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## (54) Fire protection material and its use.

(57) Fire protection material comprises a flat supporting material with a large number of through-openings and a coating of a fire protection agent, which forms an insulating layer when subjected to excessive heat. The through-openings are closed in the event of a fire by the insulating layer as it foams up. The supporting material comprises inorganic, non-metallic, heat-stable material at least 3 mm thick, which has through-openings of 2 $mm^2$ to 100 $mm^2$, and which constitute 2 to 30% of the total surface area of the supporting material. The supporting material preferably has a relatively low density. The invention also relates to a process for protecting objects against the effects of fire by enveloping the objects completely or partly with the fire protection material, to a construction for fire protection obtained according to this process, as well as to the use of fire protection materials for protecting objects against the action of fire.

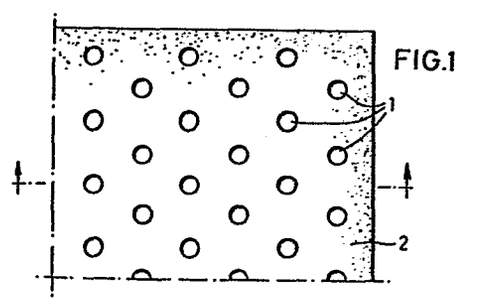


FIG.1

EP 0 106 144 A2

# FIRE PROTECTION MATERIAL AND ITS USE

## Background of the Invention

The present invention relates to a fire protection material comprising a flat supporting material with a large number of through-openings and a fire prevention coating, which, when subjected to excessive heat, forms an insulating layer, the through-openings being closed off by the insulating layer as it foams up.

The invention, furthermore, relates to a process for protecting objects from the effects of fire, a construction for fire protection, as well as the use of the fire protection material for protecting objects from the effects of fire.

Certain fire protection materials are used in order to protect objects which are to be protected in the event of a fire against destruction by heat or fire for a certain period of time. The respective regulations, partly described by law, require fire protection or prevention in the sense of different durations, the need existing for a fire preventing effect which lasts as long as possible. Previously, it was satisfactory if the period of time was 10 or 20 minutes assuming tests under ASTM Standard E119 or equivalent international standard. These requirements are, however, not adequate for dangerous installations or installations of extremely high importance, such as, for example, nuclear reaction installations and installations associated with these. Electrical cables and lines are an important group of objects, which must be protected. It is a particular requirement of the protection of such installations that ventilation of the

installation, for example, cable lines, must be ensured in the normal state, since heat is developed which must be dissipated. It is, therefore, not desirable and, in some cases, not possible to protect such installations by massive walls, which do not permit ventilation. It is necessary to make certain that the potential built-up heat, which is generated in the installations to be protected, is carried off through sufficiently large ventilation openings to allow dissipation of heat.

The use of flat supporting material, in general, for the protection of such installations is well known (compare German Auslegeschrift 3,011,453). A thin metal lattice is typically used as the flat supporting material of this known type. These thin materials, with many small openings, ensure good ventilation but not an adequate fire prevention effect over a longer period, as is required in many cases. Moreover, the fire prevention effect is not adequate at high fire room temperatures, such as 900° to 1,000°C and higher, as is required today for the protection of valuable installations.

## Summary of the Invention

The present invention is based on the task of finding a fire protection material for objects which is greatly superior to the fire protection or fire prevention obtained through known fire prevention lattices, and can be manufactured and installed in a simple manner.

The object of the present invention, therefore, is a fire protection material, comprising a flat supporting material with a large number of through-openings and a fire prevention coating which forms an insulating layer such that the through-openings are closed off in the event of a fire by the insulating layer as it foams up, wherein

(a) the supporting material comprises inorganic, non-metallic, non-combustible heat-resistant material,
(b) the supporting material has a thickness of at least 3 mm,
(c) the through-openings in each case have a cross section of 2 $mm^2$ to 100 $mm^2$,
(d) the total cross sectional area of the through-openings is 2 to 30%, based on the total surface area of the supporting material.

Advantageously, the supporting material (calculated without the through-openings) has a density of 0.01 to 3 g/cc. The supporting material is preferably open-pored material, as defined below. Glazed material offering good surface adhesion would also be acceptable. The fire protection material of the invention is preferably a single layer.

It is, furthermore, an object of the present invention to provide a process for the protection of objects against the effects of fire by enveloping the objects, wherein at least 10% of the enveloping material consists of the fire protection material described above.

