April 25, 1933. L. B. EATON 1,906,123

ACOUSTIC PLASTER

Filed Feb. 20, 1931 2 Sheets-Sheet 1

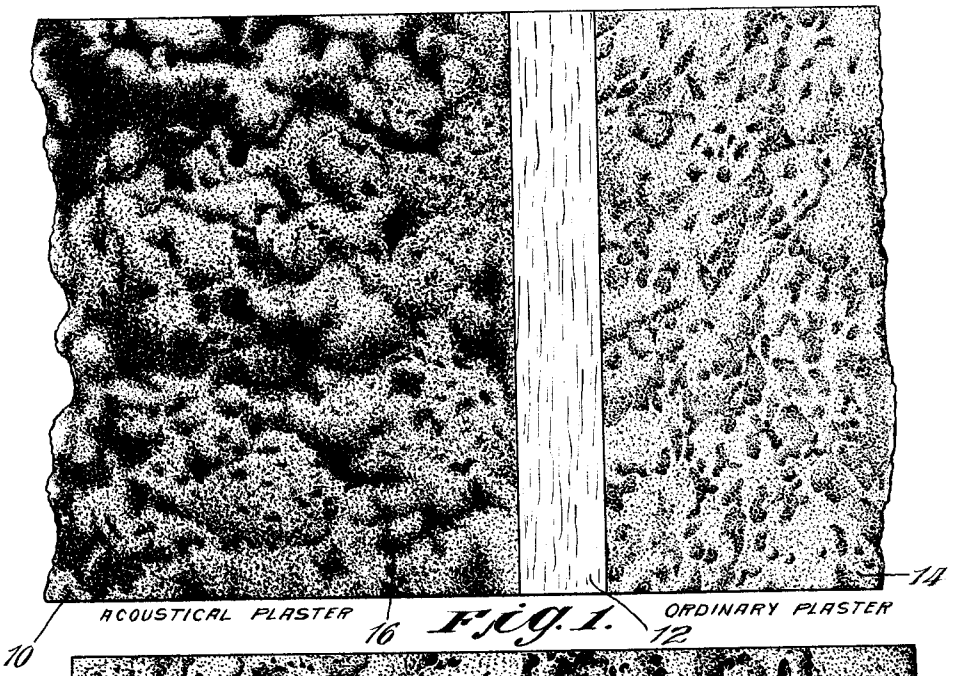


Fig. 1.

