April 30, 1963 J. J. BARUCH ET AL 3,087,575

ACOUSTIC CONSTRUCTION UNIT

Original Filed July 10, 1956 3 Sheets-Sheet 1

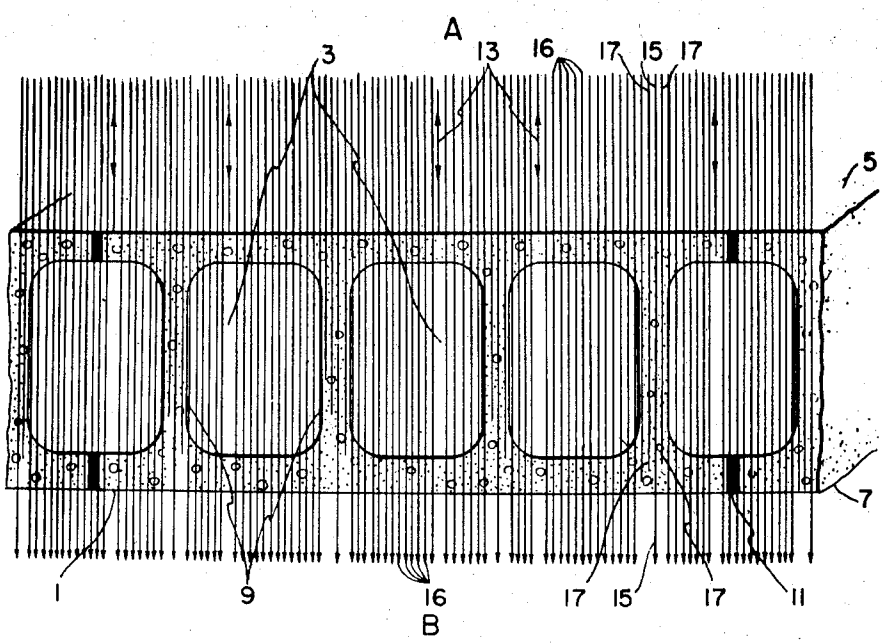


FIG. 1

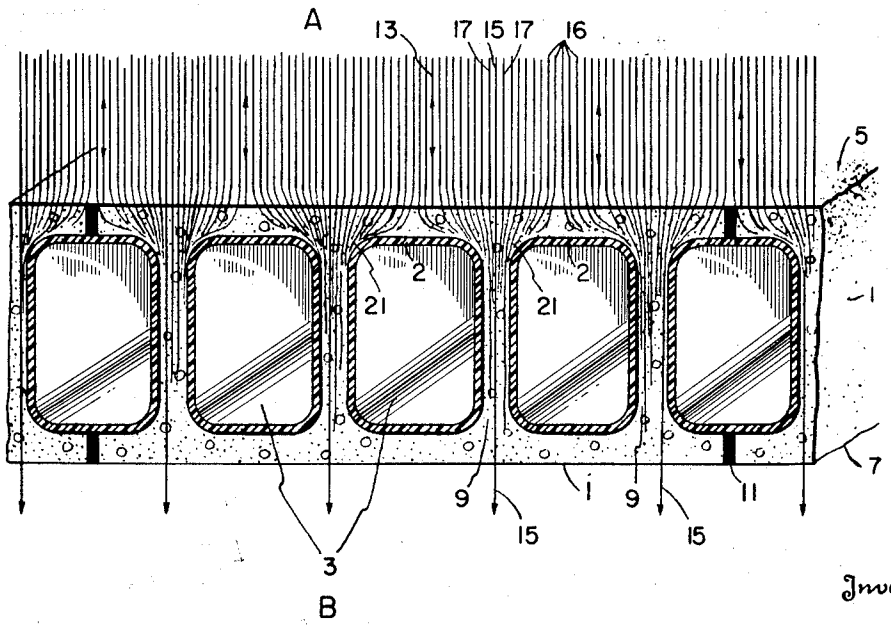


FIG. 2