The invention also relates to a construction for protecting objects against fires, comprising an enveloping material arranged at a distance from the objects to be protected against fire, wherein at least 10% of this enveloping material constitutes the fire protection material described above.

In addition, the invention relates to the use of the above-defined fire protection material for the protection of objects, especially electrical cables and/or lines against the effects of fire.

The inventive fire protection material differs from the known fire protection materials essentially in respect to the following properties:

1. The supporting material comprises a non-metallic, inorganic, non-combustible, heat-stable, preferably open-pored material. This is in contrast to the prior art where intumescent materials have typically been applied to metals or to combustible materials. As defined in the invention, the expression "open-pored" means that such supporting material is able to absorb fluids in a particular amount. Moreover, it means that such supporting material has pores and spaces over the whole of its extent, which, in accordance with the invention, become closed by the intumescent material under the effect of heat and thus ensures a continuous low thermal conductivity. Non-open-pored material or open-pored material which is glazed and permits surface adhesion of the fire protection coating may be suitable as the supporting material. The term glazing is understood to include surface treatment or coating. The invention is not, however, limited to glazed or open-pored materials. While the supporting material may be open-pored, the material is also solid, in the sense of not having a continuous void between the outer surfaces, (i.e., not "hollow"). The term "inorganic" is used herein as not excluding minor amounts of organic binders. The supporting material is coated with a fire protection material, which in case of excessive heat forms an insulating layer. As fire protection material, materials are used which are known in this technical field and will be exemplified in greater detail at a later time. It is a question of impregnating compounds or materials. Coating is accomplished appropriately by impregnating or soaking; however, it can be carried out in any suitable manner, which ensures complete coating (for example, immersing, spraying, brushing on and the like). When the supporting material is open-pored, it is guaranteed that a sufficient amount of fire protection material is applied per unit area since the liquid fire protection material can penetrate into the open-pored supporting material. It is particularly important that the surfaces of the through-openings are also

coated with fire protection material; this applies particularly for the through-openings with a relatively large cross sectional opening. The amount of fire protection composition must be such over the whole of the surface of the through-openings that, in the event of a fire, the through-openings are completely filled with the foam.

2. The supporting material is relatively thick. The thickness is preferably at least about 5 mm and advisably at least about 10 mm, while a thickness of at least about 15 mm is especially preferred. The upper limit for the thickness is determined by the fire prevention effect desired and by the weight which can be tolerated or by the thickness of fire protection material which can be tolerated. Advisably, the thickness of the supporting material does not exceed about 80 mm, preferably not above 50 mm and most preferably not above 35 mm.

3. The through-openings have a cross sectional opening, which permits satisfactory ventilation under normal conditions. For this reason, the cross sectional openings of the individual through-openings are advisably in each case at least about 5 $mm^2$, preferably at least about 10 $mm^2$ and most preferably at least about 20 $mm^2$ in size. The upper limit to the cross sectional openings is determined by the fact that, in the event of a fire, these openings must be closed off completely by the fire protection material foaming up. It is, therefore, advisably about 80 $mm^2$, preferably about 60 $mm^2$ and most preferably about 40 $mm^2$.

4. The total cross sectional area of the through-openings is large enough so that adequate ventilation is assured under normal conditions. By these means, adequate heat dissipation of dammed-up heat is assured. By through-openings it is meant openings which extend from one surface of the supporting material clear through to the opposite surface. The total

cross sectional area of the through-openings, therefore, is advisably at least about 3 %, preferably at least about 4 % and most preferably at least about 5 % of the total surface area of the fire protection material. The upper limit for the total cross sectional area of the through-openings advisably is about 20%, preferably about 15% and most preferably about 10%.

5. The density of the supporting material, calculated without the volume of the through-openings, that is, before the through-openings are produced, preferably is relatively low. Advisably, it is at least about 0.03 g/cc, preferably at least about 0.05 g/cc and most preferably at least about 0.1 g/cc. The upper limit advisably is about 1.5 g/cc, preferably about 1 g/cc and most preferably about 0.9 g/cc.

A fire protection effect can be achieved with the inventive fire protection material, which previously was regarded as impossible.