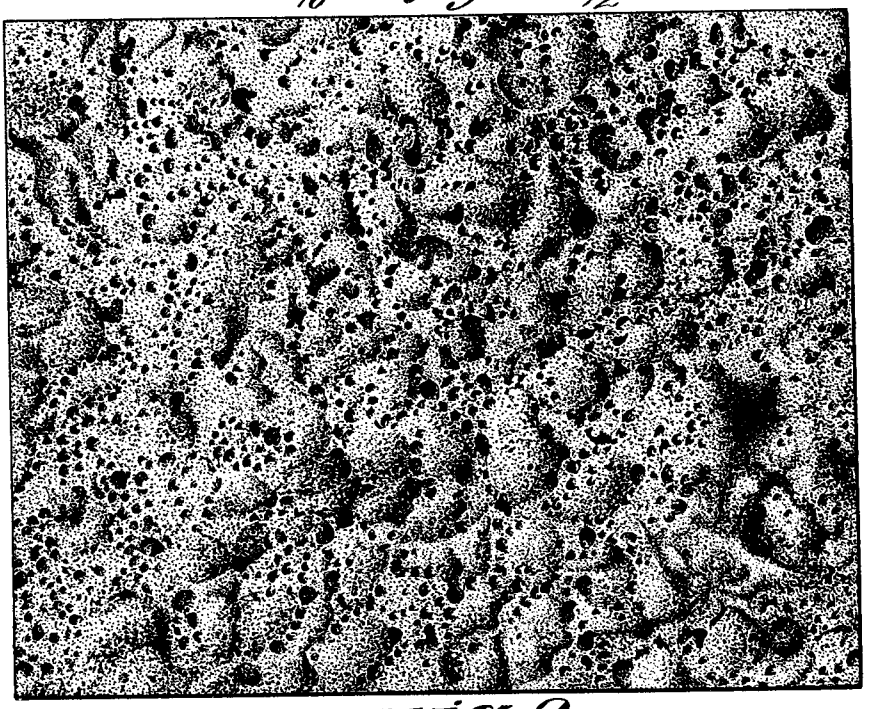


Fig. 2.

INVENTOR
LESLIE B. EATON

BY Hammond & Littell

ATTORNEYS

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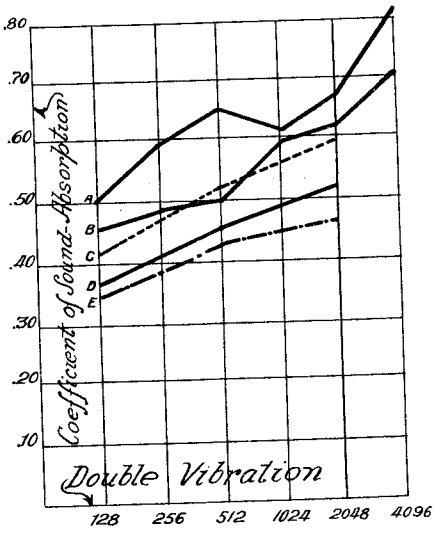


Fig. 3.

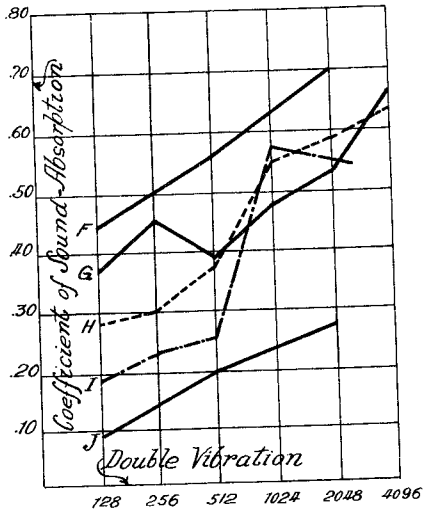


Fig. 4.

INVENTOR
LESLIE B. EATON

BY Hammond & Littell
ATTORNEYS

Patented Apr. 25, 1933 1,906,123

UNITED STATES PATENT OFFICE

LESLIE B. EATON, OF LOS ANGELES, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KALITE COMPANY, LIMITED, OF PASADENA, CALIFORNIA, A CORPORATION OF CALIFORNIA

ACOUSTIC PLASTER

Application filed February 20, 1931. Serial No. 517,147.

This invention relates to improvements in acoustical plasters, and it particularly relates to a plaster having high sound absorbing properties to be used as an acoustical plaster for wall coverings and similar purposes. It is in part, a continuation of my co-pending application Serial No. 479,929, filed September 5, 1930.

Prior acoustical plasters have depended for their sound absorptiveness on a relatively thin sound absorptive layer of a lumpy or semi-porous texture with the balance of the plaster of a firm and dense composition which acts as a sound reflector back of the surface film. The maximum sound absorption efficiency in commercial acoustical plaster of the prior art shows a coefficient of sound absorption of not more than 35% at 512 double vibrations even when applied under the most favorable laboratory conditions and in excessive thicknesses of 1 inch or 1¼ inches or more, and the average coefficient of sound absorption is around 18% at 512 double vibrations in thicknesses of ½ inch. A further objection to the acoustical plasters heretofore known is the difficulty of applying or producing them in that they often depend for the sound absorbing properties even in the surface films on special ingredients or special chemical reactions such as effervescence which make them costly to produce and difficult to apply on a commercial scale, necessitating special equipment such as cement guns and special skill or training for the operators.

