



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.02.2002 Bulletin 2002/08

(51) Int Cl.7: **G10K 11/162**

(21) Application number: **01110763.8**

(22) Date of filing: **03.05.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR
 Designated Extension States:
AL LT LV MK RO SI

- **Motomura, Hikaru, Nagasaki R & D Center**
Nagasaki, Nagasaki-ken (JP)
- **Seki, Shiro,**
Nagasaki Shipyard & Machinery Works
Nagasaki, Nagasaki-ken (JP)
- **Shibata Seizou,**
Nagasaki Shipyard Machinery Works
Nagasaki, Nagasaki-ken (JP)

(30) Priority: **15.08.2000 JP 2000246111**
23.08.2000 JP 2000251880

(71) Applicant: **Mitsubishi Heavy Industries, Ltd.**
Tokyo (JP)

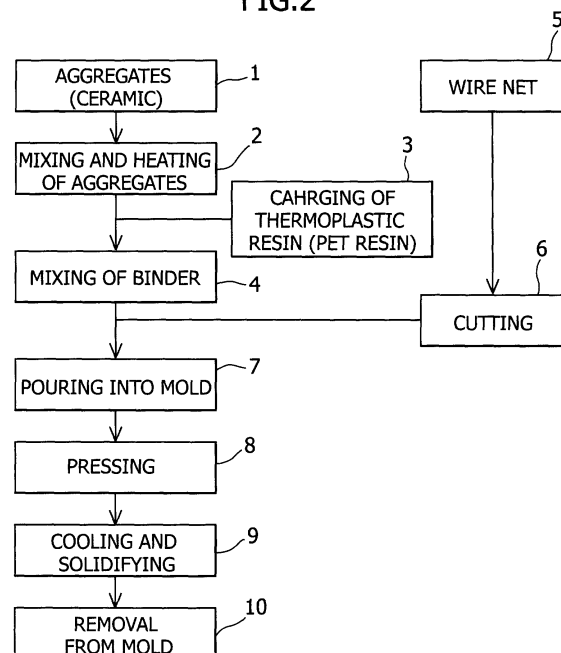
(74) Representative: **Henkel, Feiler, Hänzel**
Möhlstrasse 37
81675 München (DE)

(72) Inventors:
 • **Hasezaki, Kazuhiro, Nagasaki R & D Center**
Nagasaki, Nagasaki-ken (JP)

(54) **Ceramic sound absorbing material and manufacturing method therefor**

(57) An object of the present invention is to reuse wastes of used or defective sound absorbing material body as a raw material for sound absorbing material body. As aggregates for the sound absorbing material of the present invention, ground mullite particles with an average particle size of about 0.5 to 1 mm are used. As a binder, polyethylene terephthalate (hereinafter referred to as PET) resin, which is a thermoplastic resin, of a form of pellet not larger than 1 mm is used. The aggregates are heated to a temperature in the range of 245°C to 290°C, which is the melting point of PET resin. In order to ensure the smoothness of surface layer when a mixture is poured into a mold, pressing with a pressure of 40 to 1000 kgf/cm² is performed. After pressing, the product is cooled and solidified, and then is removed from the mold, whereby a sound absorbing board with a thickness of 8 mm is obtained.

FIG.2



Description**BACKGROUND OF THE INVENTION AND RELATED ART STATEMENT**

1. Field of the Invention

[0001] The present invention relates to a sound absorbing material and, more particularly, to a sound absorbing material used as a general sound absorbing material for houses, buildings, and the like and applied to sound insulating walls for roads, railroads, tunnels, and the like.

2. Description of Related Art

[0002] A conventional sound absorbing material is formed of particles, fiber layers, or the like because the percentage of void in the interior can be controlled relatively easily. Although some manufacturing methods for a sound absorbing material can be used, the sound absorbing material using ceramic particles is manufactured by pressing or high-temperature firing.

[0003] In a technology disclosed in Japanese Patent Provisional Publication No. 4-191800 (No. 191800/1992)(Japanese Patent Application No. 2-321238 (No. 321238/1990)), ceramic particles are bonded by heating with epoxy resin used as a binder, and they are allowed to dry naturally for a long period time, by which a sound absorbing material is obtained.

[0004] Also, in a manufacturing method for a ceramic sound absorbing material disclosed in Japanese Patent Publication No. 7-80714 (No. 80714/1995), ceramic particles containing 60 wt% and more of Al_2O_3 and 40 wt% and less of SiO_2 , having a particle size of 0.5 to 1 mm, are molded using a heat-resisting binder, and then they are fired, by which a ceramic sound absorbing material is obtained.

[0005] These sound absorbing materials are used to absorb sounds for roads, tunnels, railroad tracks, and the like. In such examples, the sound absorbing material may be damaged when a small stone flipped by an automobile or a train strikes the sound absorbing material.

[0006] In the related arts, since the low shock resistance of ceramics cannot be overcome, the load resistance has been increased. Specifically, by increasing the thickness of a ceramic sound absorbing material, the load resistance is increased to prevent damage caused by a shock. With this method, however, an effect of preventing damage from a collision with a heavy substance such as an automobile cannot be anticipated. Also, the increased thickness increases the weight of ceramic sound absorbing material, so that the construction is difficult to execute unless a crane or the like machine is used in construction of ceramic sound absorbing material. Therefore, the construction and replacement of ceramic sound absorbing material require much time and cost.

[0007] Also, these sound absorbing materials have a problem in that when they are discarded after the use, they have to be disposed of as industrial wastes because the recycling properties of sound absorbing material itself have not been considered.

[0008] Further, these sound absorbing materials have a problem in that even when a defective product that does not meet requirements for predetermined dimensions is turned out after the solidification, it has to be disposed of as industrial wastes because the recycling properties of sound absorbing material itself have not been considered.

OBJECT AND SUMMARY OF THE INVENTION

[0009] An object of the present invention is to provide a ceramic sound absorbing material and a manufacturing method therefor, in which a sound absorbing effect is achieved while excellent shock resistance is provided, and wastes of used or defective sound absorbing material body can be reused as a raw material for sound absorbing material body to make effective use of resources.

[0010] In a first mode of the present invention, there is provided a ceramic sound absorbing material with excellent shock resistance comprising aggregates consisting of ceramic particles; a ceramic particle layer formed of a synthetic resin; and a reinforcement having openings, which is mounted on the ceramic particle layer, in order to provide shock resistance, wherein the material has a Charpy impact value, which represents an impact strength, of 0.3 J/cm² to 10 J/cm². Also, there is provided a manufacturing method for a ceramic sound absorbing material with excellent shock resistance, comprising the steps of heating aggregates consisting of ceramic particles; mixing a synthetic resin with the aggregates; pouring a mixture of the synthetic resin and the aggregates into a mold after a reinforcement having openings is put in the mold, and pressing the mixture to keep smoothness of surface layer; and cooling and solidifying the pressed mixture.

[0011] The ceramic particles serving as aggregates may be new or recycled particles of glass, tile porcelain, mullite (alumina silicate having a basic chemical formula of $3Al_2O_3 \cdot 2SiO_2$), or the like. However, the ceramic particles are

not limited to the above-described particles. The ceramic particle size is preferably about 0.5 to 1 mm, but is not limited to this range.

[0012] As an example of synthetic resin, thermoplastic resin or thermosetting resin can be used. For example, polyethylene terephthalate (PET) resin, epoxy resin, acrylic resin, polybutylene terephthalate (PBT) resin, polycarbonate, nylon, polypropylene, polyethylene, polyphenylether, polystyrene, methacrylate resin, polyamide, polyacetal, acrylonitrile-butadiene-styrene (ABS) resin, or the like is preferably used, but the synthetic resin is not subject to any special restriction.

[0013] As the reinforcement, a substance of a thin sheet shape in which wires of iron, stainless steel, aluminum, or the like are crossing is preferably used. The opening of the reinforcement means a portion that is open between wires. This opening is necessary to maintain sound absorbing properties of ceramic particle layer. An opening rate, which represents a ratio of the area of openings to the total surface area, is preferably 30% to 80%, but it is not limited to this range.

[0014] The obtained ceramic sound absorbing material is characterized by having a Charpy impact value, which represents the impact strength, of 0.3 to 10 J/cm², but the Charpy impact value is not limited to this range.

[0015] Mounting means to pour the mixture of synthetic resin and aggregates in a mold measuring, for example, 10 mm and greater thick, 300 mm long, and 300 mm wide after the reinforcement having the openings is put in the mold and to incorporate the reinforcement as a component of the sound absorbing material together with the ceramic particle layer. The reinforcement may be mounted on the surface of the sound absorbing material or may be inserted in the interior thereof.

[0016] In the step in which pressing is performed to ensure smoothness of the surface layer, pressing with a pressure of 3.9×10^6 to 9.8×10^7 Pa (40 to 1000 kgf/cm²) is preferably performed, but the pressure is not limited to this range.

[0017] In the step in which the pressed mixture is cooled and solidified, cooling may be accomplished at ordinary temperature or may be accomplished by using a cooler.

[0018] By applying the present invention, there was provided a highly shock-resistant ceramic absorbing material with a Charpy impact value, which represents the impact strength, of 0.3 to 10 J/cm². Also, even when recycled ceramic particles were used as aggregates of raw material of ceramic sound absorbing material, a ceramic sound absorbing material with the equivalent shock resistance was provided.

[0019] The ceramic sound absorbing material of a second mode of the present invention uses a thermoplastic resin, which is made soft and flowable by heating, as an adhesive. As the thermoplastic resin, polyethylene terephthalate (PET) resin, polybutylene terephthalate (PBT) resin, polycarbonate, nylon, polypropylene, polyethylene, polyphenylether, polystyrene, methacrylate resin, polyamide, polyacetal, and acrylonitrile-butadiene-styrene (ABS) resin are cited. In particular, for polyethylene terephthalate (PET) resin, polybutylene terephthalate (PBT) resin, polycarbonate, nylon, polypropylene, and polyethylene, recycled resin having used for other applications can also be used.

[0020] As the aggregates, an inorganic material such as ceramic particles, which is reactive and whose strength is not decreased even when the adhesive, which is a thermoplastic resin, becomes flowable at the time of heating, that is, a material capable of being formed again by reheating is used.

[0021] Also, the sound absorbing material in accordance with the present invention can be molded by using polybutylene terephthalate (PBT) resin, which is a thermoplastic resin, and further by adding the reinforcement.