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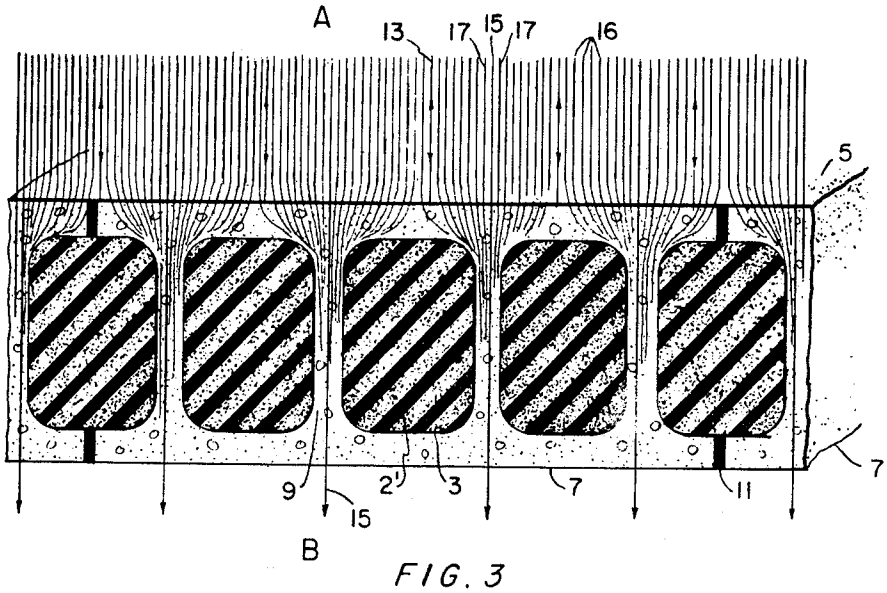


FIG. 3

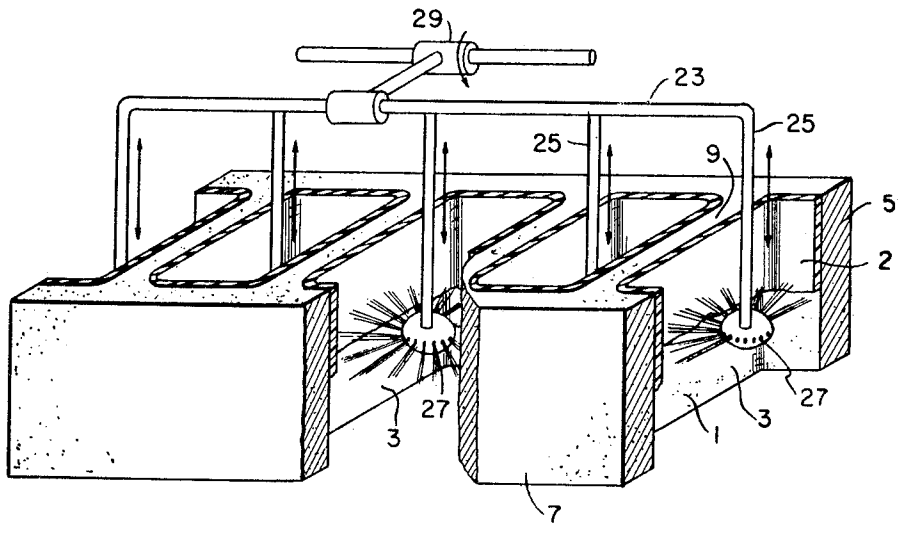


FIG. 4

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Original Filed July 10, 1956 3 Sheets-Sheet 3

