This invention relates to acoustic corrective material and has reference more particularly to a so-called acoustical tile which is intended for the absorption of impinging sound waves, for the purpose of minimizing the reverberation within a room, auditorium, or similar enclosed space.

This application is a division of applicant's prior application Serial No. 466,916, filed July 10, 1930, now matured into Patent No. 1,901,057 of March 14, 1933.

In the manufacture of tile or other molded products to be used for heat insulation, and where the composition contains gas-forming agents, it is desirable to have the individual cells, formed by the gas in the plastic mix, completely enclosed by the cell walls so as to prevent convection air currents and to thus give the maximum heat insulation efficiency. However, for the manufacture of tile used for walls and ceilings for the purpose of acoustical correction and for absorbing sound to prevent echoes, it is desirable that the cells be intercommunicating one with another so as to secure maximum sound absorption. It is also desirable that the cell walls of the acoustical tile be of a high tensile and compressive strength so that crumbling or breaking of the tile will not be experienced during installation and use.

One of the objects of this invention is to provide an improved acoustical tile in which the cell walls are in intercommunication with each other.

A further object of the invention is to provide an acoustical tile for a high sound-absorption efficiency and also to improve acoustical materials in other respects hereinafter specified and claimed.

Reference is to be had to the accompanying drawing forming a part of this specification, in which

Fig. 1 is an elevation of my improved acoustical tile after it has set but before it has been dried out;

Fig. 2 is an elevation of the finished tile after it has been dried out;

Fig. 3 is a sectional elevation on a large scale of a portion of the tile showing the character of the cell walls;

Fig. 4 is an elevation of a modified form of the acoustical tile;

Fig. 5 is an elevation of a second modified form of the acoustical tile;

Fig. 6 is a bottom view of the acoustical tile shown in Fig. 2;

Fig. 7 is a sectional elevation of a ceiling construction showing the method of attaching the acoustical tiles to form a ceiling; and

Fig. 8 is a fragmentary sectional view, on an enlarged scale, taken on the line 8—8 of Fig. 6.

The formula for preparing my improved acoustical materials is compounded so that a minimum of gas entrainer is employed, thus insuring that the cells will be rather large and have a tendency to break down, leaving the cells intercommunicating. I desire to have the cells rather large so that the surface of the molded acoustical tiles may be painted after they become soiled in use without materially diminishing the sound-absorbing efficiency of the tile. In order to assist the breaking effect in the cell walls and to cause the cells to become intercommunicating, I add several per cent of dry wood fiber to the plastic mix, and these fibers pierce the cell walls and swell up, due to the water in the plastic mix, thus also aiding in the disruption of the cell walls. Upon drying out, the wood fibers shrink in diameter, thus tending to produce a larger hole surrounding each fiber and connecting the individual cells.

Another novel ingredient which is used in my improved composition is a product which I shall designate as "alpha gypsum". This alpha gypsum is described and claimed in the copending application of Randel and Dalley, Serial No. 384,345, filed August 9, 1929, now matured into Patent No. 1,901,051, dated March 14, 1933, and entitled "High strength calcined gypsum". This product has the unique property of a high setting expansion of 0.25% to 0.4% on a consistency of 50% or less in the plastic mix. This high setting expansion also tends to disrupt the cell walls and cause the cells to be intercommunicating and thus having a higher sound absorption efficiency. This alpha gypsum has a compressive strength which is in excess of that of Portland cement, and ranges from 2000 to 6000 pounds per square inch, from a casting made at a pouring consistency of less than 50%. Because of the high strength of this alpha gypsum, the resulting acoustical tiles have a high resistance to breaking during installation and use, and are not subject to crumbling as is commonly experienced with porous acoustical tiles of this nature made from ordinary plaster of Paris. In spite of its high strength, the alpha gypsum has a setting time of 15 to 30 minutes which is advantageous in making molded acoustical products of low density.

This high strength calcined gypsum, or alpha gypsum, is manufactured by treating lumps of gypsum rock having a diameter of one-half inch to two inches in a closed container with steam at
17 to 20 pounds gauge pressure. This steam calcination is carried on for a period of 4½ to 7 hours with a constant steam pressure and with a constant withdrawal of water of condensation obtained from the heating steam, and also from the expelled water of crystallization. After calcination, the product is dried while maintaining a temperature close to 212° F., and this product is ground so that 85% of it passes through a 100 mesh screen.

The crystals of ordinary first settle calcined stucco when examined through the crossed nicols of a petrographic microscope are seen to be very fine and needle-like, these crystals being mostly less than five microns in diameter. The crystals of the improved alpha gyspum, viewed through the same microscope, are seen to be rather short, thick, and well formed. The crystals of alpha gyspum are practically pure calcium sulphate and when viewed through a polarizing microscope appear brilliantly colored, while little or no color effect is visible in the case of the tiny, needle-like crystals of ordinary plaster of Paris. Other properties of the alpha gyspum are fully described in the said co-pending application Serial No. 384,343.