I have produced as described in said previous application Serial No. 479,929 an acoustical plaster having interconnecting pores which are not merely a surface film but extend throughout the thickness of the plaster and provide a plaster having a higher sound absorbing value than any acoustical plaster heretofore known and one which becomes more sound absorptive as its thickness is increased. I have produced a plaster which shows a coefficient of sound absorption of 50 to 64% at 512 double vibrations in thicknesses of 1 inch or more and one which can be applied with the ordinary hawk and trowel without special equipment or special training of the workmen.

I have produced as a new product of manufacture an acoustical plaster having a higher sound absorbing efficiency, a lower cost per unit of sound absorption, and a plaster that is easier to mix, manipulate and apply than any previous acoustical plaster.

I have also produced an acoustical plaster having intercommunicating pores throughout which act as sound absorbing and sound deadening passages and which can be applied to any desired thickness without destroying the intercommunicating passages and which shows a proportional increase in sound absorbing efficiency with each increase in thickness.

I have also produced an acoustical plaster of high efficiency and porous texture throughout, to which I can apply a hard surface film while still maintaining the surface porosity so that the plaster can be scrubbed with soap and water without damaging the wall.

I have also produced an acoustical plaster which can be applied with ordinary plasterer's tools such as the hawk and trowel which will have more stable and uniform characteristic properties over a greater length of time and which can be made out of inexpensive porous materials such as pumice, together with an adhesive material, such as gypsum plaster and hide glue.

Other advantages of my new plaster will appear as this description proceeds with reference to the accompanying drawings in which:

Figure 1 is a reproduction of an enlarged cross-section through a specimen sample of my improved acoustical plaster and a specimen sample of ordinary plaster mounted on a common base.

Figure 2 is a reproduction of an enlarged photograph of the surface of the improved plaster shown to the left of Figure 1.

Figure 3 is a graph showing comparative efficiencies of various thicknesses of my improved acoustical plaster and Figure 4 is a graph showing the comparative efficiency of my improved plaster with reference to other plasters.

For the purpose of illustration a typical sample of my acoustical plaster was applied to one side of a base 12 and on the other side ordinary plaster was applied, the sample being cut to give a cross-section, which cross-section was photographed and reproduced in Figure 1. The acoustical plaster 10 is mounted to the left of the base 12, and ordinary plaster 14 is shown on the right. A face photograph was made from which the reproduction shown in Figure 2 was made. Figure 2 is thus a reproduction of a photographic enlargement of the surface of acoustical plaster and is a substantially correct illustration of the commercial product as applied.

The base of this mixture is preferably a light porous mineral such as pumice which occurs in very large deposits in California and is of volcanic nature, although any other light porous mineral product, or even coke breeze or other light cellular aggregate may be used. The mineral is properly ground to approximately minus 8 and plus 16 mesh and to this ordinary gypsum stucco plaster is added. Preferably a proportion of three parts of pumice to one part of gypsum by weight is used. This may be termed mix A and is a dry product which may be shipped to the job on which the plaster is to be used.

The next mix, mix P, consists of hide glue dissolved in water, preferably in the proportion of twelve ounces of hide glue to one gallon of hot water to which is added six ounces of potash alum. To this mix of approximately one gallon, is added an additional ten or twelve gallons of water as a diluent.

The dry materials, pumice, or other suitable aggregate and stucco plaster may be mixed at the job with the water to which the hide glue and potash alum have been added. When a mix is desired, it is found that about six gallons of the diluted hide glue, potash alum and water which would thus contain about six ounces of hide glue and three ounces of alum is about sufficient for the one hundred pound mix of dry materials, of seventy-five pounds of pumice and a balance of gypsum plaster. This varies slightly and depends upon the surface to be covered and the finish desired but is approximately the proper amount. It is possible of course to mix the pumice, gypsum plaster, glue and alum dry and ship them to the point of use where, upon mixing with water, the product is ready for application.