The fire protection effect can be measured, for example, according to the international standard ISO No. 834 or according to the American standard ASTM E 119 or according to the German standard DIN 4102. According to all of these standards, the temperature curves for the combustion chamber are similar in these tests. The inventive fire protection material has a fire protection effect of more than 45 minutes and fire protection effects of more than 1 hour and even 3 hours are achievable. Fire protection effects such as these were previously considered to be impossible for fire protection materials which permit the circulation of air. It is, of course, to be expected that a massive material of sufficient thickness will make an adequate fire protection effect possible. It is, however, extremely surprising that such a long-lasting fire protection effect is achieved in spite of the relatively large through-openings in the fire protection

material of the invention, which are closed up in the event of a fire by the fire protection material as it foams up. It would have been more likely to expect that the foamed-up fire protection material in the through-openings would have permitted the fire to break through after some time, so that the desired long fire protection effect does not take place. For this reason, in cases in which such a long fire protection effect of, for example, 1 hour or more is desired, massive materials were therefore used, which, however, have the serious disadvantage that they do not permit any ventilation of air, so that dammed-up heat, which develops within the objects to be protected, for example, within electrical lines, cannot be dissipated.

As explained above, the supporting material comprises non-metallic, non-combustible, inorganic, heat-stable and, preferably, open-pored material. Examples of such materials are: lime (magnesium silicates), kaolin (aluminium silicates), clays (aluminium silicates), asbestos (magnesium silicates) and the like. So-called "ceramic" materials are preferred.

The supporting material may also be a flexible material or a material which can be rolled up, whose external appearance is similar to that of a (wool) blanket. Thus, while the supporting material is flat, it may also be flexible, in the sense of a sheet or web. The fibers of such a flexible supporting material are, of course, formed from inorganic, heat-stable material. Examples of this are mineral wool, for example, rock wool with a sufficiently high melting point, fibrous aluminium silicates or other ceramic materials, plaster fibers, glass fibers with a sufficiently high melting point, and the like. The supporting material can, therefore, be rigid or flexible. It is essential, however, that the supporting material has the through-openings, defined in detail above.

Such materials are commercially available, for example, the panels sold under the registered trademark of KAOWOOL or the blankets of Babcock & Wilcox or the products of the Carborundum Company, sold under the registered trademark of FIBERFRAX. Rock wool panels or blankets are sold under the registered trademark of ROCKWOOL or ISOVER.

The through-openings can be produced in any manner desirable. For example, it is possible to produce the through-openings by drilling. The shape of the cross section of the through-openings is not of particular importance. Circular through-openings, that is drill holes, are advisable, because they can readily be produced mechanically. The through-openings may, however, also have any other geometric cross sectional shapes. The fire prevention agents for the fire protection material of the invention have a composition which, as such, is known and is used generally for fire prevention coatings. Examples of such agents may be found in the U.S.Patent 4,292,358. Some examples are given in the following:

Fire Protection Agent A

| | |
|---|---|
| Water | 20.4% |
| Surfactant | 0.5% |
| Titanium Dioxide | 8.5% |
| Monoammonium Phosphate | 25.6% |
| Melamine Formaldehyde Resin | 2.1% |
| Dicyandiamide | 8.5% |
| Pentaerythritol | 4.3% |
| Chlorinated Paraffin (70% Cl) | 5.1% |
| Carboxymethylcellulose (2%) | 6.4% |
| Polyvinyl Latex (60% solids) | 17.6% |
| Dibutyl Phthalate | 1.0% |
| | 100.0% |

Fire Protection Agent B

| | |
|---|---|
| Titanium Dioxide | 12.8% |
| Starch | 5.1% |
| Ammonium Phosphate | 29.5% |
| Aminoacetic Acid | 5.4% |
| Chlorinated Rubber | 10.6% |
| Alkyd Resin Solution | 10.2% |
| Naphtha with a high flash point | 25.7% |
| Silicone Resin solution | 0.7% |
| | 100.0% |

The invention is described further by means of the attached drawings. In the figures, the same parts are provided with the same reference numbers.

Brief Description of the Drawings

Fig. 1 is a schematic view of a fire protection material of the invention;

Fig. 2 is a cross section thereof along the lines indicated by the arrows;

Fig. 3 is a perspective view of a fire protection material of the invention;

Figs. 4 and 5 are enlarged representations of the cross section of Fig. 2.

Detailed Description of the Invention

The through-openings are labelled 1. The supporting material itself is labelled 2. The dotted areas 3 in Fig. 4 are intended to indicate the fire protection agent, which has penetrated into the surface of the preferred open-pored supporting material 2.