[0022] Specifically, in the interior or on the surface of the press molded ceramic particle layer, there is inserted or mounted the reinforcement having many openings, which is formed of a material that is not deformed by pressurization (that is, a material having stiffness under pressure). As the reinforcement, a substance of a thin sheet shape in which wires of iron, stainless steel, aluminum, or the like are crossing, such as a wire net, grating material, and fence material (in this specification, these materials are generally referred to as a wire net), is suitable. It is desirable that the opening rate (opening rate in the surface portion of reinforcement) of reinforcement be as high as possible. Generally, if the opening rate is lower than 30%, the sound absorbing effect decreases because of low opening rate, and if the opening rate exceeds 80%, the reinforcing effect cannot be achieved in some cases. An opening rate of 55% to 80% is especially desirable because it can achieve a high sound absorbing effect and also can maintain the reinforcing effect. In the present invention, an aluminum crimp wire net (wire net having a shape of rice-cake toasting grid) with an opening rate of 60% to 65% was used. The number of inserted crimp wire nets should preferably be about one to three. Four or more wire nets cause poor bonding of reinforcement to ceramics.

[0023] Also, the sound absorbing material in accordance with the present invention can be molded by using polyethylene terephthalate (PET) resin, which is a thermoplastic resin, and further by adding the reinforcement.

[0024] Specifically, the reinforcement having many openings, which is formed of a material that is not deformed by pressurization, is inserted or mounted in or on the press molded ceramic particle layer. As the reinforcement, a substance of a thin sheet shape in which wires of iron, stainless steel, aluminum, or the like are crossing, such as a wire net, grating material, and fence material, is suitable. It is desirable that the opening rate of reinforcement be as high as possible. Generally, if the opening rate is lower than 30%, the sound absorbing effect decreases because of low opening rate, and if the opening rate exceeds 80%, the reinforcing effect cannot be achieved in some cases. An opening

rate of 55% to 80% is especially desirable because it can achieve a high sound absorbing effect and also can maintain the reinforcing effect. In the present invention, an aluminum crimp wire net (wire net having a shape of rice-cake toasting grid, which is formed of crossed wavy wires) with an opening rate of 60% to 65% was mounted on both surfaces or inserted in the interior of the ceramic particle layer. The number of mounted or inserted crimp wire nets should preferably

be about one to three. Four or more wire nets cause poor bonding of reinforcement to ceramics.

[0025] As the polyethylene terephthalate resin, waste polyethylene terephthalate (PET) resin ground into a size of about 1mm, which is recycled from drink bottles or the like, was used. In particular, a colored resin of the waste PET resin is suitable for the application of the present invention because it cannot be reused for drink bottles and has to be disposed of by burning. Also, a used ceramic sound absorbing board manufactured in the present invention can be used as a reclaimed raw material.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

FIG. 1 is a construction view of a sound absorbing material with excellent shock resistance in accordance with a first embodiment of the present invention;

FIG. 2 is a flowchart showing a manufacturing process for a sound absorbing material with excellent shock resistance in accordance with the first embodiment;

FIG. 3 is a construction view of a sound absorbing material with excellent shock resistance in accordance with a second embodiment of the present invention;

FIG. 4 is a flowchart showing a manufacturing process for a sound absorbing material with excellent shock resistance in accordance with the second embodiment;

FIG. 5 is a construction view of a sound absorbing material with excellent shock resistance in accordance with a third embodiment of the present invention;

FIG. 6 is a flowchart showing a manufacturing process for a sound absorbing material with excellent shock resistance in accordance with the third embodiment;

FIG. 7 is a flowchart showing a manufacturing process for a sound absorbing material in accordance with a fourth embodiment of the present invention;

FIG. 8 is a construction view of a recycle type sound absorbing material in accordance with the fourth embodiment, in which ceramic particles are used as aggregates for sound absorbing material, and PET resin, which is a thermoplastic resin, is used as an adhesive;

FIG. 9 is a flowchart showing a manufacturing process for a sound absorbing material in accordance with a fifth embodiment of the present invention;

FIG. 10 is a construction view of a recycle type sound absorbing material in accordance with the fifth embodiment, in which ceramic particles are used as aggregates for sound absorbing material, and PBT resin, which is a thermoplastic resin, is used as an adhesive;

FIG. 11 is a flowchart showing a manufacturing process for a sound absorbing material in accordance with a sixth embodiment of the present invention;

FIG. 12 is a construction view of a recycle type sound absorbing material in accordance with the sixth embodiment, in which ceramic particles are used as aggregates for sound absorbing material, and a material obtained by grinding waste PET resin recycled from drink bottles etc. into a size of about 1 mm is used as an adhesive;

FIG. 13 is a flowchart showing a manufacturing process for a sound absorbing material in accordance with a seventh embodiment of the present invention; and

FIG. 14 is a construction view of a recycle type sound absorbing material in accordance with the seventh embodiment, in which ceramic sound absorbing boards having been used for one year and new ceramic particles are used as aggregates for sound absorbing material, and a material obtained by grinding waste PET resin recycled from drink bottles etc. into a size of about 1 mm is used as an adhesive.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0027] A ceramic sound absorbing material with excellent shock resistance, which is a first mode of the present invention, will be described with reference to first to third embodiments.

[0028] FIG. 1 shows a construction of a sound absorbing material with excellent shock resistance in accordance with the first embodiment, and FIG. 2 shows a flowchart of a manufacturing process therefor. As aggregates b, mullite particles with an average particle size of about 0.5 to 1 mm were used, and as an adhesive, polyethylene terephthalate (PET) resin, which is a thermoplastic resin, was used. In the interior or on the surface of a ceramic particle layer molded under pressure, a reinforcement d having many openings, which are formed of a material that is not deformed by

pressure, is inserted or mounted. In particular, it is desirable that the reinforcement be a structure in which the component is continuous. In the case where the reinforcement is discontinuous, breakage occurs in the discontinuous portion, so that a predetermined shock resistance cannot be provided.

[0029] As the reinforcement, a substance of a thin sheet shape in which wires of iron, stainless steel, aluminum, or the like are crossing is preferably used. For example, a wire net, grating material, and fence material are suitable. It is desirable that an opening rate, which represents a ratio of the area of openings to the surface of reinforcement, be as high as possible. If the opening rate is 30% and lower, the sound absorbing effect cannot be achieved, and if the opening rate is 80% and higher, the reinforcing effect cannot be achieved though the sound absorbing effect is great. An opening rate of 55% to 80% is especially desirable because it can achieve a high sound absorbing effect and also can maintain the reinforcing effect. In the present invention, an aluminum crimp wire net d (wire net having a shape of rice-cake toasting grid, which is formed of crossed wavy wires) with an opening rate of 60% to 65% was used. The number of inserted crimp wire nets d should preferably be about one to three. Four or more wire nets cause poor bonding of reinforcement to ceramics.

[0030] The Charpy impact value representing impact characteristics is about 0.3 to 10 J/cm².

[0031] A manufacturing method will be described with reference to a flowchart for manufacturing process of FIG. 2. As aggregates b, ground mullite particles with an average particle size of about 0.5 to 1 mm are used. Polyethylene terephthalate (PET) resin is mixed with the heated aggregates b at a ratio of 2 to 30 wt%. A cut aluminum crimp wire net d is put at the bottom of a square mold measuring 300 mm long and 300 mm wide, and the mixture is poured into the mold (steps 1 to 7). The number of inserted crimp wire nets d was one. If the ratio of polyethylene terephthalate (PET) resin to the aggregates b is lower than 2 wt%, molding is difficult to perform because satisfactory bonding ability cannot be provided. If the ratio is higher than 30 wt%, the quantity of polyethylene terephthalate (PET) resin is too large, so that the sound absorbing characteristics as a sound absorbing material cannot be ensured. In the first embodiment, PET resin of 50 g was mixed with ceramic particles of 730 g.

[0032] In order to ensure the smoothness of surface layer when the mixture is poured, pressing with a pressure of 3.9×10^6 to 9.8×10^7 Pa (40 to 1000 kgf/cm²) is performed (step 8). The material was cooled and solidified at ordinary temperature, and was removed from the mold (steps 9 to 10), by which a sound absorbing material measuring 8 mm thick, 300 mm long, and 300 mm wide was obtained. If the pressure is lower than 3.9×10^6 Pa (40 kgf/cm²), molding is difficult to perform. Even if molding is performed, a proper strength cannot be obtained. If the pressure is higher than 9.8×10^7 Pa (1000 kgf/cm²), voids c between the aggregates b are crushed, so that the sound absorbing characteristics cannot be secured.

[0033] Table 1 gives the three-point bending strength, sound absorption coefficient, and impact strength of the sound absorbing material obtained in the first embodiment.

[0034] The three-point bending strength was obtained in accordance with JIS R1601 "Testing Method for Flexural Strength of Fine Ceramics". For the sound absorption coefficient, the peak value and frequency of sound absorption coefficient were obtained in accordance with JIS A1909 (1967) "Measuring Methods for Reverberant Sound Absorption Coefficient". The impact strength was obtained at room temperature in accordance with ASTM D256 "Charpy Impact Testing Methods". For comparison, the properties of a ceramic sound absorbing material obtained in Japanese Patent Publication No. 7-80714 (No. 80714/1995) are shown.

[Table 1]

Three-point bending strength and sound absorption coefficient of sound absorbing board of first embodiment			
		Ceramic sound absorbing board obtained in Japanese Patent Publication No.7-80714	Sound absorbing board of first embodiment
Three-point bending strength (kgf/cm ²)		180	120
Peak Value of sound absorption coefficient	Frequency (Hz)	500	500
	Reverberant sound absorption coefficient (α_0)	0.93	0.95
Impact strength (J/cm ²)		0.1	0.95

[0035] Acoustic performance equivalent to that of the conventional ceramic sound absorbing material was obtained. Concerning the impact strength, the shock resistance value of the sound absorbing material in accordance with the present invention was 9.5 times that of the conventional sound absorbing material, and great improvement in shock resistant characteristics was found.

[0036] Next, a ceramic sound absorbing material in accordance with a second embodiment of the present invention will be described with reference to the accompanying drawings.

[0037] FIG. 3 shows a construction of the sound absorbing material of the second embodiment, and FIG. 4 shows a flowchart of a manufacturing process therefor. As aggregates b, ceramic particles were used, and as an adhesive, epoxy resin, which is a thermosetting resin, was used. In the interior or on the surface of a ceramic particle layer molded under pressure, a reinforcement having many openings, which is formed of a material that is not deformed by pressure, is inserted or mounted. In particular, it is desirable that the reinforcement be a continuous structure. In the case where the reinforcement is discontinuous, breakage occurs in the discontinuous portion, so that a predetermined shock resistance cannot be provided. As the reinforcement, a substance of a thin sheet shape in which wires of iron, stainless steel, aluminum, or the like are crossing is preferably used. For example, a wire net, grating material, and fence material are suitable. It is desirable that an opening rate of the reinforcement be as high as possible.