The plaster is applied with a hawk and trowel in the usual manner of applying plaster and requires no special equipment or skilled labor and may be troweled smooth without destroying its acoustical properties. It is found to have an extremely cellular structure throughout when dry and if desired, it may be painted or sprayed with various coloring substances without appreciably losing any of the acoustical properties.

The pumice is naturally light and porous so that it may be supported on air bubbles and the glue forms walls for small bubbles of air throughout the plaster in mixing. These bubbles or air holes extend throughout the plaster and when dry the walls of glue contract and disintegrate to form an open cellular structure with substantially 100% interconnecting pores. Due to their inter-dependent connection, the plaster is found to have high acoustical absorptive values which greatly exceed the sound absorbing qualities of the prior known materials.

With further reference to the drawings it will be noted that the black passages representative of the pores 16 extend substantially entirely throughout the cross-section and from the front to back. It will also be noted that the sound absorptive sections, namely the black pores cover a large proportion of the cross-section and substantially equal the solid sections. Due to the large number of pores, they inter-connect thus forming the black or dark passages as shown to the left of Figure 1, and extend from front to back of the plaster.

On the contrary the ordinary plaster as shown at 14 is very dense and there are substantially no pores, and therefore no inner passages to absorb the sound. Furthermore, the surface of the ordinary plaster is substantially smooth and acts as a sound reflector.

The surface of the acoustical plaster as shown to the left of Figure 1, and also in Figure 2 is irregular, and although the plaster is applied with the hawk and trowel, it is not rubbed entirely smooth and there are numerous hills and depressions in the surface, not only due to the irregular surface but due to the depths of the pores which extend to the surface. The result and effect is that the acoustical plaster has much higher sound absorptive properties and a very much lower degree of reflection.

As a standard of measurement and comparison of the efficiency of acoustic material a standard frequency of 512 double vibrations per second, which is a pitch range midway between low tones on the scale and the higher pitches of sustained speech and music, has been adopted for ordinary tests. The

selection of this particular frequency of 512 double vibrations does not tell the entire story, for in actual practice the noises encountered in office buildings, schools, auditoriums and the like range from the low pitch of 128 vibrations to 1024 vibrations. The scale range embraces the more common mechanical noises and the higher tones encountered in lecturing, music, and the like. The standard of measuring the coefficient of sound absorption at 512 double vibrations is a reasonable comparison, although in determining the value of any sound absorbing material, the entire range from 128 to 1024 double vibrations should be tested, and the average coefficient of sound absorption possessed by any given material used to determine the number of sound absorption units, or the sound absorbing efficiency per square yard of surface.

Since the precise acoustical results to be obtained in any room or building can be accurately figured, it is evident that the absorption of the lower tones or frequencies embraced within the pitch scale 128 to 512 double vibrations must be taken into account and that acoustical efficiency measurements based only on the absorption of higher tones and frequencies as used by some manufacturers in the past to show sound absorption with reference to musical or lecture tones do not accurately give the efficiency of the material.

Referring to the following tests and Figures 3 and 4 of the drawings it will be noted that the sound absorptive efficiency of my plaster increases with the thickness of the plaster due to the building up of the intercommunicating pores from front to back of my plaster and increases as the double vibration rate is increased. At 512 vibrations it will be noted that my improved plaster varying from ½ inch thick to 1¼ inches thick has a coefficient of sound absorption varying from 37% to 64%. The average of three other plasters of ½ inch thickness varies from 9% to 27% with the rate at 512 double vibrations of 20%. The plaster in curve G, which has a dense smooth washable surface is composed of an acoustical plaster and a finish coat of a part cement plaster. The preferred formula for the finish coat is one part white Portland cement, one part hydrated lime and eight parts 20–30 mesh pumice or other light porous mineral, the finish being applied with the hawk and trowel over a base of my acoustical plaster and trowelled to an even surface.