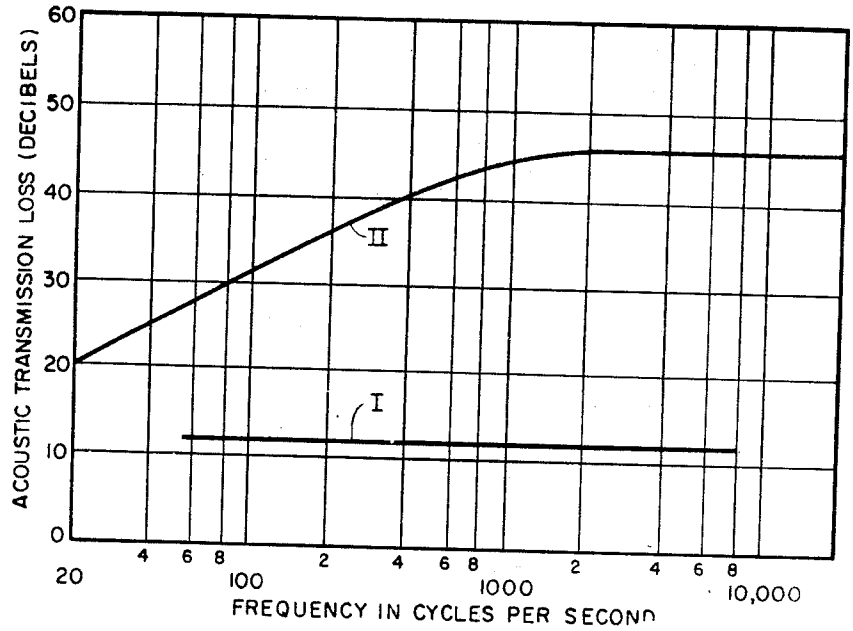


FIG. 5

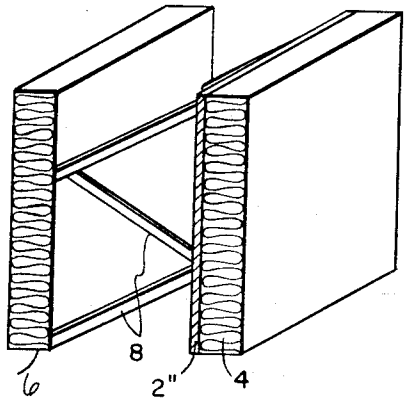


FIG. 6

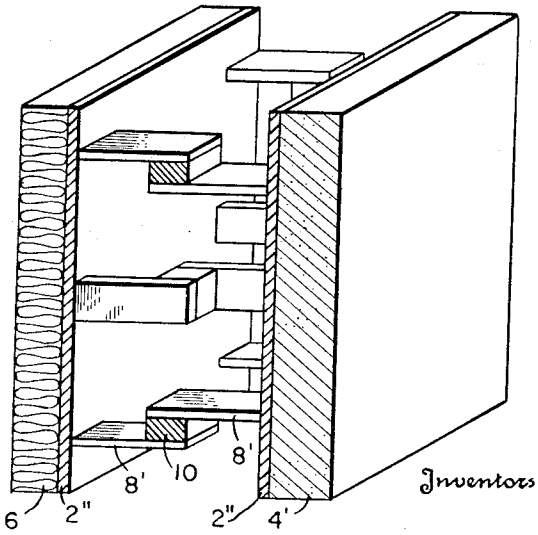


FIG. 7

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ACOUSTIC CONSTRUCTION UNIT

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Continuation of application Ser. No. 596,955, July 10, 1956. This application Nov. 7, 1960, Ser. No. 67,799
3 Claims. (Cl. 181—33)

The present invention relates to acoustic construction units and methods and, more particularly, to building construction units such as wall blocks and the like that are adapted to provide not only high acoustic absorption but also high acoustic transmission loss. This application is a continuation of Serial No. 596,955, filed July 10, 1956.

The wall structures separating rooms in many present-day buildings are frequently fabricated from construction-unit concrete cinder blocks, secured to one another to make up the wall structure. In offices, school classrooms and other buildings, it is important that the walls have a high acoustic transmission loss in order to prevent the transmission of sound from one room to an adjacent room. In order to achieve such a high transmission loss in a wall structure one block thick, the wall construction units must be both massive and substantially impervious to air. The term "impervious," as used in the specification and claims herein, is intended to connote that the acoustic-energy flow resistance through the wall material is many orders of magnitude greater than the characteristic impedance of air presented to a plane acoustic wave; namely, greater than 76 rayls, expressed in centimeter-gram-second units. A dense concrete wall and a wall formed of concrete block both have the necessary mass and imperviousness to acoustic energy to provide the desired high transmission loss. Brick walls and walls of plastered cinder block and the like similarly are quite satisfactory from the transmission loss standpoint. Unfortunately, however, such walls provide substantially no acoustic absorption, so that while the acoustic energy in one room will not be transmitted to an adjacent room, as a result of high transmission loss, the acoustic energy will reflect and scatter from the walls in the said one room, giving rise to noise and echo problems therein. From the esthetic and housecleaning point of view, moreover, such walls are flat and of smooth texture requiring frequent painting and making evident dirt and stain marks. In order to provide acoustical absorption in the room, accordingly, it is usually necessary to add materials, such as acoustic tiles, to the exposed surfaces of the walls in the room. Such additions, however, increase the construction time and the materials and labor costs appreciably.