[0038] If the opening rate is 30% and lower, a sound absorbing effect cannot be achieved, and if the opening rate is 80% and higher, the reinforcing effect cannot be achieved. An opening rate of 55% to 80% is especially desirable because it can achieve a high sound absorbing effect and also can maintain the reinforcing effect. In the present invention, an aluminum crimp wire net d (wire net having a shape of rice-cake toasting grid, which is formed of crossed wavy wires) with an opening rate of 60% to 65% was used. The number of inserted crimp wire nets should preferably be about one to three. Four or more wire nets cause poor bonding of reinforcement to ceramics. As an adhesive, epoxy resin, which is a thermosetting resin, was used.

[0039] A manufacturing method for the ceramic sound absorbing material will be described with reference to a flowchart for manufacturing process of FIG. 4. As ceramic particles, which are the aggregates b, ground mullite particles with an average particle size of about 0.5 to 1 mm are used. Epoxy resin is mixed with the aggregates b at a ratio of 2 to 30 wt%. An aluminum crimp wire net is put at the bottom of a square mold measuring 300 mm long and 300 mm wide, and the mixture is poured into the mold (steps 20 to 25). The number of inserted crimp wire nets d was one. If the ratio of epoxy resin to the aggregates b is lower than 2 wt%, molding is difficult to perform because satisfactory bonding ability cannot be provided. If the ratio of epoxy resin to the aggregates b is higher than 30 wt%, the quantity of epoxy resin is too large, so that the sound absorbing characteristics as a sound absorbing material cannot be ensured. In the second embodiment, epoxy resin of 50 g was mixed with ceramic particles of 730 g. In order to ensure the smoothness of surface layer when the mixture is poured, pressing with a pressure of 3.9×10^6 to 9.8×10^7 Pa (40 to 1000 kgf/cm²) is performed (step 26). After pressing, the aluminum wire net is pressed in the horizontal direction, by which the product can be removed easily from the mold. In this process, the mold has ordinary temperature. If the pressure is lower than 3.9×10^6 Pa (40 kgf/cm²), molding is difficult to perform.

[0040] Even if molding is performed, a proper strength cannot be obtained. If the pressure is higher than 9.8×10^7 Pa (1000 kgf/cm²), voids c between the aggregates b are crushed, so that the sound absorbing characteristics cannot be secured. By pressing, a homogeneous sound absorbing material measuring 8 mm thick, 300 mm long, and 300 mm wide was obtained. Subsequently, the molded product was removed from the mold, and was allowed to dry naturally at ordinary temperature in a room for three days.

[0041] Table 2 gives the three-point bending strength, sound absorption coefficient, and impact strength of the sound absorbing material obtained in the second embodiment.

[0042] The three-point bending strength was obtained in accordance with JIS R1601 "Testing Method for Flexural Strength of Fine Ceramics". For the sound absorption coefficient, the peak value and frequency of sound absorption coefficient were obtained in accordance with JIS A1909 (1967) "Measuring Methods for Reverberant Sound Absorption Coefficient". The impact strength was obtained at room temperature in accordance with ASTM D256 "Charpy Impact Testing Methods". For comparison, the properties of the ceramic sound absorbing material obtained in Japanese Patent Publication No. 7-80714 (No. 80714/1995) are shown.

[Table 2]

Three-point bending strength and sound absorption coefficient of sound absorbing board of second embodiment			
		Sound absorbing board properties obtained in Japanese Patent Publication No. 7-80714	Sound absorbing board of second embodiment
Three-point bending strength (kgf/cm ²)		180	130
Peak value of sound absorption coefficient	Frequency (Hz)	500	500
	Reverberant sound absorption coefficient (α_0)	0.93	0.93

[Table 2] (continued)

Three-point bending strength and sound absorption coefficient of sound absorbing board of second embodiment		
	Sound absorbing board properties obtained in Japanese Patent Publication No. 7-80714	Sound absorbing board of second embodiment
Impact strength (J/cm ²)	0.1	2.3

[0043] Acoustic performance equivalent to that of the conventional ceramic sound absorbing material was obtained. Concerning the impact strength, the shock resistance value of the sound absorbing material in accordance with the present invention was 23 times that of the conventional sound absorbing material, and great improvement in shock resistant characteristics was achieved.

[0044] Next, a ceramic sound absorbing material in accordance with a third embodiment of the present invention will be described with reference to the accompanying drawings.

[0045] FIG. 5 shows a construction of the sound absorbing material of the second embodiment, and FIG. 6 shows a flowchart of a manufacturing process therefor. As aggregates b, recycled ceramic particles obtained by cleaning, drying, and grinding sound absorbing boards having been used for one year were used. As an adhesive, epoxy resin was used. In the interior or on the surface of a ceramic particle layer molded under pressure, a reinforcement having many openings, which is formed of a material that is not deformed by pressure, is inserted or mounted. In particular, it is desirable that the reinforcement be a continuous structure.

[0046] In the case where the reinforcement is discontinuous, breakage occurs in the discontinuous portion, so that a predetermined shock resistance cannot be provided. As the reinforcement, a substance of a thin sheet shape in which wires of iron, stainless steel, aluminum, or the like are crossing is preferably used. For example, a wire net, grating material, and fence material are suitable. It is desirable that an opening rate of the reinforcement be as high as possible. If the opening rate is 30% and lower, a sound absorbing effect cannot be achieved, and if the opening rate is 80% and higher, the reinforcing effect cannot be achieved though the sound absorbing effect is great. An opening rate of 55% to 80% is especially desirable because it can achieve a high sound absorbing effect and also can maintain the reinforcing effect. In the present invention, an aluminum crimp wire net (wire net having a shape of rice-cake toasting grid, which is formed of crossed wavy wires) with an opening rate of 60% to 65% was inserted and mounted on both surfaces. The number of inserted crimp wire nets should preferably be about one to three. Four or more wire nets cause poor bonding of reinforcement to ceramics.

[0047] A manufacturing method for the ceramic sound absorbing material will be described with reference to a flowchart for manufacturing process of FIG. 5. As ceramic particles, which are the aggregates b, ground mullite particles with an average particle size of about 0.5 to 1 mm are used. Epoxy resin is mixed with the aggregates b at a ratio of 2 to 30 wt%. An aluminum crimp wire net is put at the bottom of a square mold measuring 300 mm long and 300 mm wide, and the mixture is poured into the mold (steps 30 to 35). The number of inserted crimp wire nets was one in one case and three in the other case. If the ratio of epoxy resin to the aggregates b is lower than 2 wt%, molding is difficult to perform because satisfactory bonding ability cannot be provided.

[0048] If the ratio of epoxy resin to the aggregates b is higher than 30 wt%, the quantity of epoxy resin is too large, so that the sound absorbing characteristics as a sound absorbing material cannot be ensured. In the third embodiment, epoxy resin of 50 g was mixed with ceramic particles of 730 g. After the surface of poured mixture is smoothened, an aluminum crimp wire net is laminated to reinforce the surface, and in order to ensure the smoothness of surface layer, pressing with a pressure of 3.9×10^6 to 9.8×10^7 Pa (40 to 1000 kgf/cm²) is performed (step 36). The number of crimp wire nets d laminated on the surface was one in one case and three on the other case. After pressing, the crimp wire net d is pressed in the horizontal direction, by which the product is removed easily from the mold. The mold has ordinary temperature. If the pressure is lower than 3.9×10^6 Pa (40 kgf/cm²), molding is difficult to perform. Even if molding is performed, a proper strength cannot be obtained. If the pressure is higher than 9.8×10^7 Pa (1000 kgf/cm²), voids c between the aggregates b are crushed, so that the sound absorbing characteristics cannot be secured. By pressing, a homogeneous sound absorbing material measuring 8 mm thick, 300 mm long, and 300 mm wide was obtained. Subsequently, the molded product was removed from the mold, and was allowed to dry naturally in a room for three days. The mold had ordinary temperature (Steps 37 and 38).

[0049] Table 3 gives the three-point bending strength, sound absorption coefficient, and impact strength of the sound absorbing material obtained in the third embodiment. The three-point bending strength was obtained in accordance with JIS R1601 "Testing Method for Flexural Strength of Fine Ceramics". For the sound absorption coefficient, the peak value and frequency of sound absorption coefficient were obtained in accordance with JIS A1909 (1967) "Measuring Methods for Reverberant Sound Absorption Coefficient". The impact strength was obtained at room temperature in

accordance with ASTM D256 "Charpy Impact Testing Methods". For comparison, the properties of the ceramic sound absorbing material obtained in Japanese Patent Publication No. 7-80714 (No. 80714/1995) are shown.

[Table 3]

Three-point bending strength and sound absorption coefficient of recycle type sound absorbing board of third embodiment				
		Ceramic sound absorbing board properties obtained in Japanese Patent Publication No. 7-80714	Recycle type sound absorbing board of third embodiment (one wire net mounted on one surface)	Recycle type sound absorbing board of third embodiment (three wire nets mounted on one surface)
Three-point bending strength (kgf/cm ²)		180	140	180
Peak value of sound absorption coefficient	Frequency (Hz)	500	500	500
	Reverberant sound absorption coefficient (α_0)	0.93	0.92	0.91
Impact strength (J/cm ²)		0.1	3.0	8.0

[0050] The obtained performance was equivalent to the performance of the conventional ceramic sound absorbing material in which recycle is not considered. By installing the reinforcement on both surfaces, a sound absorbing material could be obtained in which the shock resistance thereof was 30 times that of the conventional sound absorbing material in the case where one wire net was inserted and 80 times that of the conventional sound absorbing material in the case where three wire nets were inserted.

[0051] A recycle type ceramic sound absorbing material capable of being recycled, which is a second mode of the present invention, will be described with reference to fourth to seventh embodiments.

[0052] A fourth embodiment of the present invention will be described with reference to the accompanying drawings.

[0053] A manufacturing method for a recycle type sound absorbing board e shown in FIG. 8 will be described with reference to a flowchart for manufacturing process of FIG. 7. As aggregates for the sound absorbing board e, ground mullite particles with an average particle size of about 0.5 to 1 mm are used (step 41). As a binder, polyethylene terephthalate (hereinafter referred to as PET) resin, which is a thermoplastic resin, of a form of pellet not larger than 1 mm was used. The aggregates and PET resin were kept at a temperature in the range of 140°C to 150°C for five hours and longer before the use to prevent water from remaining (steps 42 and 43). If water remains, hydrolysis of PET resin takes place, resulting in a decrease in strength, so that water was prevented from remaining to the utmost. The content of water is preferably 100 ppm and less. The aggregates are heated to a temperature in the range of 245°C to 290°C, which is the melting point of PET resin. If the temperature is lower than 245°C, the bonding properties of PET resin cannot be achieved because the temperature is lower than the melting point. If the temperature exceeds 290°C, the material is not suitable for use because PET resin decomposes.