Tests on my acoustical plaster show (Figures 3 and 4):

My acoustic plaster, 1¼ inches thick (Graph A)

At 128 d.v. has .50 coefficient of sound absorption
At 256 d.v. has .59 coefficient of sound absorption
At 512 d.v. has .64 coefficient of sound absorption
At 1024 d.v. has .61 coefficient of sound absorption
At 2048 d.v. has .67 coefficient of sound absorption
At 4096 d.v. has .83 coefficient of sound absorption

My acoustic plaster, 1 inch thick (Graph B)

At 128 d.v. has .46 coefficient of sound absorption
At 256 d.v. has .48 coefficient of sound absorption
At 512 d.v. has .50 coefficient of sound absorption
At 1024 d.v. has .59 coefficient of sound absorption
At 2048 d.v. has .62 coefficient of sound absorption
At 4096 d.v. has .70 coefficient of sound absorption

My acoustic plaster, ¾ inch thick (Graph C)

At 128 d.v. has .44 coefficient of sound absorption
At 512 d.v. has .55 coefficient of sound absorption
At 2048 d.v. has .70 coefficient of sound absorption

My acoustic plaster, ½ inch thick on wall board (Graph H)

At 128 d.v. has .27 coefficient of sound absorption
At 256 d.v. has .30 coefficient of sound absorption
At 512 d.v. has .37 coefficient of sound absorption
At 1024 d.v. has .55 coefficient of sound absorption
At 2048 d.v. has .57 coefficient of sound absorption
At 4096 d.v. has .64 coefficient of sound absorption

Average of 3 other acoustic plasters, ½ inch thick (Graph J)

At 128 d.v. has .09 coefficient of sound absorption
At 256 d.v. has .14 coefficient of sound absorption
At 512 d.v. has .20 coefficient of sound absorption
At 1024 d.v. has .23 coefficient of sound absorption
At 2048 d.v. has .27 coefficient of sound absorption

My acoustic plaster, ¾ inch thick, 3 coats of lacquer (Graph E)

At 128 d.v. has .35 coefficient of sound absorption
At 256 d.v. has .38 coefficient of sound absorption
At 512 d.v. has .42 coefficient of sound absorption
At 1024 d.v. has .44 coefficient of sound absorption
At 2048 d.v. has .46 coefficient of sound absorption

My acoustic plaster, ¾ inch thick on metal lath tested at the Bureau of Standards, Washington, D. C., showed the following sound absorbing properties:

At 128 d.v. has .32 coefficient of sound absorption
At 256 d.v. has .65 coefficient of sound absorption
At 512 d.v. has .63 coefficient of sound absorption
At 1024 d.v. has .67 coefficient of sound absorption
At 2048 d.v. has .83 coefficient of sound absorption
At 4096 d.v. has .84 coefficient of sound absorption

The result of these and other tests has been used to prepare the graphs in Figures 3 and 4. Curve A represents my acoustical plaster 1¼ inches thick and shows a substantially continuous increase in coefficient of sound absorption from 128 double vibrations to 4096 double vibrations. This plaster is mixed according to the formula hereinbefore described and applied in the manner pointed out in successive layers of approximately ¼, ⅜, or ½ inch in thickness to the desired final thickness. It has a coefficient of sound absorption as shown on this graph which is higher than any form of acoustical plaster heretofore known, at 512 double vibrations the coefficient of sound absorption is approximately 64%, and is more than double the common range of sound absorbing coefficients of average plaster as shown for example by curve J in Figure 4, which represents the average of three typical acoustic plasters.

Curve B represents my acoustical plaster 1 inch thick the determinative points of which are indicated on the preceding data sheet. It will be noted that this plaster has a coefficient of sound absorption of 50% at 512 double vibrations, but due to its lesser thickness the sound waves do not travel so far

into the pores and it does not equal the thicker plaster.

