lbs.	300
Mica AA	lbs.	250
Santobrite	lb.	1
Borotherm	lbs.	300
Binder:		
Protein	lbs.	60
Borax	lbs.	10
Pine oil	lbs.	8
Waxine	lbs.	8

In the foregoing formulation the asbestos, of course, is of the very fine or short fibered grade normally used as a paint filler. The Aquasol is a surface active agent product of the American Cyanamid Company, technically a sulphonated castor oil. Ti Pure FF is a white pigment available from E. I. du Pont de Nemours, being the anatase form of titanium dioxide. The Hi White china clay is a white clay of the grade normally used in paints, which is primarily a filler, although it has some pigmentation effect. Mica AA is a usual finely divided mica such as is commonly used as a paint filler ingredient. The Santobrite is a fungicide available from Monsanto Chemical Company, the active ingredient of which is sodium pentachlorophenate. The Borotherm is a flame retardent agent available from the American Potash Company, being a water-soluble complex borate salt containing 57% B_2O_3 by analysis. The protein is the so-called "A" or substantially pure protein which is available from many sources. The Waxine is an acid stable type wax emulsion of crystal and paraffin wax of melting point 122° F. and which is comprised of 45% wax emulsified in water with 5% rosin based on the total composition.

The procedure of preparation of the above base coat is that first the pigment ingredients are slurried with water as a heavy paste, such being added to a previously prepared solution in water of the binding ingredients and in which the borax constitutes the solubilizing agent for the protein ingredient. This mix, made up to 150 gallons with water, is, of course, suitably agitated, preferably while heated to about 130° F., and after a short holding period is ready for application.

The base coat above described is applied to a surface sheet **12** of the base unit at the rate of approximately 2.75 to 3.25 gallons per 1000 square feet and dried. The Aquasol wetting agent causes this coating to strike into the paper surface and in particular to carry thereinto the fungicide and flame retardant ingredients of the base coat, and thus to modify the sheet **12** to the extent of rendering it relatively flame and fungus resistant.

Over the base coat there is subsequently applied a protective coat which is comprised of pigment and binder portions as follows:

	Pounds
Pigment:	
Asbestos	10
Ti Pure FF	125
Hi White china clay	350
Mica AA	200
Santobrite	1
For tinting, raw sienna	0.2
Binder:	
Carboxy methyl cellulose	1.5
Protein	60
Borax	8
Pine oil	8
Waxine	8

This second coating composition is made up in the same manner as above described for making up the base coat mixture, and it is applied over the dried base coat mixture at the rate of approximately 1.5 to 1.75 gallons per 1000 square feet and suitably dried.

Finally, to consolidate and integrate the paper facing **12** and protective coating thereon, there is applied a third or "hardening" coat which insolubilizes the binder ingredients of the preceding coatings and anchors such to the paper facing **12**, particularly through the integration or consolidation of the protein contents in which, as referred to, protein of the first coating has been caused to soak into or penetrate into the facing sheet **12**. The such hardening of the coatings by the application of the third coat not only integrates and consolidates the paper facing **12** and the coatings thereon, but it additionally so hardens the coating that it is protected from attack by roaches and is sufficiently hardened and waterproofed that a high degree of washability is imparted.

The hardening coat comprises—

	Pounds
Dry alum	100
Borax	57
Sodium acetate	50
Formaldehyde, 35 to 40%	8

The above composition is made up with water to 150 gallons and is applied over the second or protective above described coat at the approximate rate of 1.5 to 2 gallons per 1000 square feet and subjected to suitable drying.

The composite coating 14, as above described, combines with and alters the character of the paper facing sheet 12 so as to render it flame resistant, and additionally provides an integrated and mineralized protective layer thereon which together impart characteristics to constitute a combination which is capable of passing the Class "A" fire resistant rating of Federal Specification SS–A–118*b*. Additionally, the such coating integrated with the paper facing 12 provides a finished product, the surface of which is roach and fungus resistant and is sufficiently hard and insolubilized to the extent that it is quite washable, but it additionally comprises a decorative surfacing which in the present instance, based on the compositions as above, is white and highly light-reflective, which is a normal requisite for a ceiling sound absorbing product. It will, of course, be understood that if desired suitable usual tinting components may be added to tint the applied coating.

Although the sound absorbing unit above described is in fact a complete structure comprising a sound absorbing unit which will pass the requirements of Federal Specification SS–A–118*b*, Class "A" or fireproof, it is necessary that such be installed as will hereinafter be described in order that its ability as a sound absorber may function.

Based on theoretical considerations and checked by actual test, it has been determined that the sound absorbing units, as described, function most efficiently when mounted in such manner that they are spaced approximately between 10 and 12 inches from a surface, as, for example, the ceiling of a room.

