# United States Patent [19]

**Fujii**

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[54] **MUFFLING BLOCK**


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[73] Assignee: **Kabushiki Kaisha Fujii Kogyo,** Tokyo, Japan



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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **181/33 G,** 181/33 GD

[51] **Int. Cl.** ..... **E04b 1/84**

[58] **Field of Search** ..... 181/63, 71, 33 GB, 181/33 GD, 33 G, 30, 33 GE; 52/144



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*Attorney, Agent, or Firm*—Michael S. Striker



[57] **ABSTRACT**

Sound-absorbing blocks of box-like shape are combined to form a unit. The unit consists of two kinds of blocks, one being shorter and having a lower density than the other. In use, every unit is fixed to a wall or ceiling so that a discontinuous side of each unit faces away from the surface of the wall or ceiling and a smooth side thereof is fixed to the latter. Every unit consists of four or five sound-absorbing blocks which latter are made of a fiber material.

One of the features of this invention is that the unit can be adapted for use in a rather wide sound-absorbing chamber by making the walls thin.

Another feature is that the structure of the sound-absorbing unit is so simple that the manufacturing cost is very low.


**10 Claims, 10 Drawing Figures**

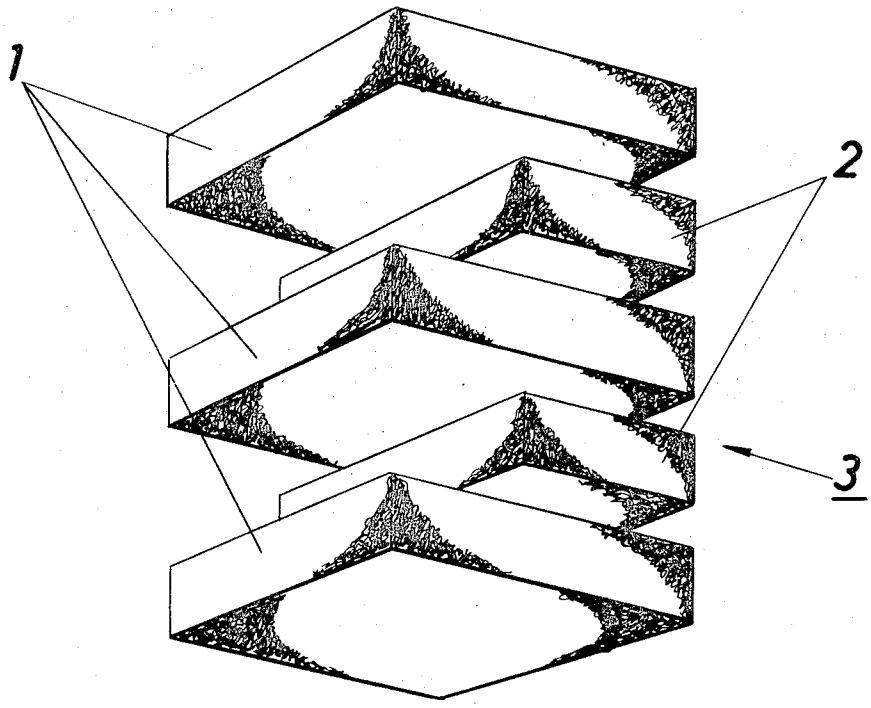


Fig.1

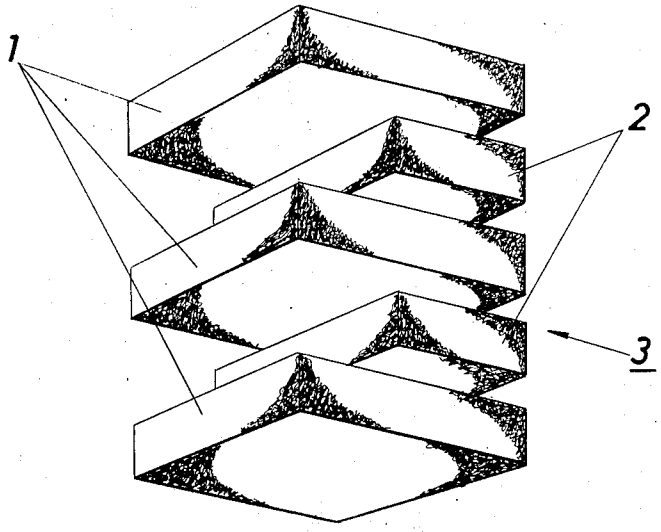



Fig.2a

PRIOR ART

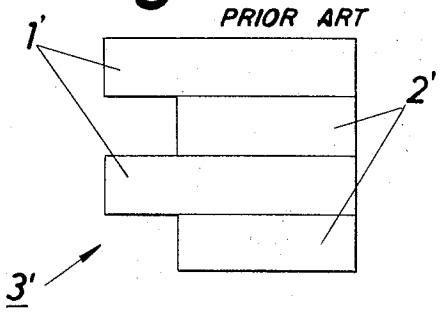



Fig.2b

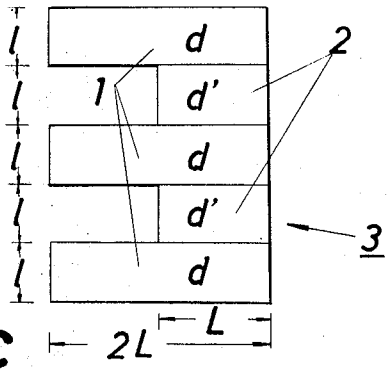



Fig.2c

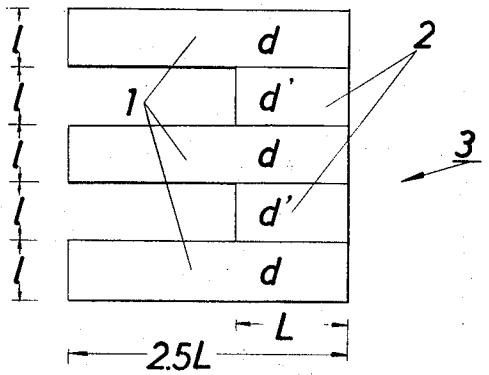


Fig.3

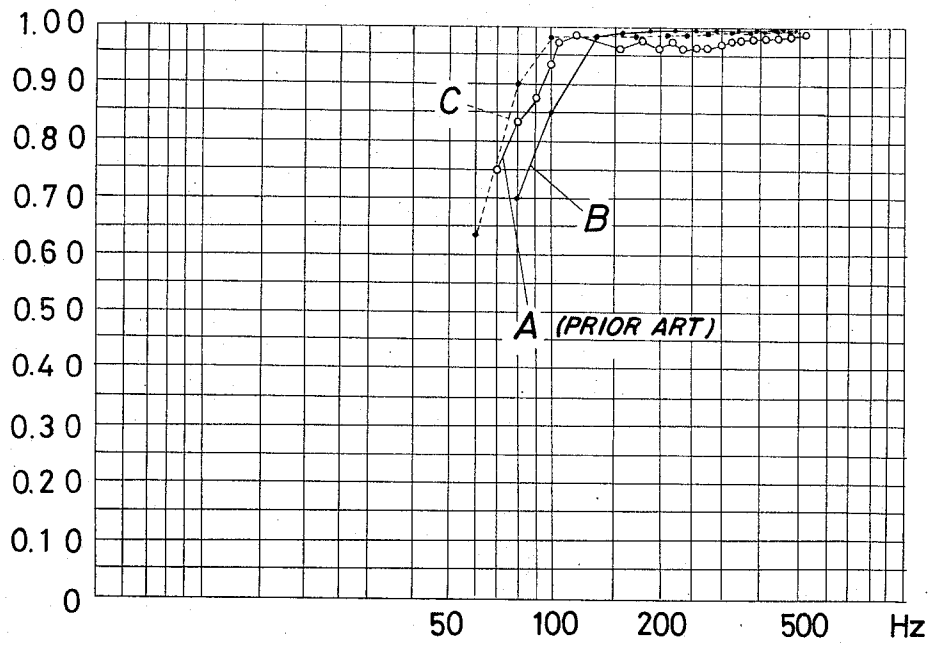
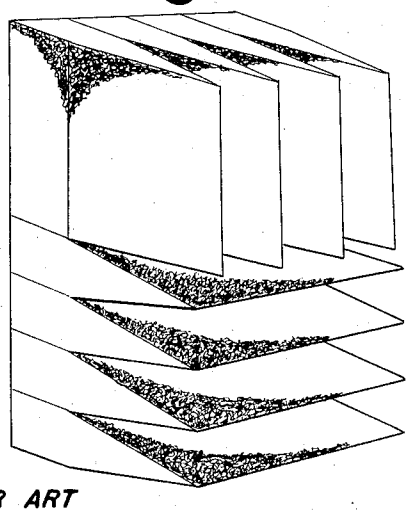
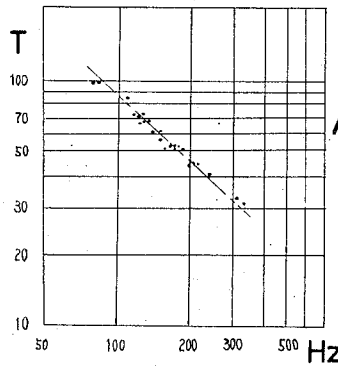