More recently, blocks of cement have been utilized as wall construction units containing an aggregate, such as pumice, as interior partitions. While such blocks have a high enough porosity to provide a reasonable degree of absorption of the sound in the room striking the walls thereof, this same porosity, unfortunately, renders the blocks extremely poor structural units from the point of view of transmission loss between adjacent rooms. The poor transmission loss property of such blocks may be partly overcome by external painting or by thoroughly sealing the external surfaces, as by plastering. This step, however, vitiates against the inherent absorption properties of the wall material and, in addition, eliminates the esthetically desirable rough-texture appearance of the wall which obviates the necessity for painting or other wall finishing and conceals dirt and stain marks. The poor transmission loss of such blocks could be improved, however, by constructing a wall two blocks thick with an acoustically impermeable septum between them that is

either a heavy septum or that is attached to one or both of the walls. While such a construction would render the wall satisfactory from the point of view of both transmission loss and acoustic absorption, and would maintain all of the desirable esthetic and housecleaning features before referred to, the cost of such a wall is more than double the cost of a single-block wall.

An object of the present invention is to provide a new and improved construction unit that shall inherently possess all of the desirable properties above referred to and none of the undesirable properties of prior-art construction units. Specifically, a construction unit is provided in accordance with the present invention that has both excellent acoustic transmission loss and excellent acoustic absorption characteristics and, in addition, may have the desirable physical properties that obviate the display of dirt and stain marks and the necessity for painting or other finishing.

A further object is to provide a new and improved construction block.

Still a further object is to provide a novel method of rendering construction units that have satisfactory acoustical absorption properties capable of simultaneously assuming high transmission-loss properties, as well. In summary, from perhaps its broadest viewpoint, the present invention contemplates a construction unit having a pair of acoustically absorptive wall surfaces adjacent one another with a space therebetween, the space being rendered acoustically resistive to a much higher degree than the acoustic resistivity of the wall materials by preferably covering the inner surfaces of the walls with a substantially air-impervious material. Preferred constructional details are hereinafter set forth.

Other and further objects will be explained hereinafter and will be more particularly pointed out in the appended claims.

The invention will now be described in connection with the accompanying drawing, FIG. 1 of which is a fragmentary perspective view of a plurality of wall construction units of the conventional type presently in use;

FIG. 2 is a similar view of the units of FIG. 1, modified in accordance with the present invention to produce the novel results thereof;

FIG. 3 is a similar view of a further modification;

FIG. 4 is a perspective view illustrating a preferred technique for treating construction blocks to attain the results of the present invention;

FIG. 5 is a graph illustrating the marked difference in performance of conventional building blocks and a block constructed in accordance with the present invention; and

FIGS. 6 and 7 are perspective views of further modified construction units.

Referring to FIG. 1, a conventional building block construction unit is shown at **1** comprising a substantially prismatic construction block of porous material, such as pumice, cinder block, cement and pumice aggregate, or organic and filler binder material, to mention a few illustrations. The block contains a plurality of similar spaced intermediate cells, cavities, or air spaces **3** which extend transversely of the block between opposite edges thereof, being defined by the front wall **5** of the block, shown at the top in FIG. 1, the coextensive rear wall **7**, shown at the bottom, and webs or side-wall partitions as shown at **9**. While the block and cavities are shown of substantially rectangular configuration, the latter having rounded corners, other shapes may also, of course, be employed. The blocks **1** are secured to one another, as is well known, with the aid of cement junctions **11** to build up the required wall or other partition structure. The vertical lines shown in FIG. 1 represent ray traces of the path of acoustic energy produced on one side of

the block 1, say, in a room A facing the wall 5, and transmitted through the block 1 to a room B on the other side thereof, facing the wall 7. It will be observed that some of the acoustic energy striking the wall 5 will be reflected back into the room A as is indicated by the doubled-arrow rays 13, but the number of reflected or scattered rays 13 is very small compared with the number of rays incident upon the wall 5. Such porous blocks are therefore sufficiently acoustically absorptive to prevent appreciable reflections and thus serve to minimize echoes and to quiet sounds within the room A.