The formula of my improved composition is as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha gyspum</td>
<td>2000</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>87</td>
</tr>
<tr>
<td>Aluminum sulphate</td>
<td>59</td>
</tr>
<tr>
<td>Gum arabic</td>
<td>10</td>
</tr>
<tr>
<td>Plastic fiber</td>
<td>44</td>
</tr>
<tr>
<td>Water to bring to molding consistency</td>
<td></td>
</tr>
</tbody>
</table>

The solid ingredients in the above formula are mixed together in any order, and when water is added to the powdered mixture, the calcium carbonate and aluminum sulphate react to produce carbon dioxide gas, which serves to puff up the plastic mass and introduce a multitude of gas cells 10 into the mix. Aluminum hydroxide and calcium sulphate are other products of this reaction.

The dry wood fiber 11 in the mixture pierces the cell walls and swells up due to the action of the water, thus causing the cell walls to be disrupted. Upon drying, the wood fiber shrinks, thus leaving a larger hole in the cementitious cell walls, these holes around the individual fibers serving to connect the individual cells and cause them to be intercommunicating for maximum sound absorption efficiency.

Only a slight gas entraining action is desired, and this is accomplished by means of a gum arabic. By permitting some of the gas to escape from the soft molded mass, there is a tendency to make the cell walls still more intercommunicating. The high setting expansion of the alpha gyspum also aids in disrupting the cell walls and thus connecting up the individual cells.

The ingredients in the above formula may be varied somewhat as follows with varying success:

<table>
<thead>
<tr>
<th>Material</th>
<th>20-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium carbonate</td>
<td></td>
</tr>
<tr>
<td>Aluminum sulphate</td>
<td></td>
</tr>
<tr>
<td>Gum arabic</td>
<td>5-20</td>
</tr>
<tr>
<td>Plastic fiber</td>
<td>25-75</td>
</tr>
<tr>
<td>Water to bring to molding consistency</td>
<td></td>
</tr>
</tbody>
</table>

Gum tragacanth or light colored dextrines may be substituted instead of the gum arabic. However, the gum arabic has a decided strengthening action for the finished set and dry composition. Sodium hydrogen sulphate and calcium carbonate may be used if desired to cause the generation of carbon dioxide. Sodium bicarbonate may also be used alone, as a gas generating agent, since this reacts with calcium sulphate of the tile. Ordinary first settle calcined gyspum hydraulic cement and other cementitious materials may be used instead of alpha gyspum with less satisfactory results.

In molding the tile, a stiff backing sheet 12 of plaster board, fiber board or other suitable sheet material, is placed in the bottom of a similarly sized mold, and the plastic cementitious mix is then poured on top of this backing sheet. When the mass has set to solid form, the tile is removed from the mold and placed in a suitable dryer until the cementitious material is thoroughly dry.

The outer surface 13 of the tile which is exposed to the impinging sound waves may be removed by buffing or abrading with a grinding wheel to expose the interior of the cells, and the exposed edges of the tile may be provided with bevels 14 for giving a pleasing appearance when the tile is applied to a ceiling or wall of a room.

If desired, the back of the tile may be provided with an opening 16 (Fig. 4). A separate mineral wool or hair felt mat 16 about ½" or ¾" thick may then be provided in the form of a quilt with a cheesecloth wrapping, or it may be a sewed quilt or even a mat which was loosely stuck together with sodium silicate. This mat is made slightly smaller than the opening 16 and may be placed in the tile at the job just before the erection of the tile.

Still another form of the invention is shown in Fig. 5, in which a mineral wool or hair felt mat 11 is completely coated with a plastic mix and laid in the mold on top of the backing sheet 12. The plastic mix is then poured on top of the mat 17 to the desired depth. The purpose of the mats 16 and 17 is to improve the sound absorbing characteristics of the tile.

Regardless of the structure of the sound absorbing tile itself, it will usually be found desirable to provide a plurality of openings 18 (Fig. 6), such as one in each of the four corners. Wire hangers having outstanding legs 19 embedded in the cementitious material are provided with loops 20 which extend outwardly through the openings 18 (Figs. 7 and 8). Wires 21 are then fastened through the loops 20 and passed upwardly over any suitable supporting framework 22. The framework 22 may be in the form of horizontal grillage work secured by wires 23 to main supporting beams 24. It will usually be found desirable to place a sheet of paper 25 or other impervious material over the acoustical ceiling tile 80 so as to prevent air infiltration into the room through the tile. Other mechanical fastening means for the tiles may be used if desired.

If desired, the plastic cementitious mix may be poured onto the upper surface of a plaster board immediately after it is formed on a plaster board machine. After setting of the plaster board and the upper layer of porous cementitious material has occurred, the boards may be cut to the desired size for acoustical tile, and these tiles then passed through the dryer in the usual way.

The composition of materials thus employed for the manufacture of this tile has been claimed.
in the aforesaid co-pending application Serial No. 466,916 (now Patent No. 1,901,057).

I would state in conclusion that while the illustrated examples constitute a practical embodiment of my invention, I do not wish to limit myself precisely to these details, since manifestly the same may be considerably varied without departing from the spirit of the invention as defined in the appended claims.