[0054] PET resin is mixed with the heated aggregates at a ratio of 2 to 30 wt%, and the mixture is poured into a square mold measuring 300 mm x 300 mm (steps 44 and 45). If the mixing ratio is lower than 2 wt%, molding is difficult to perform because satisfactory bonding ability cannot be provided. If the ratio exceeds 30 wt%, the quantity of PET resin is too large, so that the sound absorbing characteristics as a sound absorbing material cannot be ensured.

[0055] In this embodiment, PET resin of 50 g was mixed with ceramic particles of 730 g. In order to ensure the smoothness of surface layer when the mixture is poured, pressing with a pressure of 40 to 1000 kgf/cm² is performed (step 46). The mold has ordinary temperature. If the pressure is lower than 40 kgf/cm², molding is difficult to perform. Even if molding is performed, a proper strength cannot be obtained. If the pressure exceeds 1000 kgf/cm², voids between the aggregates are crushed, so that the sound absorbing characteristics cannot be secured. After pressing, the product was cooled and solidified, and then was removed from the mold. Thereby, the sound absorbing board e with a thickness of 8 mm as shown in FIG. 8 was obtained (steps 47 and 48). This sound absorbing board e is a ceramic permeable board of a type such that only ceramics and PET resin are mixedly molded, and does not contain a reinforcement for reinforcing the panel.

[0056] Table 4 gives the three-point bending strength and sound absorption coefficient of the sound absorbing board e obtained in this embodiment.

[0057] The three-point bending strength was obtained in accordance with JIS R1601 "Testing Method for Flexural Strength of Fine Ceramics". For the sound absorption coefficient, the peak value and frequency of sound absorption

coefficient were obtained in accordance with JIS A1909 (1967) "Measuring Methods for Reverberant Sound Absorption Coefficient". For comparison, the properties of a conventional sound absorbing board which is not of a recycle type obtained in Japanese Patent Provisional Publication No. 4-191800 (No. 191800/1992) are shown.

[Table 4]

Three-point bending strength and sound absorption coefficient of recycle type sound absorbing board of fourth embodiment			
		Sound absorbing board properties obtained in Japanese Patent Provisional Publication No. 4-191800	Recycle type sound absorbing board of fourth embodiment
Three-point bending strength (kgf/cm ²)		120	120
Peak value of sound absorption coefficient	Frequency (Hz)	500	500
	Reverberant sound absorption coefficient (α_0)	0.93	0.95

[0058] The obtained bending strength was 120 kgf/cm², which was equal to the bending strength of the conventional sound absorbing board in which recycle is not considered, and the reverberant sound absorption coefficient obtained in this embodiment was about 2% higher than that of the conventional sound absorbing board. Further, in this embodiment, a defective product, for example, with improper dimensions turned out at the time of manufacture could be added again in the aggregate mixing step and the heating step. For this reason, the yield rate at the final stage could be improved remarkably.

[0059] In the case where a thermosetting resin is used for molding, curing time of about three days is needed before solidification after press molding. Contrarily, in the case where a thermoplastic resin described in the present invention is used, the molded product can be removed from the mold after curing time of several minutes in which the product has a temperature lower than the resin temperature. Therefore, the manufacturing time can be shortened, and the manufacturing cost can be reduced.

[0060] Next, a fifth embodiment of the present invention will be described with reference to the accompanying drawings.

[0061] A manufacturing method for a sound absorbing board e shown in FIG. 10 will be described with reference to a flowchart for manufacturing process of FIG. 9. As aggregates, ground mullite particles with an average particle size of about 0.5 to 1 mm are used (step 51). Polybutylene terephthalate (hereinafter referred to as PBT) resin, which is a thermoplastic resin, of a form of pellet not larger than 1 mm was used (steps 52 to 54). The aggregates and PBT resin were kept at a temperature in the range of 120°C to 150°C for three hours and longer before the use to prevent water from remaining. If water remains, hydrolysis of PBT resin takes place, resulting in a decrease in strength, so that water was prevented from remaining to the utmost.

[0062] The content of water is preferably 100 ppm and less. The aggregates are heated to a temperature in the range of 225°C to 270°C, which is the melting point of PBT resin. If the temperature is lower than 225°C, the bonding properties of PBT resin cannot be achieved because the temperature is lower than the melting point. If the temperature exceeds 270°C, the material is not suitable for use because PBT resin decomposes.

[0063] PBT resin is mixed with the heated aggregates at a ratio of 2 to 30 wt%. An aluminum crimp wire net f is put at the bottom of a square mold measuring 300 mm x 300 mm as a reinforcement, and the mixture is poured into the mold (steps 55 to 57). In this embodiment, the number of inserted wire nets was one, but one to three layers of wire nets can be used. If the mixing ratio of PBT resin is lower than 2 wt%, molding is difficult to perform because satisfactory bonding ability cannot be provided. If the ratio exceeds 30 wt%, the quantity of polybutylene terephthalate (PBT) resin is too large, so that the sound absorbing characteristics as a sound absorbing board cannot be ensured. In this embodiment, PBT resin of 50 g was mixed with ceramic particles of 730 g. In order to ensure the smoothness of surface layer when the mixture is poured, pressing with a pressure of 40 to 1000 kgf/cm² is performed. After pressing, the aluminum wire net f is pressed in the horizontal direction, by which the product can be removed easily from the mold. The mold has ordinary temperature. If the pressure is lower than 40 kgf/cm², molding is difficult to perform. Even if molding is performed, a proper strength cannot be obtained. If the pressure exceeds 1000 kgf/cm², voids between the aggregates are crushed and decreased, so that the sound absorbing characteristics cannot be secured. After pressing, the product was cooled and solidified, and then was removed from the mold. Thereby, the sound absorbing board a with a thickness of 8 mm as shown in FIG. 10 was obtained. This sound absorbing board e is a board obtained by

mixedly molding ceramics and PBT resin g and by mounting a wire net f serving as a reinforcement on either of the top and bottom surfaces. The wire net f can be inserted in an intermediate layer of the sound absorbing board e.

[0064] Table 5 gives the three-point bending strength and sound absorption coefficient of the sound absorbing board e obtained in the fifth embodiment. The three-point bending strength was obtained in accordance with JIS R1601 "Testing Method for Flexural Strength of Fine Ceramics". For the sound absorption coefficient, the peak value and frequency of sound absorption coefficient were obtained in accordance with JIS A1909 (1967) "Measuring Methods for Reverberant Sound Absorption Coefficient". For comparison, the properties of the conventional sound absorbing board which is not of a recycle type obtained in Japanese Patent Provisional Publication No. 4-191800 (No. 191800/1992) are shown.

[Table 5]

Three-point bending strength and sound absorption coefficient of recycle type sound absorbing board of fifth embodiment			
		Sound absorbing board properties obtained in Japanese Patent Provisional Publication No. 4-191800	Recycle type sound absorbing board of fifth embodiment
Three-point bending strength (kgf/cm ²)		120	130
Peak value of sound absorption coefficient	Frequency (Hz)	500	500
	Reverberant sound absorption coefficient (α_0)	0.93	0.93

[0065] The bending strength obtained in this embodiment was 10 kgf/cm² higher than that of the conventional sound absorbing board in which recycle is not considered. The reverberant sound absorption coefficient obtained in this embodiment was equal to that of the conventional sound absorbing board. Further, in this embodiment, a defective product, for example, with improper dimensions turned out at the time of manufacture could be added again in the aggregate mixing step and the heating step. For this reason, the yield rate at the final stage could be improved remarkably.

[0066] In the case where a thermosetting resin is used for molding, curing time of about three days is needed before solidification after press molding. Contrarily, in the case where a thermoplastic resin described in the present invention is used, the molded product can be removed from the mold after curing time of several minutes in which the product has a temperature lower than the resin temperature. Further, the mold release properties were improved remarkably by the cooling effect of wire net. Therefore, the manufacturing time can be shortened, and the manufacturing cost can be reduced.

[0067] Next, a sixth embodiment of the present invention will be described with reference to the accompanying drawings.

[0068] A manufacturing method for a sound absorbing board e of a recycle type shown in FIG. 12 will be described with reference to a flowchart for manufacturing process of FIG. 11. As aggregates, ground mullite particles with an average particle size of about 0.5 to 1 mm are used (steps 61 and 62). Polyethylene terephthalate (PET) resin, which is a thermoplastic resin, was used in a form of pellets obtained by grinding a portion unsuitable for reclamation of a drink bottle into a size of 1mm and smaller. The aggregates and PET resin were kept at a temperature in the range of 140°C to 150°C for five hours and longer before the use to prevent water from remaining. If water remains, hydrolysis of PET resin takes place, resulting in a decrease in strength, so that water was prevented from remaining to the utmost. The content of water is preferably 100 ppm and less.

[0069] The aggregates are heated to a temperature in the range of 245°C to 290°C, which is the melting point of PET resin. If the temperature is lower than 245°C, the bonding properties of PET resin cannot be achieved because the temperature is lower than the melting point. If the temperature exceeds 290°C, the material is not suitable for use because PET resin decomposes.

[0070] PET resin is mixed with the heated aggregates at a ratio of 2 to 30 wt%. An aluminum crimp wire net f is put at the bottom of a square mold measuring 300 mm x 300 mm, and the mixture is poured into the mold (steps 63 to 66). In this embodiment, the number of inserted wire nets was two, but one to three layers of wire nets can be used. If the mixing ratio of PET resin is lower than 2 wt%, molding is difficult to perform because satisfactory bonding ability cannot be provided. If the ratio exceeds 30 wt%, the quantity of polyethylene terephthalate (PET) resin is too large, so that the sound absorbing characteristics as a sound absorbing board cannot be ensured. In this embodiment, PET

resin of 50 g was mixed with ceramic particles of 730 g. In order to reinforce the surface, the aluminum crimp wire net f is laminated after the pouring surface is smoothed. In order to ensure the smoothness of surface layer, pressing with a pressure of 40 to 1000 kgf/cm² is performed (step 68). After pressing, the aluminum wire net f is pressed in the horizontal direction, by which the product can be removed easily from the mold (steps 69 and 70). The mold has ordinary temperature. If the pressure is lower than 40 kgf/cm², molding is difficult to perform. Even if molding is performed, a proper strength cannot be obtained. If the pressure exceeds 1000 kgf/cm², voids between the aggregates are decreased, so that the sound absorbing characteristics cannot be secured. After pressing, the product was cooled and solidified, and then was removed from the mold. Thereby, the sound absorbing board e with a thickness of 8 mm as shown in FIG. 12 was obtained. This sound absorbing board e is a board obtained by mixedly molding ceramics and PBT resin g and by mounting a wire net f serving as a reinforcement on both of the top and bottom surfaces.