A so suspended ceiling is shown in Fig. 1 of the drawings, wherein the sound absorbing units are mounted on a grid of inverted T members 20 resting on the upwardly directed flanges thereof, and which inverted T members are suspended from a room ceiling or the like 21 by means of hangers 22. It is to be understood that this method of mounting the sound absorbing units is illustrative only and that any suitable mounting may be employed for supporting an assemblage of the sound absorbing units as a ceiling surface or the like which is spaced from a structural wall or like 21 as referred to.

Merely as an example of a possible alternative mounting of the sound absorbing units 10, they may be mounted against the lower faces of spaced wood joists or the like 25 by nails or screws or the like 26, and at the edge of an assemblage of such units 10, where they abut against a side wall, the extreme edge of a unit may be supported by means of an L shape support member 27, or an equivalent support member nailed or otherwise suitably secured to the side wall, as by beams 28.

Since there is a latitude with respect to a number of variables involved in the design of a sound absorbing unit, such as it is above described, there have been included in the attached drawings four design graphs which have been developed in part based on theory and in part derived from experimental determination of sound absorption as affected by variation of physical constants, principally dimensions of the variable factors involved.

The graph, Fig. 5, shows the relation of sound absorption to factor L, which factor L is determined by a formula which takes into consideration the thickness of the base element of unit 10, in this case the gypsum board, which has been described, the diameter of perforations and spacing between perforations, center to center, and wherein the spacing of perforations is uniform based on a square pattern of perforating. Based on this graph it will be seen that within the limits as plotted, the sound absorption of a unit does not vary greatly, so that for the values of L, between zero and 0.01, the total variation of absorption is about 8 points, or a variation as the value of L increases of between 74% and 66%. It being evident that the noise reduction constant is of a substantially uniformly decreased value, as the value of L increases, values were not plotted for values of the factor L above 0.01, since, obviously, absorption within the range of the highest possible absorption which might be obtained is that absorption which is desired for the product, and in fact necessary for the successful application of the product as an acoustical corrective treatment.

In connection with the foregoing, the formula for the determination of the factor L referred to, is:

$$L=\frac{0.00306[t+0.85D(1-1.108D/S)]}{0.785(D/S)^2}$$

In the above, t represents the thickness of the base sheet in inches, D the diameter of perforations in inches, and S the hole spacing center to center in inches based on a uniform square pattern of perforation.

Figure 6 is a graph in which the hole spacing in inches for a square pattern, as referred to, is plotted against the hole diameter in inches. As previously pointed out, since the optimum structure for maximum sound absorption cannot be achieved, that is, a sound absorbing surface comprising merely a porous sheet 13 rigidly mounted, it is necessary that such be supported by a board or base sheet such as the gypsum board sheet as has been described, which in combination with the porous sheet 13 brings into the combination the effect of board thickness, hole diameter and hole spacing. This graph has been developed to show the effect of variation of such factors and to show that other factors remaining constant, the hole spacing and diameters may be varied without varying the sound absorption resulting.

Taking a specific condition, for example board of a thickness t of ¼", L factor of 0.005, and NRC of 0.70, it will be seen that within the limits of a hole diameter of between 0.2 and 0.4", which is probably the practical limits of hole diameter variation, that with the other variables fixed, the NRC absorption of 0.70 will result within the limits of hole diameter of 0.2" and spacing of 0.4" and hole diameter of 0.4" and spacing of 0.72". Other hole diameters and spacing between the limits specifically referred to can be taken from the graph referred to, which is the lowermost dash line of the group labeled t equals ¼" for the conditions of L equals 0.005, and NRC equals 0.70, as indicated on the graph.

In the graph of Figure 6, the graphs have been shown only for the conditions of base sheet of a thickness t equals ⅛" and ¼". Similar graphs can readily be developed for base sheets of other thicknesses t which will be generally similar to those shown, and which, as the thickness t increases will fall below the graphs as shown in generally similar fanwise relation. Also similar graphs may be developed for other conditions of the constant L, acoustic mass, and other conditions of NRC, noise reduction coefficient. It will, of course, be understood that the particular graphs as are illustrated in the accompanying drawings have been developed for the particular and preferred product resulting from the invention, which preferred form has been described in detail in the preceding description.

Figure 7 is a graph showing the relationship between noise reduction coefficients and acoustic factor X, which is the product of the air permeability of sheet 13, as heretofore described, times the open area ratio, that is, the ratio of the area of perforations for a unit area of unit 10 divided by the area of such unit area. This relationship has been plotted for several air spacings, that is, the space provided between the back of the installed units 10 and the structural ceiling or the like 21 with

which the installation is associated. It will be seen that this constitutes a family of generally similar curves, the distance between which decreases as the air space progresses from a space of from 2 inches to that of 12 inches, and that obviously there will be little increase in the NRC value above a spacing of 12 inches. Based on this family of curves it is obvious that the maximum noise reduction coefficient is obtained at approximately X factor equals 32, and that generally for the X factor value of between approximately 25 and 35, the NRC value is substantially maximum and relatively constant.