Having thus described my invention, I claim as new and desire to secure by Letters Patent the following:

1. An acoustical tile comprising a backing sheet, a porous, sound-absorbing cementitious material adorning a surface of said backing sheet, and mechanical attaching devices molded in said cementitious material.

2. An acoustical tile comprising a backing sheet, a porous, sound-absorbing cementitious material molded onto one surface of said backing sheet, and mechanical attaching devices molded into said cementitious material and extending through said backing sheet.

3. An acoustical ceiling comprising structural support members for a ceiling, acoustical and porous sound-absorbing molded material, mechanical attaching devices embedded and molded in said acoustical material, and wires connecting said attaching devices to said structural support members.

4. An acoustical tile comprising a slab of cementitious material having intercommunicating gas cells, said slab having a recess formed in one surface thereof, and a mat of fibrous material positioned in said recess.

5. An acoustical tile comprising a mat of fibrous material, a cementitious sound-absorbing material having intercommunicating cells and surrounding said mat, and a backing sheet of stiff material attached to one surface of said slab.

6. An acoustical ceiling comprising tiles of cementitious material having a multitude of intercommunicating cells, means for suspending said tiles in a horizontal plane, and an impervious sheet of material extending over said tiles so as to prevent air filtration through said tiles.

7. A wall or ceiling structure embodying a coat of porous material formed with isolated vibratory sections on its surface, and damping means for the vibratory sections.

8. A wall or ceiling structure embodying a coat of porous material formed with isolated porous vibratory sections on its surface, and damping means for the vibratory sections.

9. A wall structure comprising a coat of porous sound absorbing body material, and elastic bodies embedded in isolated relation in the body material.

10. A wall structure comprising a coat of porous sound absorbing body material, and cellular pads of yieldable nature embedded in isolated relation in the body material providing vibratory body material sections spaced apart over the surface of the wall.

11. A wall structure comprising a porous body material having voids opening at the face of the wall, and elastic pads embedded in isolated relation in the material parallel to the face of the wall.

12. A wall structure for the treatment of acoustics comprising a coating of plastic body material, and a plurality of flat yieldable pads embedded in isolated relation in the body material in a plane parallel to the face of the wall.

13. An acoustical wall structure comprising a coat of body material, and yieldable pads embedded in the material in spaced apart relation providing separate vibratory sections, said vibratory sections having voids opening at the face of the wall.

14. An acoustical wall block composed of a plastic body material, and an elastic pad embedded in the material parallel to the face of the block.

15. An acoustical wall block comprising a porous body portion having sound absorbing qualities, and a cellular pad of a yieldable character embedded in the body portion parallel to the face of the block.

16. An acoustical tile comprising a rigid backing sheet, a mass of porous gypsum composition adhering to one side thereof, the composition containing innumerable interconnecting voids, and means embedded in the gypsum and extending through the backing sheet for fastening the tile to a support.

17. An acoustical tile comprising a piece of plaster board, a mass of porous gypsum composition adhering to one side thereof, the composition containing innumerable interconnecting voids, and means embedded in the gypsum and extending through the plaster board for fastening the tile to a support.

18. An acoustical tile comprising a slab of porous, sound-permeable gypsum, said slab having a recess formed in one surface thereof, and a mat of fibrous material positioned in said recess.

19. An acoustical tile comprising a mat of fibrous material, a connectedly porous sound-permeable mass of gypsum surrounding the same, and a backing sheet of stiff material attached to one surface of said slab.

20. An acoustical tile comprising a backing sheet, a mass of porous, sound-permeable gypsum material adhering to a surface of said backing sheet, and mechanical means molded into said gypsum for permitting attachment of the tile to a support.

21. An acoustical wall block comprising a porous gypsum portion having sound absorbing qualities, and a pad of yieldable fibrous material embedded in the gypsum parallel to the face of the block.

22. A sound-absorbing unit comprising a piece of plaster board, a layer of connectedly porous sound-permeable gypsum on one side thereof, openings being provided through said plaster board giving access to the gypsum layer, and suspension means embedded in the gypsum and extending through the said openings.

23. A sound-absorbing ceiling and wall construction comprising the combination of supporting means, rigid board tile, a layer of connectedly porous sound-permeable cement thereon, openings being provided in said board, suspension means embedded in said cement and extending through the board, and means connecting said suspension means with the supporting means.

24. A sound-absorbing ceiling and wall construction comprising the combination of supporting means, a piece of plaster board, a layer of connectedly porous sound-permeable gypsum cement thereon, openings being provided in said board near the corners thereof, suspending wires embedded in the gypsum and extending through said openings, forming loops therein, and means for connecting said loops with said supporting means.
25. A sound-absorbing ceiling construction comprising the combination of supporting beams, transverse supports supported thereby, a plurality of mutually abutting tile consisting of plaster board having a layer of connectedly porous sound-penetrable gypsum composition on the lower side thereof, holes being provided in said board, suspending means embedded in said gypsum and extending upwardly through said holes, forming loops, and tie-wires connecting said loops with said transverse supports.

CARLISLE K. ROOS.