Fig.5



PRIOR ART

Fig.4b




PRIOR ART

Fig.4a

PRIOR ART

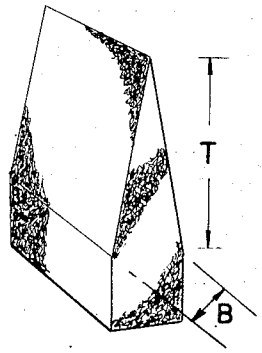


Fig. 6a

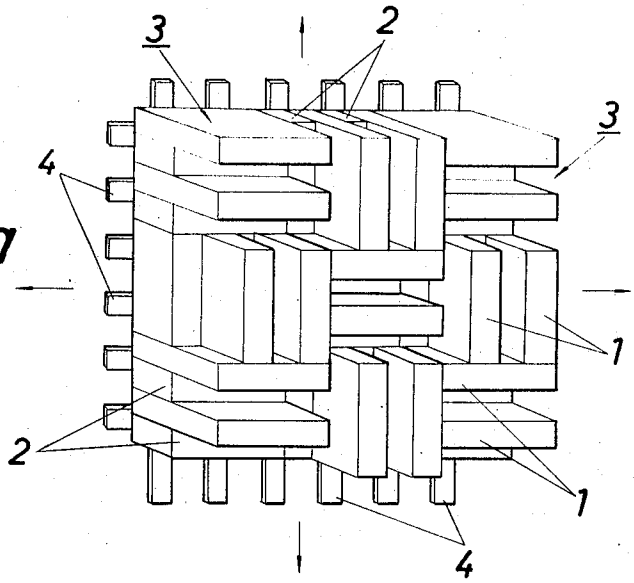
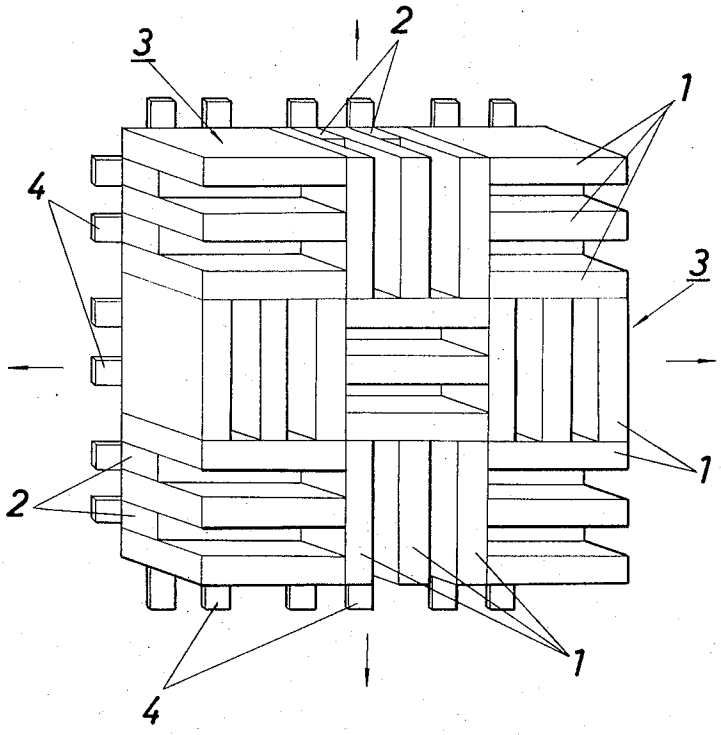



Fig. 6b



# MUFFLING BLOCK

## BACKGROUND OF THE INVENTION

This invention relates to a unit for absorbing sound, especially to a unit composed of blocks and capable of absorbing low-pitch sound effectively, and which is of simple construction.

A known block for use in this type of unit is shown in FIG. 4*a*. The block is shaped like a wedge at one end and is arranged together with several similar blocks in a mosaic pattern, the assembled blocks being secured to a frame before use. However, because of the taper of the blocks and of the difficulty in securing them to the frame, which is necessary for protecting the tapered blocks, the manufacturing cost becomes expensive. An arrangement of the blocks of FIG. 4*a* is shown in FIG. 5.