Other acoustic-energy rays, however, will pass into the porous front wall 5 of the block 1. Those rays entering the front wall 5 in the region of the webs or cavity side-wall partitions 9, such as the rays 15, 17, will have to travel through porous material of length equal to the complete width of the block 1 in order to reach the opposite wall 7. Since the block is relatively thick, these sound waves will become well dissipated during travel along this relatively long path provided by the web 9. Of the incident rays 15, 17, accordingly, only very little acoustic energy, represented by the single ray 15, will emerge from the wall 7 and enter the room B, the bulk of the remaining acoustic energy, represented by the rays 17, being absorbed and hence terminating within the web portions 9. In view of the fact that the webs 9 are relatively thin compared with the width of the cells, cavities or air spaces 3, however, most of the acoustic energy entering the porous front wall 5, represented by the rays 16, will pass through the thin wall 5 bounding the upper sides of the cavities 3, as shown in FIG. 1, and into the air space of the cavities 3. The rays 16 will continue almost unabated through the cavity air space and through the thin lower wall 7, emerging therefrom into the room B. The volume occupied by the spaces 3 is very much greater than the volume occupied by the absorptive material of the block 1 so that a very large proportion of the acoustic energy generated in room A is therefore transmitted through the block 1 into room B. This is represented by the large number of rays incident upon the wall 5 that emerge from the wall 7. The volume of the cavity 3 as compared with the volume of the absorptive-material block may be in ratio of about 1.5 to 1 to about 2 to 1, more or less.

It will thus be evident that, as before stated, while porous construction blocks may be satisfactory as sound-absorbing surfaces to quiet noise within the room A facing the wall surface 5, and within the room B facing wall surface 7, by their very nature of construction, they have extremely poor transmission-loss characteristics that permit sound to pass in large measure through the blocks 1 between the adjacent rooms A and B. In accordance with the present invention, this poor transmission-loss characteristic is remedied by effectively rendering the cells, cavities or spaces 3 substantially impervious to the flow of the fluid medium carrying the acoustic energy; namely, in this case, impervious to the flow of air, as before defined. This is shown accomplished in FIG. 2 by lining the walls of the cells, cavities or spaces 3 with a covering or layer 2 of air-impervious material such as, for example, a latex-base paint covering, an oil paint layer, an asphalt layer, a layer of asphaltum, a plastic coating as of vinyl plastic, and the like, all of which provide air-tight layers that are accordingly substantially impervious to the transmission of acoustic energy. The covering or layer 2 may, on the other hand, be of a plaster or cement grout and the like, which has an extremely high acoustic resistivity. A cardboard or similar lining 2, may also be employed. The criterion that must be satisfied in all cases, however, is that the space between the walls 5 and 7 be effectively rendered substantially air-impervious, or, from another point of view, be rendered of such high acoustic resistance, that the air or other fluid medium carrying the acoustic energy is forced to travel substantially exclusively along the webs or cavity side-wall partitions 9 as a result of a very much higher impedance presented to the acoustic energy in the region of the cavities 3. This is illustrated in FIG. 2 by the bunching or crowding of the incident rays 16 into the neck 21 formed by the webs or partitions 9, resulting in very little of the incident acoustic energy emerging, as at 15, from the wall 7. Since the acoustic resistivity of the layer or layers 2 is greater than the resistivity of the sound-absorbing wall material of the block 1, it is, of course, very much greater than the acoustic resistivity of the air in the cavities 3. While any degree of increased resistivity over that of the characteristic impedance presented by air to a plane acoustic wave, namely, 76 rayls, as before stated, will provide improvement in the transmission-loss characteristic of the construction block, it is desirable that the layer or layers 2 be of high acoustic resistivity having a flow resistance considerably in excess of 76 rayls. While the covering 2 could be applied only to the cavity-bounding top or bottom walls, or both, as viewed in FIG. 2, it is preferable to cover all the walls thereof.

As an illustration of the effectiveness of the present invention, FIG. 5 graphically presents a comparison of the acoustic transmission loss of a substantially standard pumice block 1 approximately 8 inches wide and 16 inches long, before and after treatment in accordance with the present invention. The front- and rear-wall thickness (upper and lower-wall thickness as viewed in FIGS. 1 and 2) and the cavity side-wall or web-partition thickness were all substantially an inch. The ordinate in FIG. 5 represents the acoustic transmission-loss expressed in units of decibels, and frequency is plotted along the abscissa. Curve I illustrates the substantially negligible constant 12 decibels of transmission loss provided by the standard block of FIG. 1 over the principal portion of the audible sound-frequency spectrum. Curve II, on the other hand, demonstrates that the construction unit of FIG. 2 provides acoustic transmission loss of the order of 20 decibels at very low acoustic frequencies in the neighborhood of 20 cycles per second, 30 to 42 decibels in the low and intermediate-frequency range of from about 90 to 600 cycles, and about 46 decibels for the higher frequencies above 1000 cycles. The specific or average flow resistance of a block when treated with a coating 2 formed by two layers of latex has been found to be approximately sixteen times the actual flow resistance of the porous material of the pumice block 1. The transmission loss of the said 46 decibels, indeed, represents a flow resistance of more than one hundred times the characteristic impedance presented by air to a plane acoustic wave, namely, more than 760 rayls.