Fig. 5 shows the fire protection material after the fire. The openings 1 are filled up with the carbon foam 4 of the fire protection agent; the same is true for the surface of the supporting material 2. The invention is described in greater detail by means of the following example:

Example 1

A panel of aluminium silicate known as an M Board (commercially available from Babcock & Wilcox, as of the date of filing of the application, under the registered trademark of KAOWOOL), 20 mm thick, had drill holes with a diameter of about 6 mm. The drill holes were distributed essentially uniformly over the whole of the surface. The distance between the centers of the individual drill holes was approximately 25 mm. There were about 30 to 40 of these drill holes in a 100 $cm^2$ of the panel. This corresponds to a total surface area of the drill holes of about 10%, based on the total surface area of the panel. This panel, provided with drill holes, was immersed in a solution of fire prevention agent A. After having been immersed in the solution, the panel was allowed to dry in air, so that an insulating layer is formed in the event of a fire.

This panel was mounted on cable trays, which were otherwise protected on three sides against fire (e.g., by massive walls or other methods). The fourth side was, therefore, covered by the inventive fire protection panel and brought about adequate circulation of air. It is, of course, also possible to surround two, three or even all four sides of the cable lines completely or partly with the inventive fire protection panel.

In a fire test according to ASTM E119, UL 263 or ANI(American Nuclear Insurers) Standard for "Protective Envelope for Electrical Curcuits", the protection time was greater than 45 minutes.

It may also be adequate to cover or surround the cable lines on one side only partially or on several sides only partially with the fire protection panel of the invention, provided that adequate ventilation is assured.

In summary, the invention involves fire protection material comprising a flat supporting material with a large number of through-openings and a coating of a fire protection agent, which forms an insulating layer, the through-openings being closed in the event of a fire by the insulating layer as it foams up. The supporting material comprises non-metallic, non-combustible inorganic, heat-stable, preferably open pored material, at least 3 mm thick, which has through-openings in each case of 2 $mm^2$ to 100 $mm^2$ which constitute 2 to 30% of the total surface area of the supporting material. The supporting material preferably has a relatively low density. The invention also relates to a process for protecting objects against the effects of fire by enveloping the objects completely or partly with the fire protection material, to a construction for fire protection, obtained according to this process, as well as to the use of fire protection materials for protecting objects against the action of fire.

It should be understood, of course, that the specific form of the invention herein illustrated and described is intended to be representative only, as certain changes may be made therein without departing from the clear teachings of the disclosure. Accordingly, reference should be made to the following appended claims in determining the full scope of the invention.

1 **Claim:**

1. Fire protection material comprising:
   (a) a non-metallic, non-combustible inorganic heat resistant solid supporting material having a plurality of through-openings,
   (b) said supporting material having a thickness of at least 3 mm,
   (c) each of said through-openings having a cross sectional area of 2 $mm^2$ to 100 $mm^2$,
   (d) the total cross sectional area of the through-openings being from 2 to 30% of the total surface area of the supporting material,
   (e) a fire protection coating capable of foaming up in the event of fire to close off the through-openings and form an insulating layer.

2. Fire protection material according to claim 1, wherein the supporting material is open-pored and has a density (calculated without the through-openings) of from 0.01 to 3 g/cc.

3. Fire protection material as defined in claim 1, wherein the supporting material comprises magnesium and/or aluminium silicates.

4. Fire protection material as defined in claim 1, wherein the supporting material has a thickness of 5 to 80 mm.

5. Fire protection material as defined in claim 1, wherein the cross sections of the openings in each case are 10 to 60 $mm^2$ in size.

6. Fire protection material as defined in claim 2, wherein the cross sections of the openings in each case are 10 to 60 $mm^2$ in size.

7. Fire protection material as defined in claim 3, wherein the cross sections of the openings in each case are 10 to 60 $mm^2$ in size.

8. Fire protection material as defined in claim 1, wherein the total cross sectional area of the through-openings is 5 to 15% of the total surface area of the supporting material.

9. Fire protection material as defined in claim 2, wherein the total cross sectional area of the through-openings is 5 to 15% of the total surface area of the supporting material.

10. Fire protection material as defined in claim 7, wherein the total cross sectional area of the through-openings is 5 to 15% of the total surface area of the supporting material.

11. Fire protection material as defined in claim 2, wherein the supporting material has a density of 0.03 to 1 g/cc.

12. Fire protection material as defined in claim 5, wherein the supporting material has a density of 0.03 to 1 g/cc.

13. Fire protection material as defined in claim 8, wherein the supporting material has a density of 0.03 to 1 g/cc.

14. Process for protecting objects against the effects of fire by enveloping the objects, wherein at least 10% of the enveloping material comprises the fire protection material defined in claim 1.