Another disadvantage of this type of block resides in the fact that the effective area of a sound-absorbing chamber utilizing such blocks is greatly reduced due to the excessive space required by the blocks when the sound-absorbing effect of the chamber is to be increased. FIG. 4*b* shows the results of experiments in which the relation between the length T of the wedge-shaped portion of such blocks and the frequency (Hz) of the sound absorbed was determined. The curve in this Figure, which was obtained for 98 percent sound-absorption, is seen to be linear and is inclined at an angle of 45° to the vertical. The data in this Figure is applicable where the width (B) of the wedge-shaped portion at its widest point is between 10 and 30 cm. and where the density of the glass fibers of which the blocks are composed is between 20 and 64 kg/m$^3$. It will be clear that, in order to absorb 98 percent of sound having a frequency of 150 Hz, the length (T) of the wedge-shaped portion should be 60 cm., whereas if the sound has a frequency of 100 Hz, the length (T) should be 85 cm. For the purpose of absorbing lower pitched or lower frequency sound, the length of the wedge portion (T) should be longer and the thickness of the absorbing wall or the depth of the block should also be increased.

Another known construction, proposed by the instant applicant, is shown in FIG. 2*a*. The unit (3′) shown in this Figure is composed of glass fiber, sound-absorbing blocks (1′) and (2′) having the same width and density but being of different lengths, the blocks (1′) being longer than the blocks (2′). The blocks (1′) and (2′) are alternately arranged and are secured to a non-illustrated frame. Although the manufacturing costs for this known construction is low, it is not possible to obtain perfect sound-absorption. This is shown by curve a in FIG. 3 which indicates that 98 percent sound-absorption is obtained only at frequencies of 120 Hz or so whereas at frequencies of about 200 Hz, the percentage of sound-absorption becomes very low.

It has been found that wedge-shaped blocks are effective in absorbing low-pitched sound. However, as mentioned above, such blocks have the disadvantage that the effective area of a sound-absorbing chamber wherein they are utilized is greatly reduced.

## SUMMARY OF THE INVENTION

It is an object of the present invention to provide a unit comprising sound-absorbing blocks which is effective for absorbing low-pitched sound and which includes a plurality of two types of sound-absorbing blocks, one of which is made from glass fibers, and wherein the two types of blocks have different densities and lengths and are combined with each other.



Another object of the present invention is to provide a unit comprising sound-absorbing blocks which is effective for absorbing low-pitched sound and which does not require a large decrease in the effective area of a sound-absorbing chamber in which it is utilized in order to be effective.

These and further features and advantages of the invention will best be understood from the following detailed description of an exemplary embodiment thereof taken in conjunction with the accompanying drawings wherein:

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a unit of alternately arranged longer and shorter sound-absorbing blocks in accordance with the invention.

FIG. 2*a* is a side view of known sound-absorbing blocks fixed together.

FIG. 2*b* is a side view of one embodiment according to the invention showing the relationship between the lengths of the longer and shorter blocks.

FIG. 2*c* is a view similar to FIG. 2*b* but showing another embodiment of the present invention.

FIG. 3 is a diagram showing the percentage sound-absorption for the embodiments of FIGS. 2*a*, 2*b* and 2*c*.

FIG. 4*a* is a perspective view of a known sound-absorbing block.

FIG. 4*b* is a graph showing the relationship, at 98 percent sound-absorption, between the length of the wedge-shaped portion of the block of FIG. 4*a* and the frequency of the sound absorbed.

FIG. 5 is a perspective view showing a unit composed of the blocks of FIG. 4*a*.

FIG. 6*a* is a perspective view showing one arrangement of units of sound-absorbing blocks according to the invention mounted on a wall frame.

FIG. 6*b* is a view similar to FIG. 6a but showing a different arrangement.

## DETAILED DESCRIPTION OF THE INVENTION

In the drawing, the numeral 1 denotes sound-absorbing blocks made of a material such as glass fibers and having a high density (d). The numeral 2 denotes sound-absorbing blocks made of glass fibers and having a low density (d′). The blocks 1 and 2 have the shape of an oblong, flat box. The blocks 1 are of greater width than the blocks 2 although the blocks 1 and 2 have the same thickness.

A unit 3 comprises a plurality of blocks 1 and 2, as shown in FIGS. 1, 2*b* and 2*c*, which are fixed relative to one another by a suitable frame or by adhesive means. The blocks 1 and 2 are arranged alternately so that a wider block is always located adjacent a narrower block.