Curve C represents my acoustical plaster in a thickness of ¾ of an inch and similarly closely approximates the thicker plaster, but has a more regular increase in absorption. It is to be noted that the increase in the coefficient to sound absorption does not directly increase with the thickness of plaster, apparently indicating that the amount of air bubbles entrapped varies slightly and the porosity of the samples has some effect on the absorption coefficient. It is to be noted however, that generally the thicker the sample the greater the sound absorption efficiency. The results shown are the results of numerous tests conducted in the laboratories of the University of California and the characteristics are substantially correct regardless of variations in individual samples. Curves D and E are acoustical plasters ¾ of an inch thick and similar to the curve C with the exception that the plaster in curve D had one coat of lacquer, and the plaster in curve E had three coats of lacquer. It is to be noted that although curves D and E are of acoustical plasters which have been painted the coefficient at 512 double vibrations is not less than 43%.

In Figure 4 curves are drawn representing the coefficient of sound absorption at different double vibration rates, and curve F is acoustical plaster ¾ of an inch thick corresponding to curve C, but having a hard smooth finish previously described. It is to be noted that the hard smooth finish has increased the sound absorbing efficiency and at 512 double vibrations the coefficient is approximately 57% as compared with 52% for curve C. This is unusual for an acoustical plaster, as ordinarily a hard smooth surface means high sound reflection and low sound absorption. By providing however a porous background consisting principally of pumice and gypsum plaster with interconnecting pores formed by the air bubbles entrapped by the glue, and covering this with a surface coat consisting of cement, lime, and pumice the hard washable surface is still porous enough to permit the penetration of the sound into the backing layer, and once in the porous caverns the sound wave gradually expends its energy and dies without being reflected back into the room.

Curve G is a similar ¾ inch thickness of acoustical plaster with a dense, smooth, washable finish. Such plaster has a more irregular coefficient of sound absorption which however, equals nearly 39% at 512 double vibrations, and which has a high coefficient of absorption both in the range above and below the central 512 point.

Curves H and I are ½ inch acoustical plaster tests, the data of which is included in the tables, curve H indicating ½ inch plaster on wall board base and curve I indicating ½ inch acoustical plaster on hard wall plaster base. As both the wall board and hard wall plaster act as a sound reflector the coefficient of sound absorption is relatively low. Even in this thickness however the results indicate that acoustical plaster applied to present wall surfaces causes an appreciable improvement in sound absorption. Such plaster treatment is not as satisfactory however as using the improved acoustical plaster from the base out as, for example, the material on which the tests in curves H and I were made is substantially the same as the material on which curve A was made, the difference being, in curve A the entire thickness of material for 1¼ inches was acoustical plaster whereas, in curves H and I the material tested was only ½ inch of acoustical plaster and the remainder being a sound reflector such as hard wall plaster or wall board.

The final curve J is the average of three ordinary plasters the equivalent of ½ inch thick and shows a coefficient of sound absorption of only 20% at 512 double vibrations. It shows by its comparison that the acoustical plaster even mounted on hard wall plaster has an improved sound efficiency and when painted as shown in curves D and E it still has an additional advantage equal to more than double the coefficient of absorption of ordinary plaster and with the sample 1¼ inches thick the improved acoustical plaster shows an advantage of five to one in the lower range, and three to one at 512 double vibrations and substantially three to one in the higher range over ordinary plaster.

Increasing the thickness of ordinary plaster does not ordinarily increase its sound absorption as ordinary plaster has a sound reflecting surface and no matter how thick it may be approximately 90% of the sound waves striking it are reflected back into the room.