[0071] Table 6 gives the three-point bending strength and sound absorption coefficient of the sound absorbing board e obtained in the sixth embodiment.

[0072] The three-point bending strength was obtained in accordance with JIS R1601 "Testing Method for Flexural Strength of Fine Ceramics". For the sound absorption coefficient, the peak value and frequency of sound absorption coefficient were obtained in accordance with JIS A1909 (1967) "Measuring Methods for Reverberant Sound Absorption Coefficient". For comparison, the properties of the conventional sound absorbing board which is not of a recycle type obtained in Japanese Patent Provisional Publication No. 4-191800 (No. 191800/1992) are shown.

[Table 6]

Three-point bending strength and sound absorption coefficient of recycle type sound absorbing board of sixth embodiment			
		Sound absorbing board properties obtained in Japanese Patent Provisional Publication No.4-191800	Recycle type sound absorbing board of sixth embodiment
Three-point bending strength (kgf/cm ²)		120	140
Peak value of sound absorption coefficient	Frequency Hz)	500	500
	Reverberant sound absorption coefficient (α_0)	0.93	0.92

[0073] The bending strength obtained in this embodiment was about 20 kgf/cm² higher than that of the conventional sound absorbing board in which recycle is not considered. The acoustic performance obtained in this embodiment was approximately equal to that of the conventional sound absorbing board though the reverberant sound absorption coefficient was about 1% lower. Further, in this embodiment, a defective product, for example, with improper dimensions turned out at the time of manufacture could be added again in the aggregate mixing step and the heating step. For this reason, the yield rate at the final stage could be improved remarkably.

[0074] In the case where a thermosetting resin is used for molding, curing time of about three days is needed before solidification after press molding. Contrarily, in the case where a thermoplastic resin described in the present invention is used, the molded product can be removed from the mold after curing time of several minutes in which the product has a temperature lower than the resin temperature. Further, the mold release properties were improved remarkably by the cooling effect of wire net. Therefore, the manufacturing time can be shortened, and the manufacturing cost can be reduced.

[0075] Because recycled PET resin was used, there was a fear of decreased strength. However, by installing the reinforcement on both surfaces, a sound absorbing board with a strength higher than before could be obtained.

[0076] Next, a seventh embodiment of the present invention will be described with reference to the accompanying drawings.

[0077] A manufacturing method for a sound absorbing board e of a recycle type shown in FIG. 14 will be described with reference to a flowchart for manufacturing process of FIG. 13. A ceramic sound absorbing board having used for one year was cleaned to remove contamination. Further, aggregates were kept at a temperature in the range of 140°C to 150°C for five hours and longer to prevent water from remaining (steps 71 and 72). Thereafter, a wire net adhering firmly as a reinforcement was removed by local heating (step 73). The ceramic sound absorbing board from which the wire net has been removed was heated to be used as a reclaimed raw material (step 74).

[0078] As a new ceramic raw material, ground mullite particles with an average particle size of about 0.5 to 1 mm are used. Polyethylene terephthalate (PET) resin was used in a form of pellets obtained by grinding a portion unsuitable

for reclamation of a drink bottle into a size of 1mm and smaller.

[0079] The aggregates and PET resin were kept at a temperature in the range of 140°C to 150°C for five hours and longer to prevent water from remaining (steps 75 to 78). If water remains, hydrolysis of PET resin takes place, resulting in a decrease in strength, so that water was prevented from remaining to the utmost. The content of water is preferably 100 ppm and less. The aggregates are heated to a temperature in the range of 245°C to 290°C, which is the melting point of PET resin. If the temperature is lower than 245°C, the bonding properties of PET resin cannot be achieved because the temperature is lower than the melting point. If the temperature exceeds 290°C, the material is not suitable for use because PET resin decomposes.

[0080] PET resin is mixed with the heated aggregates at a ratio of 2 to 30 wt%. An aluminum crimp wire net f is put at the bottom of a square mold measuring 300 mm x 300 mm, and the mixture is poured into the mold (steps 79 to 82). In this embodiment, the number of inserted wire nets was two. If the mixing ratio of PET resin is lower than 2 wt%, molding is difficult to perform because satisfactory bonding ability cannot be provided. If the ratio exceeds 30 wt%, the quantity of PET resin is too large, so that the sound absorbing characteristics as a sound absorbing board cannot be ensured. In this embodiment, PET resin of 15 g and reclaimed raw material of ceramic sound absorbing board of 470 g were mixed with new ceramic particles of 300 g. In order to reinforce the surface, the aluminum crimp wire net is laminated after the pouring surface is smoothed. In order to ensure the smoothness of surface layer, pressing with a pressure of 40 to 1000 kgf/cm² is performed (step 83). After pressing, the aluminum wire net f is pressed in the horizontal direction, by which the product is removed easily from the mold. The mold has ordinary temperature. If the pressure is lower than 40 kgf/cm², molding is difficult to perform. Even if molding is performed, a proper strength cannot be obtained. If the pressure exceeds 1000 kgf/cm², voids between the aggregates are decreased, so that the sound absorbing characteristics cannot be secured. After pressing, the product was cooled and solidified, and then was removed from the mold. Thereby, the sound absorbing board e with a thickness of 8 mm as shown in FIG. 14 was obtained. This sound absorbing board e is a board g obtained by mixedly molding ceramics and PBT resin and by mounting a wire net f serving as a reinforcement on both of the top and bottom surfaces.

[0081] Table 7 gives the three-point bending strength and sound absorption coefficient of the recycle type sound absorbing board e obtained in the seventh embodiment.

[0082] The three-point bending strength was obtained in accordance with JIS R1601 "Testing Method for Flexural Strength of Fine Ceramics". For the sound absorption coefficient, the peak value and frequency of sound absorption coefficient were obtained in accordance with JIS A1909 (1967) "Measuring Methods for Reverberant Sound Absorption Coefficient". For comparison, the properties of the conventional sound absorbing board which is not of a recycle type obtained in Japanese Patent Provisional Publication No. 4-191800 (No. 191800/1992) are shown.

[Table 7]

Three-point bending strength and sound absorption coefficient of recycle type sound absorbing board of seventh embodiment			
		Sound absorbing board properties obtained in Japanese Patent Provisional Publication No.4-191800	Recycle type sound absorbing board of seventh embodiment
Three-point bending strength (kgf/cm ²)		120	140
Peak value of sound absorption coefficient	Frequency (Hz)	500	500
	Reverberant sound absorption coefficient (α_0)	0.93	0.92

[0083] The bending strength obtained in this embodiment was about 20 kgf/cm² higher than that of the conventional sound absorbing board in which recycle is not considered. The acoustic performance obtained in this embodiment was approximately equal to that of the conventional sound absorbing board though the reverberant sound absorption coefficient was about 1% lower. Further, in this embodiment, a defective product, for example, with improper dimensions turned out at the time of manufacture could be added again in the aggregate mixing step and the heating step. For this reason, the yield rate at the final stage could be improved remarkably.

[0084] In the case where a thermosetting resin is used for molding, curing time of about three days is needed before solidification after press molding. Contrarily, in the case where a thermoplastic resin described in the present invention is used, the molded product can be removed from the mold after curing time of several minutes in which the product has a temperature lower than the resin temperature. Further, the mold release properties were improved remarkably

by the cooling effect of wire net. Therefore, the manufacturing time can be shortened, and the manufacturing cost can be reduced.

[0085] Because a reclaimed raw material of used ceramic sound absorbing board and PET resin were used, there was a fear of decreased strength. However, by installing the reinforcement on both surfaces, a sound absorbing board with a bending strength equivalent to that of the related art could be obtained.

[0086] The above is a description of the embodiments of the present invention. Needless to say, the present invention is not limited to these embodiments, and various modifications can be made based on the technical concept of the present invention.

[0087] For example, although an example in which a sound absorbing board measuring 300 mm long x 300 mm wide is manufactured has been described in the above embodiments, the size of the sound absorbing board is not limited to the above-described dimensions, and the thickness thereof is also arbitrary.

[0088] According to the first mode of the present invention, although the conventional ceramic sound absorbing material is vulnerable to shock, the present invention can provide a ceramic sound absorbing material with excellent shock resistance, the Charpy impact value thereof being 0.3 J/cm² to 10 J/cm². Also, even when a reclaimed raw material of ceramic sound absorbing material is used as an aggregate, a ceramic sound absorbing material with shock resistance of the same level can be obtained. Also, a manufacturing method for these ceramic sound absorbing materials are provided.

[0089] According to the second mode of the present invention, performance equivalent to that of the conventional sound absorbing board in which recycle is not considered can be obtained. Further, a defective product, for example, with improper dimensions can be added again in the aggregate mixing step and the heating step. For this reason, the yield rate at the final stage can be improved remarkably.

[0090] Further, conventionally, in the case where a thermosetting resin is used for molding, curing time of about three days has been needed before solidification after press molding. Contrarily, in the case where a thermoplastic resin described in the present invention is used, the molded product can be removed from the mold after curing time of several minutes in which the product has a temperature lower than the resin temperature. Therefore, the manufacturing time can be shortened, and the manufacturing cost can be reduced.

Claims

1. A ceramic sound absorbing material comprising aggregates consisting of ceramic particles; a ceramic particle layer formed of a synthetic resin; and a reinforcement having openings, which is mounted on said ceramic particle layer,
wherein said material has a Charpy impact value, which represents an impact strength, of 0.3 J/cm² to 10 J/cm².
2. The ceramic sound absorbing material with excellent shock resistance according to claim 1, wherein said ceramic particles are particles obtained by recycling a used sound absorbing material.
3. The ceramic sound absorbing material with excellent shock resistance according to claim 1 or 2, wherein said ceramic particles have an average particle size of 0.5 to 1 mm.
4. The ceramic sound absorbing material with excellent shock resistance according to claim 1 or 3, wherein said reinforcement has openings with an opening rate in the range of 30% to 80%.
5. A sound absorbing material manufactured by pressure molding a mixture of ceramic particles and a heated and melted thermoplastic resin serving as a binder,
wherein said ceramic particles and thermoplastic resin are non-reactive and the strengths thereof is not decreased at the time of mixing and pressure molding.
6. A sound absorbing material manufactured by pressure molding a mixture of ceramic particles and a heated and melted thermoplastic resin serving as a binder and by inserting or mounting a net-like reinforcement having many openings, which is formed of a rigid material, in the interior or on the surface of the molded layer of said ceramic particles and thermoplastic resin,
wherein said ceramic particles and thermoplastic resin are non-reactive and the strengths thereof is not decreased at the time of mixing and pressure molding, and said thermoplastic resin is polybutylene terephthalate resin.