15. Process for protecting objects against the effects of fire by enveloping the objects, wherein at least 10% of the enveloping material comprises the fire protection material defined in claim 2.

16. Construction for protecting objects against fires, comprising an enveloping material arranged at a distance from the objects to be protected against fire, wherein at least 10% of the enveloping material comprises the fire protection material defined in claim 1.

17. Construction for protecting objects against fires, comprising an enveloping material arranged at a distance from the objects to be protected against fire, wherein at least 10% of the enveloping material comprises the fire protection material defined in claim 2.

18. Use of the fire protection material as defined in claim 1 for protecting objects, especially electrical cables and/or lines, against the effect of fire.

19. Use of the fire protection material as defined in claim 2 for protecting objects, especially electrical cables and/or lines, against the effect of fire.

20. Fire protection material comprising

(a) a single layer, non-metallic, solid, inorganic heat resistant supporting material having a plurality of through-openings,

(b) said supporting material having a thickness of 5 to 80 mm,

(c) each of said through openings having a cross sectional area of from 10 $mm^2$ to 60 $mm^2$,

(d) the total cross sectional area of the through openings being from 5 to 15% of the total surface area of the supporting materials,

(e) the sensity of said support material calculated without the through openings being from 0.03 to 4 g/cc, and

(f) a fire protection coating capable of foaming up in the event of fire to close off the through openings and form an insulating layer.

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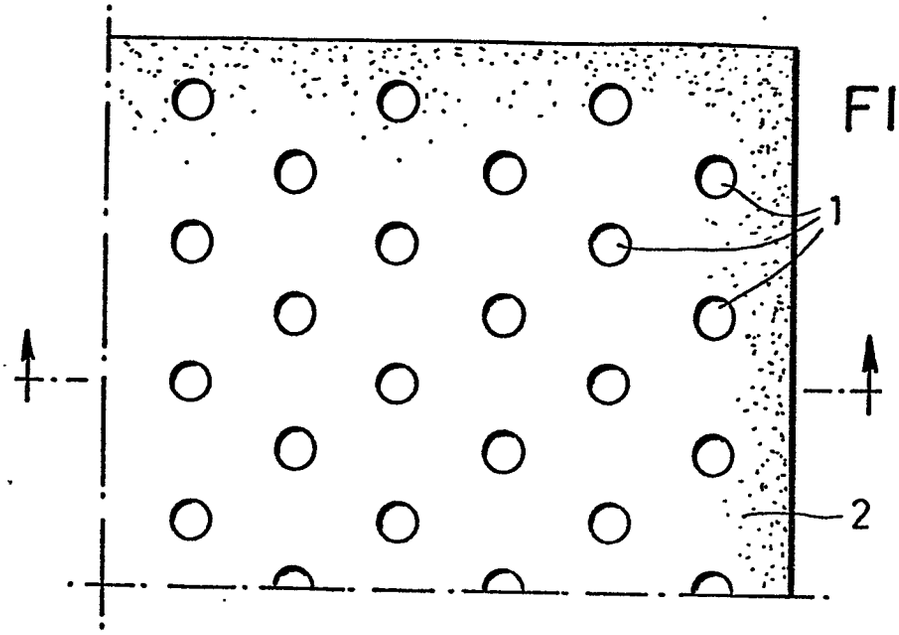