My acoustical plaster may be applied in various degrees of thickness to meet required conditions of all types of interiors. To have the highest absorptive coefficient it is desirable to apply the plaster to a thickness of 1¼ inches which gives the unusually high absorptive coefficient of 64% at 512 double vibrations but the commercial thickness of ½ inch shows substantially twice the coefficient of sound absorption of acoustical plaster prior to my invention. Due to the high absorptive coefficient it is possible to gage with absolute accuracy the final result desired and the walls and ceilings may be covered with varying thicknesses of plaster as desired. The sound is controlled without creating deadness as sounds of all pitches are absorbed equally.

The acoustical plaster produced hereby even with the gypsum plaster binder has a hard surface that will not rub or scale off.

It not only has a high absorptive value but has a surface allowing any type of decoration. It may be sprayed for example with a non-bridging lacquer that does not close its pores, or the surface may be stencil designed or hand decorated with lacquer. The surface appears smooth at a distance.

The improved acoustical plaster is applied preferably in three separate coats, the first or scratch coat being applied to a thickness of 1/4 inch and allowed to thoroughly dry before applying the second coat. The plaster is preferably applied to metal lath, although it may be applied to hard wall plaster base, plaster board, or even to concrete. The second or browning coat is applied preferably to a thickness of 1/4 inch and leveled off with a rod or darby without water and allowed to thoroughly dry before applying the finish coat. The finish coat may be applied to a thickness of 1/4 inch and finished with a trowel, bringing the surface to as even a plane as possible with the least amount of troweling, always troweling in one direction only. If the 1 1/4 inch thickness of plaster is desired it is merely necessary to increase the amount of plaster applied in the separate coatings. All work should be carried to completion at one time where possible and finished at the natural breaks. As shown by the charts and when applied to a thickness of 1 1/4 inches strictly according as directed above the improved acoustical plaster will have an absorptive value not less than 60% at 512 double vibrations.

The improved acoustical plaster is very porous and in appearance is similar to the ordinary lime and gypsum plasters. It is plastic and can be easily applied to curved surfaces and run into moulds. It has a natural appearance in place and is fireproof and fire resisting. Due to its natural mineral base and scientific formula germ life will absolutely not live in it and it is therefore germ-proof and vermin-proof. There is no hair felt or fibre to which the germs and vermin might be attracted. Its density is less than 30% of the density of solid material, the other 70% consisting of voids or communicating cells from the face to the back of the plaster.

It is possible to use hydrated lime instead of gypsum and the mix can be made of ground pumice with the proper amount of gypsum or lime, or a combination of gypsum and lime. It is also possible to use siliceous porous materials in the natural state or artificial products such as expanded slags of various metals, or to use silica in expanded form. It is also possible to use cork or other light porous cinders such as coke instead of pumice, although not as good results are obtainable as when the pumice is used. Certain of the other materials however, have a lower cost making it possible to apply the plaster in heavier coats. It is also possible to use Portland cement instead of gypsum plaster as a base, and in such a case the wall covering is slightly more dense and therefore less absorptive.

As there is nothing in the mix to effervesce or spoil, and as there is no chemical action it is possible to apply the plaster in a reasonable time and it is unnecessary after drying to cut the surface as the cells when drying will automatically communicate to the outer wall. This is due to the fact that as long as the mix is wet enough to apply the glue will be moist and tough. Only on drying does glue become brittle and crack to form the inter-communicating pores. The alum used in the mix is purely to facilitate setting and aids to dry out the plaster.

It is extremely easy to mix the plaster as it is merely necessary to take dry materials of natural pumice or similar raw materials which have been finely ground and mix with gypsum plaster and then to add water, to which sufficient glue and alum have been added, it being understood that hide glue and similar water soluble glues are used and preferably preliminarily dissolved in hot water to hasten the solution.

It is my belief that the high sound absorbing efficiency of my acoustical plaster is due to its surface porosity and to the fact that the inner pores or cavities are substantially 100% inter-communicating from front to back of the plaster so that sound waves entering the surface pores are reverberated through the labyrinth of sub-surface cavities until they are absorbed in a manner similar to the principle of absorbing the sound of a rifle shot or an automobile exhaust by a silencer consisting of a multitude of sound absorbing chambers.