7. A sound absorbing material manufactured by pressure molding a mixture of ceramic particles and a heated and melted thermoplastic resin serving as a binder and by inserting or mounting a net-like reinforcement having many openings, which is formed of a rigid material, in the interior or on the surface of the molded layer of said ceramic particles and thermoplastic resin,

wherein said ceramic particles and thermoplastic resin are non-reactive and the strengths thereof is not decreased at the time of mixing and pressure molding, and said thermoplastic resin is polyethylene terephthalate resin.

8. The sound absorbing material according to claim 6 or 7, wherein the opening rate of said reinforcement is in the range of 30% to 80%, and one to three reinforcements are inserted in or mounted on said molded layer.

9. The sound absorbing material according to claim 7, wherein said polyethylene terephthalate resin is waste polyethylene terephthalate resin ground into a size of 0.5 to 1 mm.

10. The sound absorbing material according to claim 6 or 7, wherein wastes of said sound absorbing material is mixed with said heated ceramic particles and heated and melted thermoplastic resin serving as a binder.

11. A manufacturing method for a ceramic sound absorbing material with excellent shock resistance, comprising the steps of:

heating aggregates consisting of ceramic particles;
mixing a synthetic resin with said aggregates;
pouring a mixture of said synthetic resin and said aggregates into a mold after a reinforcement having openings is put in said mold, and pressing said mixture to keep smoothness of surface layer; and
cooling and solidifying said pressed mixture.