Every unit 3 has smooth or continuous faces and discontinuous faces. The units 3 are secured to the surface of a wall or ceiling with a continuous face abutting this surface and with a discontinuous face located outwardly thereof. This is illustrated in FIGS. 6a and 6b where a plurality of units 3 are shown secured to a wall frame or support 4 or the like. It will be seen that adjacent ones of the units 3 are rotated relative to one an-

other by 90°. The assembly of the units 3 may be extended in any of the directions indicated by the arrows simply by adding additional ones of the units 3.

The behavior of the sound-absorbing blocks of the present invention will now be explained on the basis of the above-described structure.

It is assumed that the characteristics of the blocks of FIGS. 2*b* and 2*c* are as follows:

| | FIG. 2b | FIG. 2c |
|---|---|---|
| *d*=Density of a wider block | 24 kg./M³ | 24 kg./M³ |
| 1=Thickness of each wider block | 100 mm. | 100 mm. |
| Width of a wider block | 2L=400 mm. | 2.5L=500 mm. |
| *d'*=Density of a narrower block | 48kg./M³ | 32 kg./M³ |
| 1 =Thickness of each narrower block | 100 mm. | 100 mm. |
| Width of a narrower block | L =200 mm. | L =200 mm. |

The curves *b* and *c* in FIG. 3 correspond, respectively, to FIGS. 2*b* and 2*c*. It is seen that 98 percent sound absorption may be obtained at frequencies as low as 140 and 100 Hz for the respective structures of FIGS. 2*b* and 2*c*. This means that, in the case of FIG. 2*c*, the low-pitched sound to be absorbed by 98 percent may have a frequency as low as 100 Hz. The experimental data of FIG. 3 show that, by suitably combining wider and narrower blocks having different densities, most sound from the high-frequency to the low-frequency range can be effectively absorbed.

According to the present invention, by varying the densities and lengths of the blocks, it becomes possible to absorb the sound in a sound-absorbing chamber as desired. In particular, it has become possible to absorb low-pitched sound even though the sound-absorbing walls of the chamber are thin so that the effective area of the chamber is not greatly reduced, whereas it has been thought impossible heretofore to absorb low-pitched sound without significantly reducing the effective area of the sound-absorbing chamber. Thus, the invention has a remarkable sound-absorbing effect.

While the principles of the invention have now been made clear by illustrative embodiments, it will be obvious to those skilled in the art that many modifications in structure, arrangement, proportions, elements, materials and components used in the practice of the invention, which are particularly adapted for specific environments and operating requirements, may readily be made therein without departing from these principles.

The appended claims are therefore intended to cover and embrace any such modifications, within the limits only of the true spirit of the invention.

I claim:

**1.** A sound-absorbing unit, comprising at least one first block of substantially rectangular cross section having an edge face and a first dimension in a direction normal thereto, said first block having a first density; and at least one second block of substantially rectangular cross section connected with said first block in surface-to-surface contact, said second block having an edge face and a second dimension in a direction normal thereto which is smaller than said first dimension, and said second block having a second density different from said first density, said first and second blocks being arranged with said edge faces located in a common plane, and said unit being mountable on a wall, ceiling or the like.

**2.** A sound-absorbing unit as defined in claim **1**, further comprising additional ones of said first and second blocks; and wherein each of said first blocks is in contact with said second blocks only, and each of said second blocks is in contact with said first blocks only.

**3.** A sound-absorbing unit as defined in claim **2**, wherein said unit comprises two of said first blocks and two of said second blocks.

**4.** A sound-absorbing unit as defined in claim **2**, wherein said unit comprises two of said first blocks and three of said second blocks.

**5.** A sound-absorbing unit as defined in claim **2**, wherein said unit comprises three of said first blocks and two of said second blocks.

**6.** A sound-absorbing unit as defined in claim **1**, said first and second blocks each having a length, a width and a thickness; and wherein said first and second dimensions correspond to the respective widths of said first and second blocks, the length of said first block being substantially equal to the length of said second block, and the thickness of said first block being substantially equal to the thickness of said second block.

**7.** A sound-absorbing unit as defined in claim **1**, further comprising a frame; and wherein said first and second blocks are mounted on said frame thereby being connected with one another.

**8.** A sound-absorbing unit as defined in claim **1**, wherein said first and second blocks comprise glass fibers.

**9.** A second absorbing unit as defined in claim **1**, wherein said first dimension is substantially equal to twice said second dimension.

**10.** A sound-absorbing unit as defined in claim **1**, wherein said first dimension is substantially equal to two and one-half times said second dimension.

* * * * *