

Fire protection part of planar-like design, method of
producing it and use thereof

Description

The present invention relates to a fire protection part of planar-like design which is connected to at least one room limiting face part, the fire protection part being formed from a fire protection material based upon an inorganic sol. In addition, the present invention relates to a method of producing the fire protection part and to possible purposes of use.

In this case, room limiting face parts comprise all possible parts which are suitable for limiting a room, in particular static walls, ceilings, floors, partition walls, doors or window panes. The materials of these room limiting face parts are capable of being selected as desired, so that for example glass, plastics material, composite materials, natural materials, synthetic materials, wood, plasterboard, stone, cement, concrete, Ytong or metal are used. The room limiting face parts can thus be made both transparent and non-transparent and at least transparent in part, respectively.

Fire protection parts are known from the prior art which are produced on the basis of a strongly alkaline silicate. If the fire protection part is arranged for example between two panes of glass in order to form a fire protection window, then glass corrosion can be observed even after a short period of time. On the common contact faces of the glass and the fire protection part the high pH value environment causes the glass network to dissolve or disintegrate. The latter corrodes and becomes milky

to turbid. The fire protection window has to be replaced. It is known for the composition of the fire protection part to be produced in a time-consuming manner in a multiple-step process, so that time intervals of days or weeks occur between the production and the processing to form the fire protection part.

The object of the present invention is therefore to provide a fire protection part, the fire protection material of which in the hardened state has a good ageing resistance as well as a good stability with respect to corrosion. In addition, an object of the present invention is to provide a method of producing a fire protection part as well as the use thereof, so that a more rapid and inexpensive production is made possible.

This object is attained in terms of the product by the features of claim 1 and in terms of the method by claim 8. In addition, this object is attained in terms of the use by claims 14 and 15.

Advantageous embodiments and further developments form the subject matter of the sub-claims.

The core concept of the present invention is to provide a fire protection part of planar-like design which is connected to at least one room limiting face part, the fire protection part being formed from a fire protection material based upon an inorganic sol and the composition of the fire protection material comprising the following:

- 25 to 70 % by weight of SiO_2 (solid content)
- 0.05 to 10 % by weight of surfactants
- 0.01 to 25 % by weight of polyol
- 0.05 to 2 % by weight of alkali-metal oxide

- 0.05 to 20 % by weight of acid
- 0.01 to 10 % by weight of corrosion protection material
- distilled or de-ionized water,

the composition of the fire protection material being capable of being poured during the production and being capable of being hardened by the addition of a base.

In this case a colloid solution, preferably based upon water, is to be understood as the sol, the colloids being present as virtually monodispersed primary particles with a diameter in the range of from 1 to 1000 nm. It is advantageous for silica sols to be used according to the invention. In addition, however, it is also possible for other inorganic sols to be used, for example based on titanium or aluminium.

The use of a sol is advantageous since the colloidal primary particles - which can also be understood as being a precursor or an initial stage - are capable of being cross-linked with one another in a rapid and simple manner. It is preferable for a cross-linking of this type to take place chemically, for example by the addition of a base. In addition, cross-linking reactions are also possible which take place by the addition of an acid.

As a result of the cross-linking of the inorganic sol, preferably by hydrolysis and condensation reactions, an increase in the viscosity can be observed. A gel is formed which has both a liquid phase, in this case preferably water, and a solid phase. This is particularly advantageous in the event of fire since the water contained in the gel serves to limit the fire.

It is preferable for the fire protection material to have from 25 to 70 % by weight of SiO_2 (solid content), preferably from 35 to 55 % by weight of SiO_2 and in a particularly preferred manner from 45 to 50 % by weight of SiO_2 relative to the overall mass of the material. This is advantageous since the silica sol forms the starting material as a precursor for the basic structure of the fire protection part. This is particularly advantageous since in this way, depending upon the level of the solid content of silicon dioxide, the degree of cross-linking, the stability and the inherent strength of the resulting fire protection material can be controlled in accordance with the addition of the base. In this way, a large solid content of silicon dioxide also results in a high degree of stability and inherent strength of the fire protection material, since a dense network is produced by the addition of a base.

In addition, the fire protection material advantageously has from 0.05 to 10 % by weight of surfactants. This is advantageous since these surfactants are preferably present in the charged state. As a result of the addition of the surfactants to the fire protection material an improved adhesion to the room limiting face parts is achieved in the production process of the fire protection material. Depending upon the surface charging of these room limiting face parts, it is possible for the surface tension of the fire protection material to be capable of being altered in a manner capable of being pre-determined as a result of a suitable selection and addition of the surfactants to the aforesaid fire protection material, so that for every material of the room limiting face parts, such as for example glass or concrete, the adhesion capacity of the fire protection material to the latter is

significantly improved. In this way, it is advantageous for surfactants to be selected which assist a uniform wetting of the surface of the room limiting face parts with the fire protection material, for example by lowering the surface tension. The wetting is advantageously permanent, so that the wetting continues to take place in a uniform manner both during the production process, during the hardening process and during the ageing process, without the occurrence of wetting absence spots in the form of de-wetting. In addition, in the event of a fire the surfactants advantageously have the effect that the fracture of the room limiting face part caused by the thermal expansion of the side of the room limiting face part facing the fire takes place in a clean manner, without pieces or parts of the fire protection material adhering to it. It is advantageous for the hardened fire protection part to remain intact in the event of a fire. The surfactants used are thus advantageously used for adhesive bonding.