In accordance with the present invention, therefore, a standard construction unit having all of the desirable properties of the pumice or other porous-block material, is so treated that it acquires, also, a very high transmission-loss characteristic. The added cost of so treating the conventional construction-unit block is extremely slight, as may be evident from the preferred technique illustrated in FIG. 4. A pipe 23 carrying the coating material is provided with a plurality of outlets 25 that terminate in 360-degree spray nozzles 27. The nozzles 27 may be progressively lowered and raised within the cavity apertures 3, through operation of swivel bearings 29 that permit vertical lowering and raising of the pipe 23, thus spray-coating the walls of the cavities 3. Other coating methods may, of course, also be employed, and, indeed, preformed liners 2 may be used, if desired. It is not essential, however, though it is considered most economical, merely to cover the walls of the cavity 3 with a thin layer or layers. If desired, the cavity-wall covering may extend throughout the complete space of the cavity 3 as shown at 2' in FIG. 3. The filler 2' again will be substantially impervious to air flow and of very high acoustic flow resistance.

The present invention also permits the fabrication of

construction units of different form than the prismatic block of FIGS. 1 to 3. In FIG. 6, for example, an acoustically absorptive wall member **4** of any desired acoustically absorptive material is shown disposed opposite and substantially parallelly coextensive with a similar absorptive wall member **6**. The members **4** and **6** are maintained spaced apart a predetermined distance by spacer elements or struts **8**. One or both of the inner-wall surfaces of the absorptive members **4** and **6** may be provided with a layer or covering of the extremely high flow resistance substantially air-impervious material, so attached that there can be no significant motion between the layer or covering and the member. For illustrative purposes, the inner or left-hand wall of the member **4** is shown so provided at **2''**. In the modification of FIG. 7 a pumice or similar front wall **4'** is illustrated as provided with an air-impervious or high flow resistance covering **2''** upon its inner or left-hand wall surface, and the other sound-absorptive wall member which may be of the same pumice material or may take the form of some other fibrous or porous material **6**, depending upon the application to which the construction unit is to be put, may similarly be provided with an air-impervious or high flow resistance covering **2''** over its inner or right-hand surface. The struts or spacer members **8'** of FIG. 7 are shown joined by acoustic damping junction elements or isolators **10**, as of rubber and the like, further to minimize any transmission of acoustic energy along the spacer member **8'** between the construction-unit wall members **4'** and **6**.

Further modifications will occur to those skilled in the art and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims. The term "air-pervious cinder-like material" employed in the claims is intended to embrace cinder block material and other similar materials exemplified by the materials set forth in the specification, which, like cinder, are permeated by air paths, so that the materials serve to absorb air-carried acoustic energy in the manner set forth in the claims.

What is claimed is:

1. A building block of air-pervious cinder-like material having opposed faces, said block having at least one internal cavity surrounded by webs of said material, some of said webs respectively extending from said cavity to said opposed faces, being thin relative to said cavity and being permeated by air paths permitting air and air-carried acoustic waves to penetrate the material between the faces of the block and said cavity, others of said webs extending between said faces along the sides of said cavity and providing paths having substantially greater acoustic transmission loss than paths through the first-mentioned webs and said cavity, the ratio of the cavity volume to the volume of cinder-like material being from at least substantially 1½:1 to substantially 2:1, said cavity having a lining of substantially air-impervious material preventing the air penetrating the first-mentioned webs from entering said cavity and constraining air-carried acoustic waves to pass around said cavity and to be dissipated in the block material.

2. The block of claim 1, said block being rectangular and having a plurality of cavities separated by webs extending between said block faces which are relatively thin in comparison to the corresponding cavity dimensions.

3. The block of claim 1, said cavity being filled with said air-impervious material.

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