While I am aware that modifications may be made to the formula of the product set forth it is understood that the product is a preferred one and that certain modifications may be made thereto within the scope and spirit of this invention, and I therefore desire a broad interpretation of this invention within the scope and spirit of the decription thereof and the claims appended hereinafter.

I claim:

1. An acoustical plaster consisting of a porous aggregate, a gypsum plaster binder, a glutinous air binding material and alum and having interconnected pores throughout, and having a hard washable surface with a porous surface, said plaster in a thickness of 3/4 inch having a coefficient of sound absorption above 35% at 512 double vibrations.

2. An acoustical plaster consisting of a pumice aggregate, a cementitious binder, a glue, alum and water, said plaster when applied to the walls or ceiling by ordinary hawk and trowel methods having a smooth, hard

washable surface with pores from front to back thereof and having a coefficient of sound absorption from 30% at 512 double vibrations in thicknesses of ½ inch to 50% at 512 double vibrations in thicknesses of 1 inch or more.

3. A plaster having acoustical absorbent properties comprising 75 pounds of pumice, 25 pounds of stucco plaster, approximately 6 gallons of water, 6 ounces of hide glue and 3 ounces of alum.

4. A composition of matter consisting of natural volcanic pumice and gypsum stucco plaster in the ratio of 3 to 1 by weight and mechanically mixed with an aqueous solution of a gelatinous material of glue and alum forming temporary air bubbles, breaking on drying.

5. An acoustical plaster which is applied by ordinary hawk and trowel methods and on drying has a cellular porous sound absorptive structure from front to back thereof with intercommunicating pores, comprising a pumice aggregate, a gypsum plaster binder, glue sufficient to act as an air binder during application of the mix, a hardening agent, and water.

6. An acoustical plaster which is applied by ordinary hawk and trowel methods and on drying has a cellular porous sound absorptive structure, comprising a porous mineral aggregate, a plaster binder, a glutinous material capable of acting as an air binder during application of the mix, alum and water.

7. An acoustical plaster comprising a finely ground pumice aggregate varying from minus 8 to plus 40 mesh, a calcined gypsum binder, a glue air binding ingredient and an alum hardening agent, said plaster being capable of application to a wall or ceiling by ordinary hawk and trowel methods, and when applied and set having a smooth, hard, washable surface with intercommunicating pores extending from front to back thereof and having a coefficient of sound absorption above 30% at 512 double vibrations in a thickness of one-half inch.

8. An acoustical plaster when gauged with water forming a plastic for application to walls and ceilings with ordinary plastering tools, including a porous mineral aggregate, a cementitious binder glue and a hardening agent, said glue entrapping mechanically intermixed air bubbles to form intercommunicating cavities when set extending from the surface to the back thereof, said plaster when applied having a coefficient of sound absorption above 40% at 512 double vibrations in a thickness of three quarters of an inch.

9. An acoustical plaster when gauged with water forming a plastic for application to walls, ceilings and the like, and capable of application by ordinary hawk and trowel methods to form a smooth porous surface, and comprising a porous aggregate and gypsum plaster binder, a glue air binding material to entrap air bubbles, said air bubbles on drying forming interconnected pores throughout the plaster, said plaster having a hard, washable surface, and in the thickness of three quarters of an inch, having a coefficient of sound absorption above 35% at 512 double vibrations.

10. An acoustical plaster comprising a pumice aggregate, a calcined gypsum binder, a glue air binding ingredient, and a hardening agent, said plaster being capable of application to a wall by ordinary hawk and trowel methods and when applied having a smooth, hard, washable surface with intercommunicating pores extending from front to back thereof and having a coefficient of sound absorption above 30% at 512 double vibrations in a thickness of one-half inch.

In testimony whereof I have affixed my signature to this specification.

LESLIE B. EATON.