FIG.1

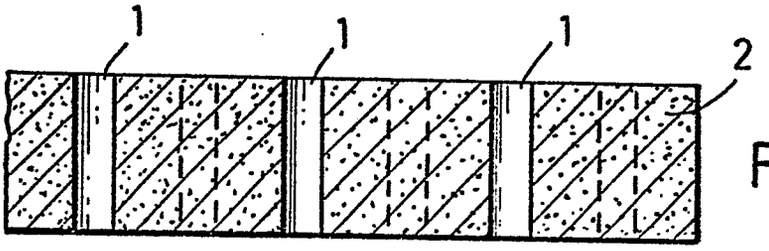


FIG.2

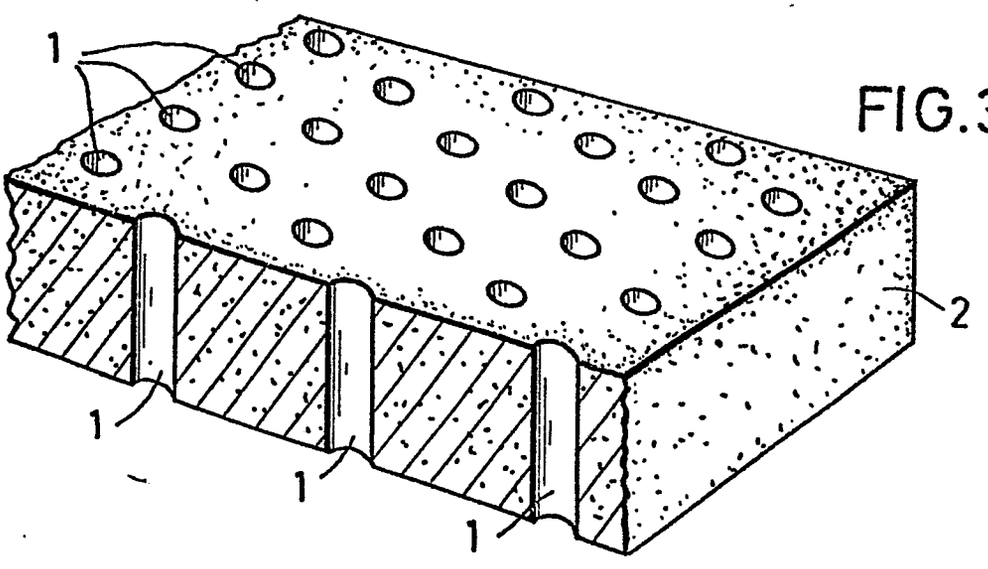


FIG.3

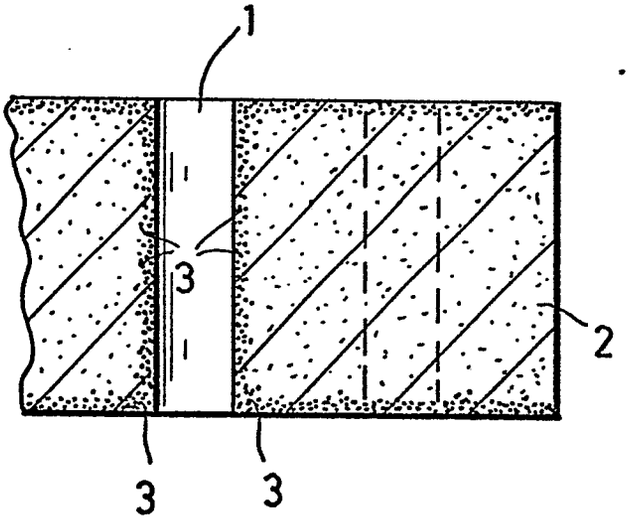


FIG.4

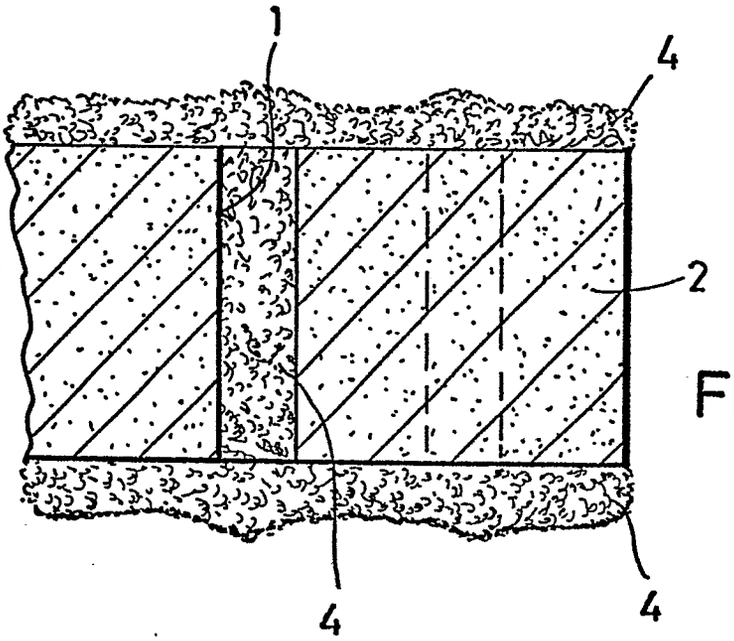


FIG.5