Figure 8 is a graph of noise reduction coefficient plotted against air space in inches, showing a family of curves for various values of L or acoustic mass of between the value of 0 and 0.01. It will again be seen in this family of graphs that an air space of the order of 12 inches for the various values of L give maximum NRC values, and that for the range of variation of air space from about 8 inches to 16 inches, provides maximum and substantially uniform absorption.

It will, of course, be obvious that in connection with each of the Figures 5 to 8, additional graphs might be plotted for other conditions, but as previously referred to, the graphs shown are those particularly relating to the preferred form of the commercial exemplification of the invention as particularly described in the preceding specification.

The noise reduction coefficient or NRC values above referred to are those determined as accepted in the industry and is an overall coefficient determined from and based on sound absoprtion measurements for the values of 250, 500, 1,000 and 2,000 cycles per second.

Porous fabric sheet **13** above referred to should have an air porosity of between about 90 to 200 cubic feet of air per minute per square foot of area with air supplied to one face at a pressure equal to ½" water pressure, that is, under such conditions the air flow through the sheet should be between the limits as stated. While 90 to 200 cubic feet porosity has just above been referred to, the preferred porosity of porous sheet **13** of the particular sound absorbing element described above in detail is that of between about 120 to 150.

The invention hereof having been above described in detail, I claim:

1. A fireproof acoustical correction unit comprising paper-faced gypsum board as the base sheet thereof, the said gypsum board comprising spaced paper face sheets applied to the face surfaces of a spacing core principally of set gypsum, the said core portion thereof incorporated about 10 percent of Wollastonite, principally of particle size between 20 and 35 mesh, and about ½ percent of mineral fiber of average length of about ½ inch, an air porous sheet firmly adhered to the outer surface of a paper facing of the gypsum board base sheet, a protective and decorative coating on the outer face of the other paper facing of the gypsum board base sheet, the coating including as ingredients a surface active agent and a complex water-soluble borate salt and intruding into the paper facing, and passageways extending through the thickness of the gypsum board base sheet and constituted by substantially uniformly distributed perforations of substantially like cross sectional area, in total comprising about 17 percent of the area of the gypsum board base sheet.

2. The fireproof acoustical correction unit as set out in claim 1 wherein the said gypsum board base sheet is between about ¼ to ½ inch in thickness, the air porous sheet has porosity to air at pressure of ½ inch water pressure of between about 90 to 200 cubic feet per minute per square foot of area and the passageways are of substantially circular section of area about equal to that of a circle of ¼ inch diameter and are arranged in a substantially square pattern, spaced about 9/16 inch center to center.

3. An acoustical correction construction comprising in combination sound absorbing units mounted in spaced relation to a wall surface, the spacing of such elements being between the limits of about 6 to 18 inches, the sound absorbing unit of composite construction and comprising as a base a paper faced gypsum board sheet, the gypsum core portion thereof incorporating, substantially uniformly distributed throughout, based on the weight of gypsum in the core, about 10 percent of finely divided Wollastonite of between 20 and 200 mesh size and of which the greater part thereof is of between 20 and 35 mesh size and between ¼ and 1 percent of finely divided mineral fiber of about ½ inch average length, the gypsum board sheet having perforations extending therethrough and comprising passageways in substantially uniform distribution of substantially like cross section totalling about 17 percent of the gypsum board area, air porous sheet material covering the ends of the passageways on one side of the gypsum board sheet and sealingly secured around the peripheries of the passageways to the paper facing, the air porous sheet being of porosity to pass per square foot between about 90 to 200 cubic feet of air per minute at applied pressure equal to 0.5 inch water.

4. An acoustical correction construction comprising in combination sound absorbing units and supporting means therefor, the supporting means consisting of an intersecting grid of supporting runner members, each runner member having outwardly extending unit supporting flanges and connecting members supporting the grid spaced from a wall, spaced about 6 to 12 inches therefrom, and the sound absorbing units comprising a gypsum core composition incorporating substantially uniformly distributed therein, based on the weight of gypsum, about 10 percent of finely divided Wollastonite particles and about ½ percent of fine mineral fibers of about average length of ½ inch, the core having paper facings and being of overall of a thickness of about ⅜ inch, the sound absorbing units having passageway extending through the thickness thereof, the passages being of substantially circular form of about ¼ inch diameter, substantially uniformly spaced 9/16 inch center to center, arranged in square pattern, and constituting about 17 percent open area, and an air porous sheet mounted on a face of each unit and securely adhered around the periphery of each such said passageway.

5. In the acoustical correction construction as set out in claim 4, a fireproofing coating applied to the other paper facing of the sound absorbing units and comprising mineral pigment and filler together with protein binder as the principal ingredients and borate fireproofing salts in small amount together with other minor ingredients, the coating intruded into the paper facing by the wetting action of a surface active agent as one of the other minor ingredients, and the coating being bonded and adhered to the paper facing by the product of reaction of formaldehyde with the protein ingredient.

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