FIG.1

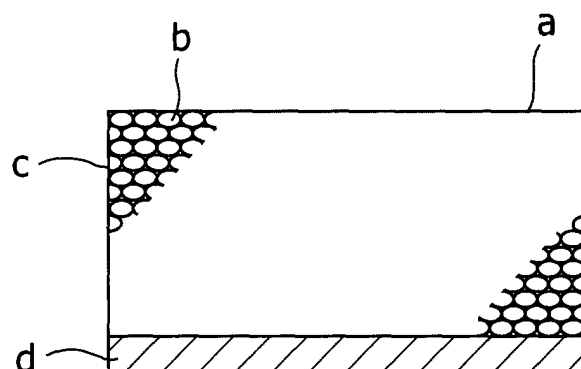


FIG.2

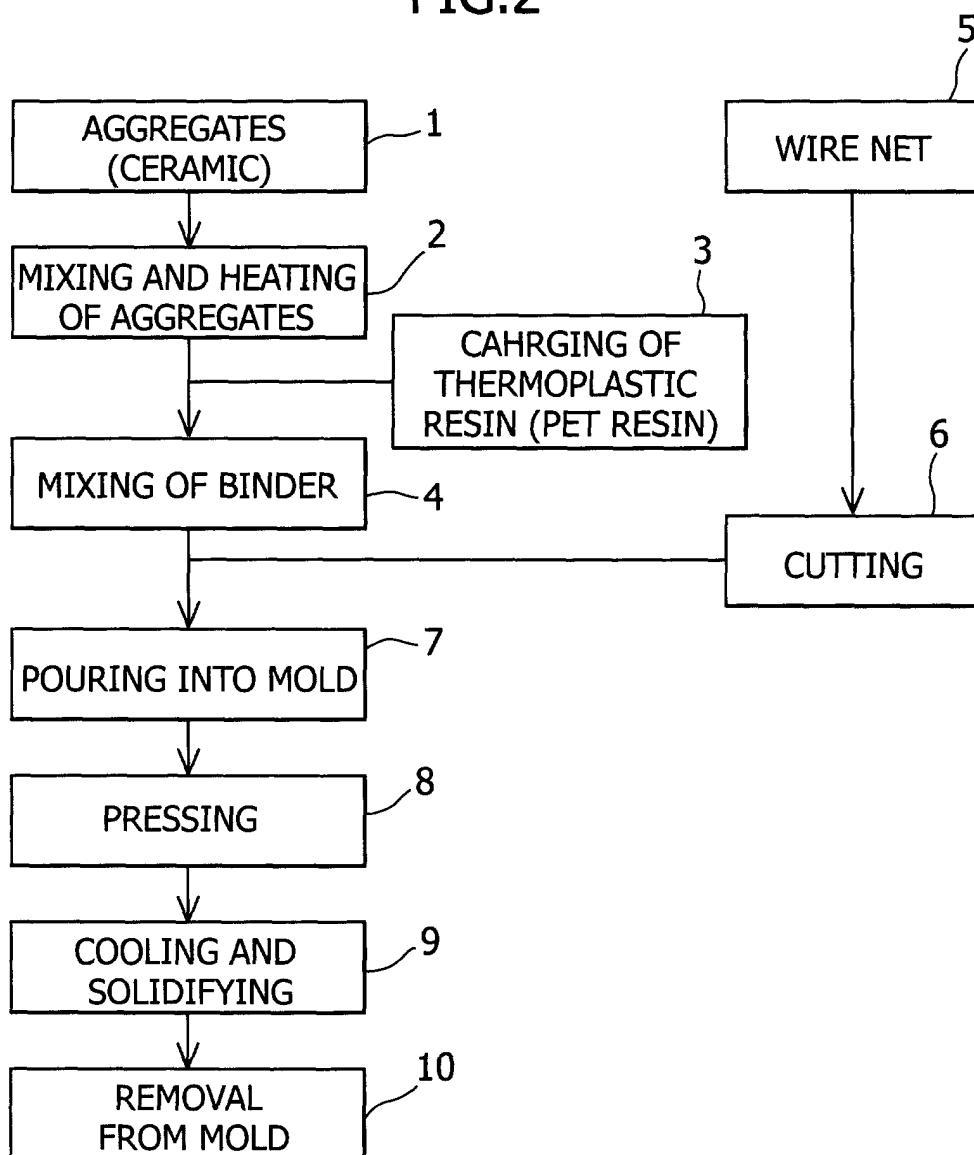


FIG.3

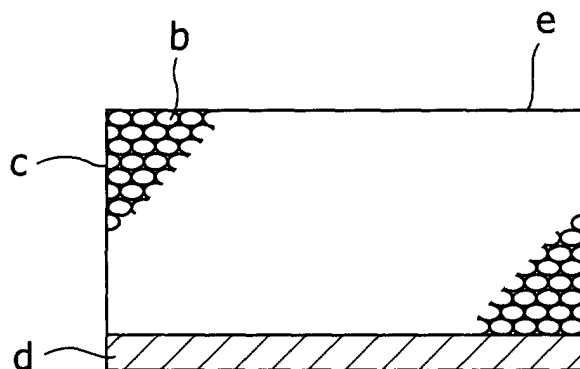


FIG.4

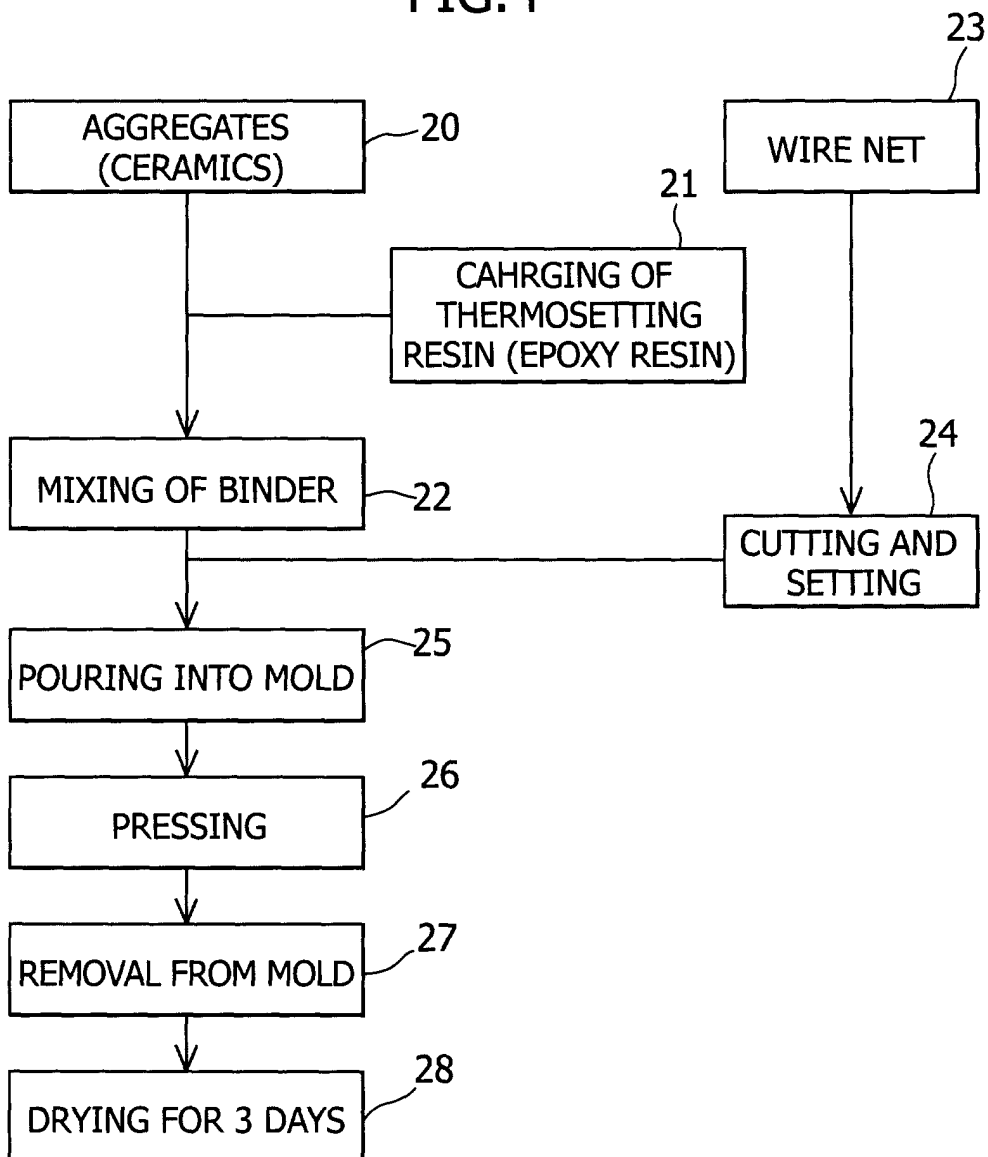


FIG.5

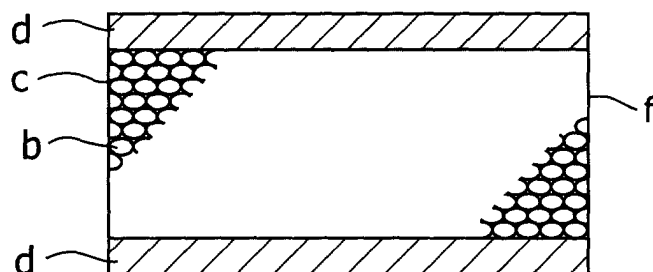


FIG.6

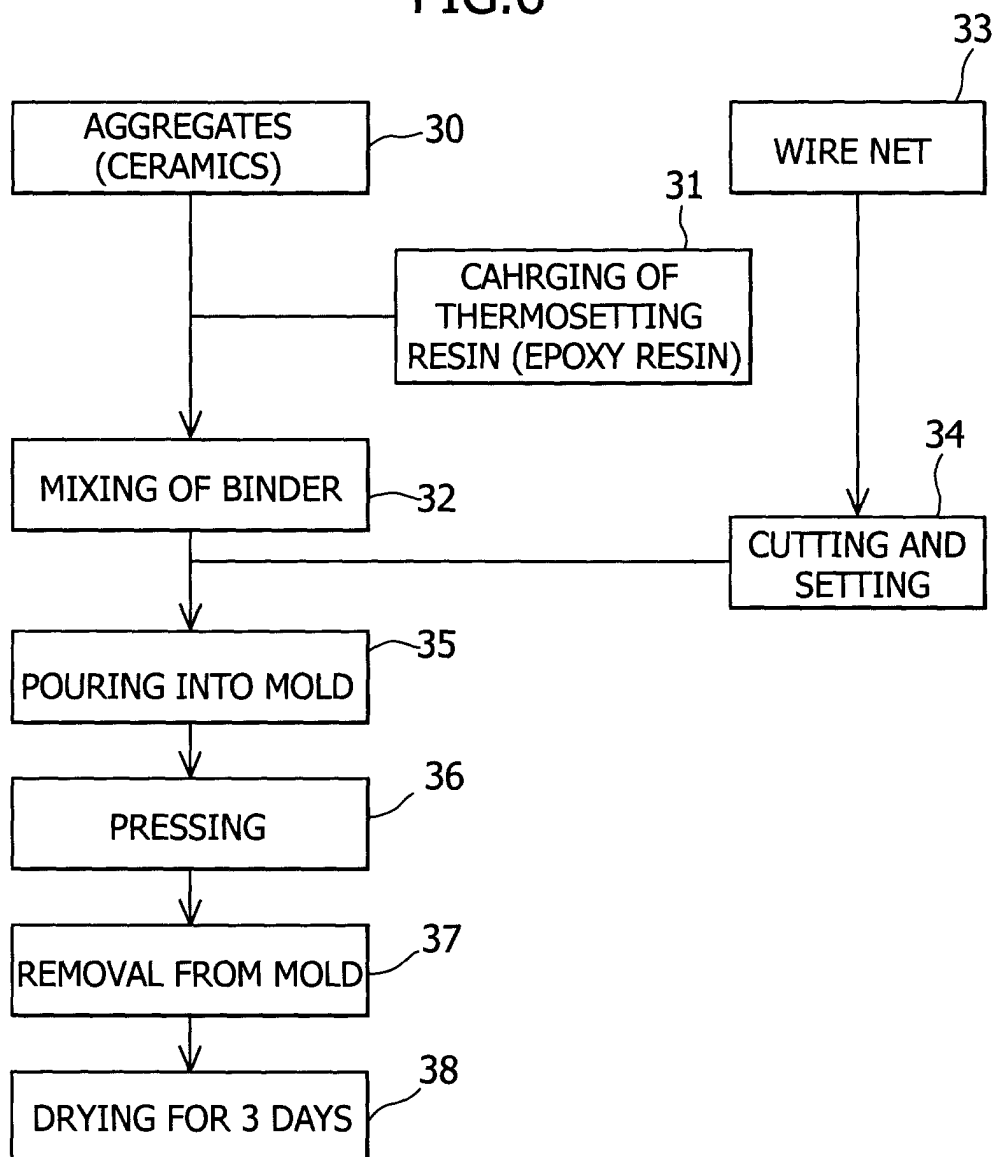


FIG.7

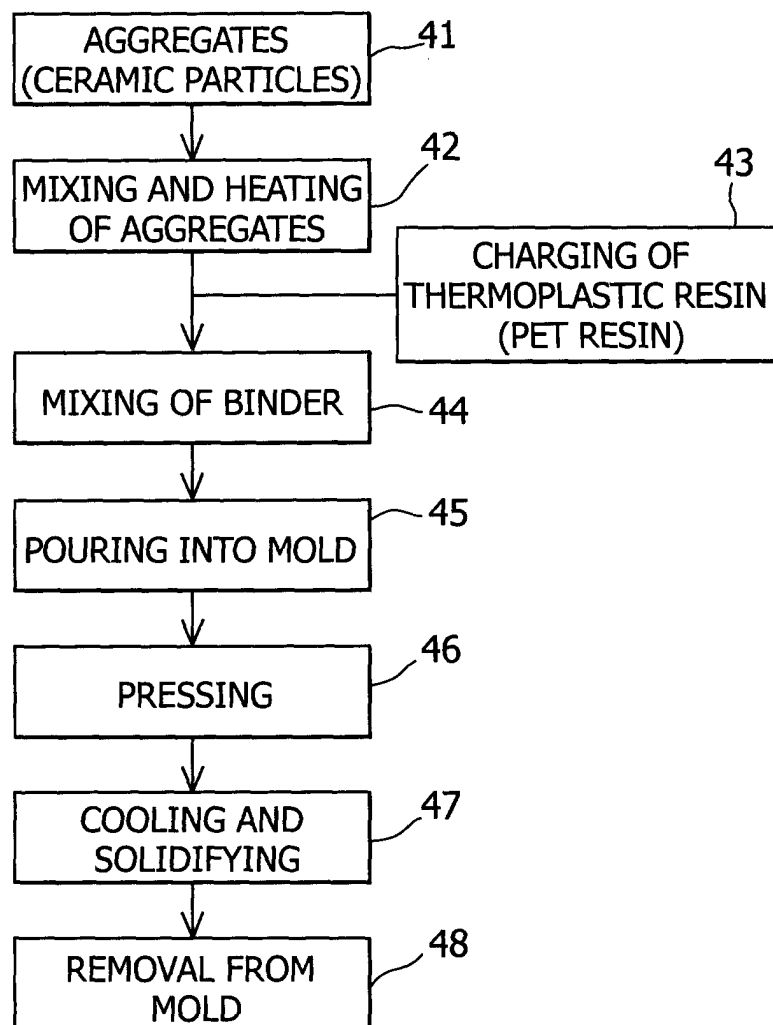


FIG.8

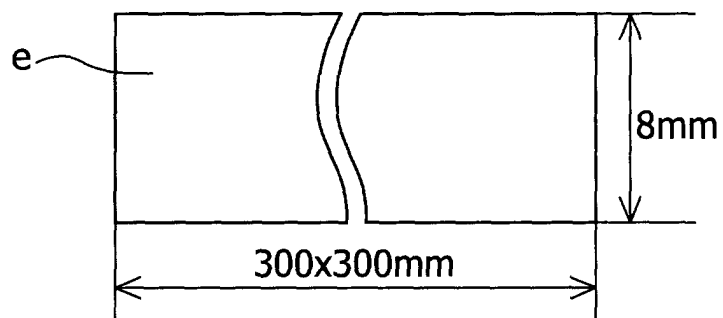


FIG.9

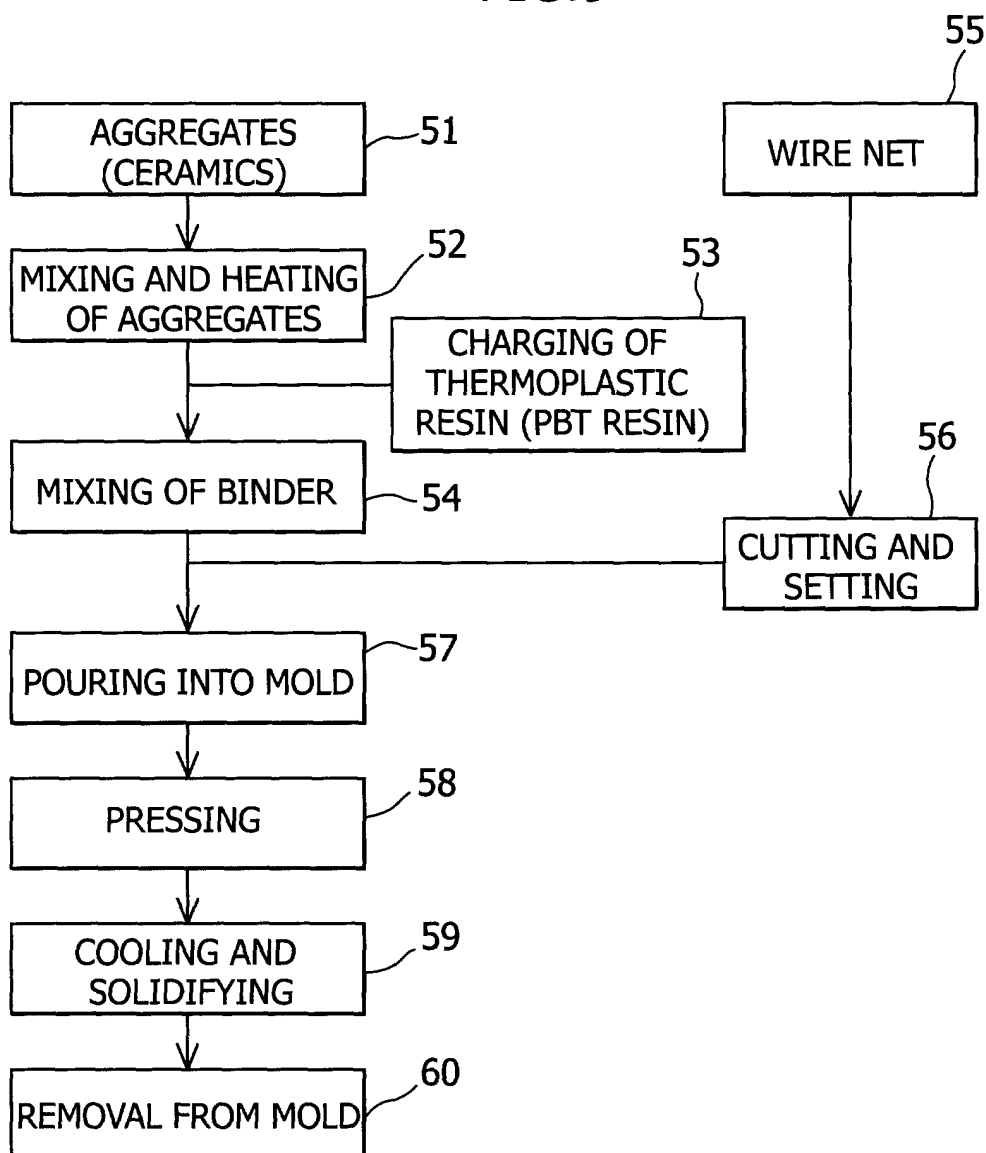


FIG.10

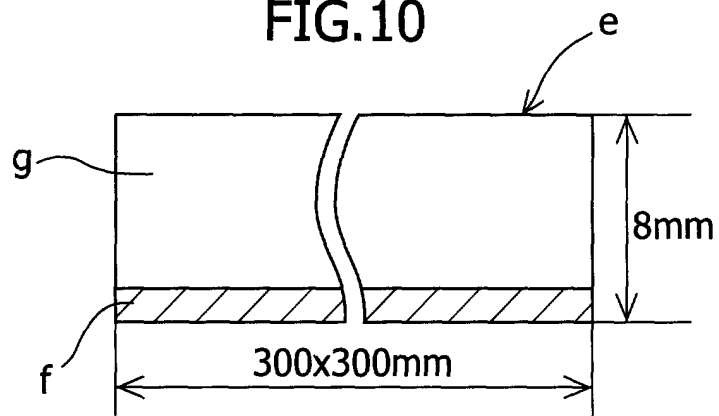


FIG.11

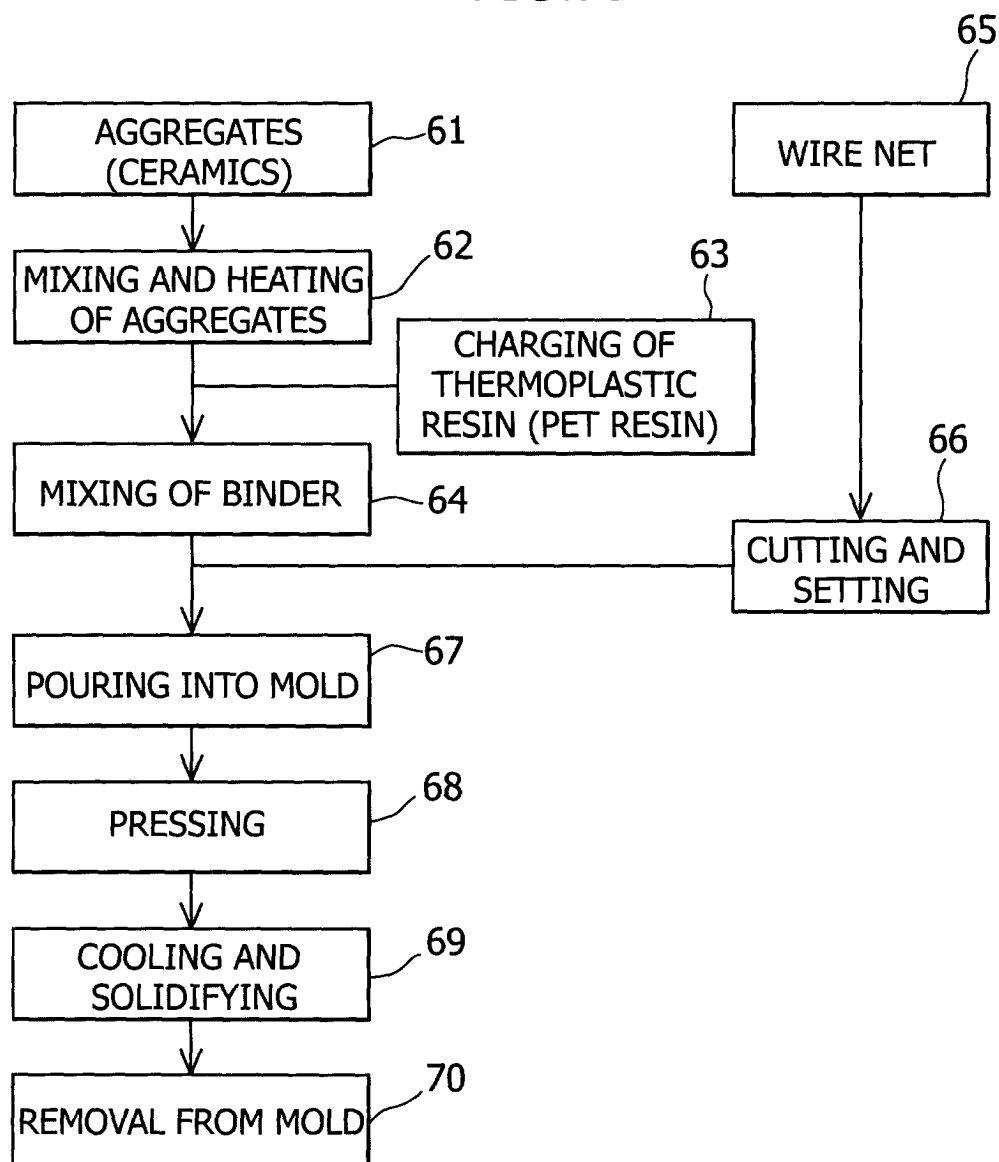


FIG.12

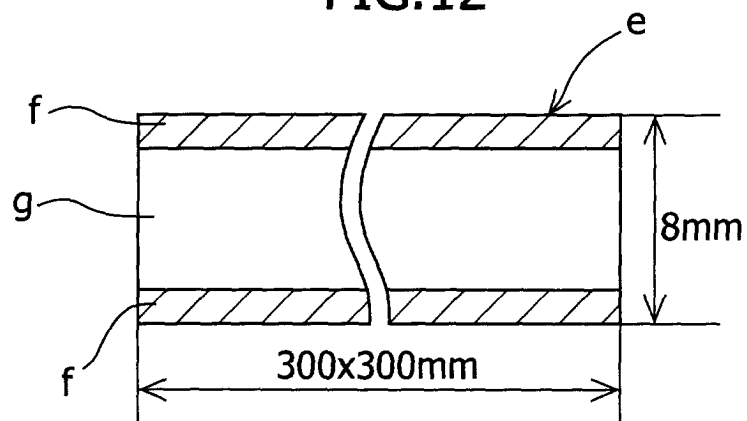


FIG.13

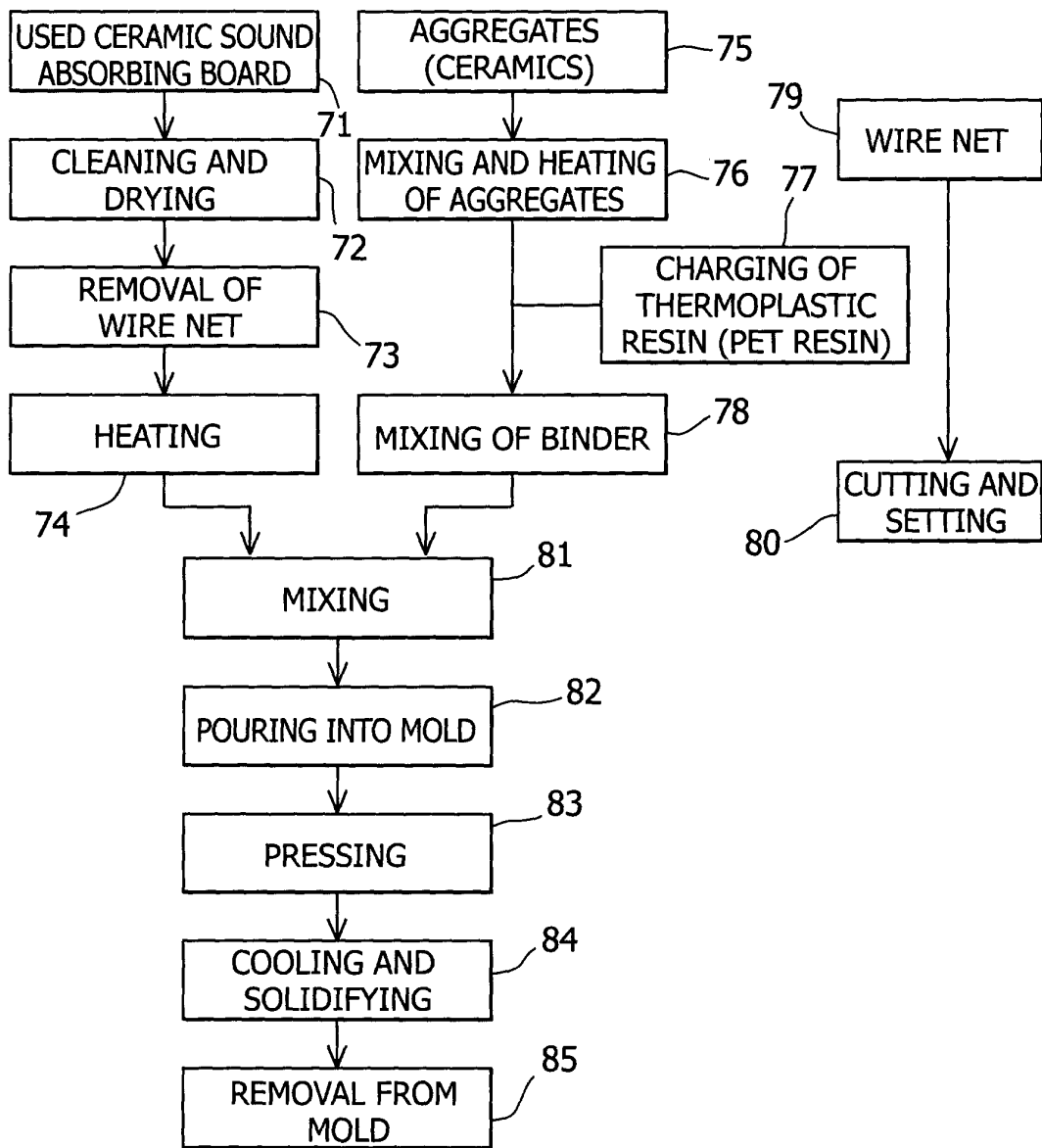


FIG.14