In addition, the fire protection material contains from 0.01 to 25 % by weight of polyol. The addition of the polyol is preferably carried out in a range of from 0.01 to 20 % by weight, in particular in a range of from 1 to 15 % by weight, and in a particularly preferred manner in a range of from 5 to 12 % by weight, relative to the overall mass of the fire protection material. It is advantageous for the freezing point of the fire protection material to be lowered in the low-temperature range by the addition of at least one polyol. If a non-modified silica sol is acted upon with temperatures of below 0°C, then the irreversible precipitation of solid, white silicic acid is caused. In the present invention this would have a significant adverse effect upon the trans-

parency of the fire protection material. In this way, for example, transparent panes of glass would become permanently turbid as soon as the ambient temperature fell below 0°C. It is therefore advantageous, by the addition of at least one polyol to the fire protection material, for the freezing point thereof to be lowered, so that the precipitation of the solid silicic acid is preferably caused to be only from temperatures of less than -15°C and in a particularly preferred manner of less than -30°C.

According to the invention, polyols such as for example ethylene glycol, diethylene glycol, triethylene glycol, polyethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, polypropylene glycol and glycerol or mixtures thereof are used in this case.

In addition, the fire protection material has from 0.05 to 2 % by weight of an alkali-metal oxide, preferably from 0.1 to 1 % by weight relative to the overall mass of the fire protection material. It is advantageous for the alkali-metal oxide to be already contained in the silica sol.

It is preferable for the fire protection material to have from 0.05 to 20 % by weight of an acid. This is advantageous since the setting of the pH value of the fire protection material, preferably based on water, is carried out by the addition of the acid. The basic glass corrosion is advantageously counteracted by the lowering of the pH value of the fire protection material if the room limiting face parts are made of glass. This is advantageous, since no turbidity caused by the corrosion of the glass is caused on the surface of the glass in this way. Furthermore, it is advantageous that the

suitability for storage of the hardened fire protection part is additionally improved by the lowering of the pH value. In addition, a lowered pH value also has a germicidal effect upon fungi or bacteria in the fire protection material, so that the addition of expensive fungicides or bactericides to the fire protection material is unnecessary.

It is advantageous for the fire protection material to have, in addition, from 0.01 to 10 % by weight, preferably from 0.05 to 2 % by weight and in a particularly preferred manner from 0.1 to 1 % by weight, of a corrosion protection material relative to the overall mass of the fire protection material. As a result of the addition of this corrosion protection material the corroding effect of the fire protection material on the limiting faces to the room limiting face parts is advantageously substantially reduced.

In addition, the fire protection material advantageously has distilled or de-ionized water. The latter is used as a solvent, so that the fire protection material according to the invention can be processed in a simple manner. The addition of water is carried out depending upon the desired viscosity. It is advantageous for just so much water to be added that a fire protection material capable of being poured is produced.

It is advantageous for the fire protection material according to the invention to be capable of being hardened by the addition of a base, it being advantageous for "capable of being hardened" to be understood in this case as "capable of being cross-linked". By means of the addition of the base the sol contained in the fire

protection material is advantageously cross-linked to form a gel, as a result of which an increase in the viscosity is caused. In this way, the fire protection material is hardened. It is advantageous for the degree of hardening to be capable of being controlled by the added quantity of the base. Depending upon the use it is also possible for a gel of a fire protection material which is not completely hardened, i.e. cross-linked, to be used. After the hardening it is advantageous for a porous network based upon silicon to be formed, in the pores of which the solvent used, in this case preferably water, is advantageously embedded.

The base can be any basic compounds, such as for example alkali or alkaline earth hydroxides, alkoxides or alkali silicates, such as for example water glass, preferably potassium water glass. It is advantageous for the base to be supplied according to the invention as a 30 to 50 % alkali hydroxide solution in water, for example sodium hydroxide or potassium hydroxide or a mixture thereof, to the fire protection material. It is preferable for the base to have from 5 to 25 % by weight and in a particularly preferred manner from 12 to 15 % by weight of pure hydroxide, relative to the overall mass of the fire protection material.

It is advantageous for the addition of the base described here to the fire protection material described above to result in a reaction product, preferably an alkali-metal oxide, in the range of from 2 to 20 % by weight, preferably from 5 to 15 % by weight, relative to the overall mass of the fire protection material after the addition of the base. It is preferable for the reaction caused by the bringing together of the fire protection material

with the base to result in a molar ratio of silicon dioxide to alkali-metal oxide of preferably larger than 4.5 : 1 and in a particularly preferred manner of 5 to 6 : 1.

It is preferable for the fire protection material according to the invention to be made transparent in the hardened state. This is particularly advantageous when it is arranged as a fire protection between two panes of glass as room limiting face parts. In addition, however, it is also possible for the fire protection material according to the invention to be made opaque at least in part, for example when the room limiting face parts are also made non-transparent, for example of concrete.

In the event of fire an evaporation of the water is advantageously caused by the temperature increase, as a result of which the hardened fire protection material is foamed by the formation of gas.

In a further preferred embodiment, before the addition of the base the fire protection material of the fire protection part has a pH value in the range of from 2 to 7, preferably in the range of from 3 to 5. The fire protection material is thus preferably acid to neutral and is not introduced, as known from the prior art, already as a base with a pH value of > 7 . As a result of this acid to neutral property of the fire protection material the common limiting faces of the room limiting face parts are advantageously not attacked in the manner of a base during the processing and ageing process of the fire protection part. Corrosion of the material is thus prevented. This is particularly advantageous when the room limiting face parts are formed from transparent

glass or even plastics material, where corrosion of the material occurs in the form of turbidity and the transparency is thus adversely affected. It is thus advantageous for turbidity caused by corrosion or even dissolution of the network of the room limiting face parts to be prevented according to the invention. In addition, a low pH value also has a negative effect upon the growth of bacteria and fungi.

Furthermore, it is preferred for the corrosion protection material to have a composition in which at least one or more chemical elements are from the group of transition metals, non-metals, semi-metals or metals. In particular, zinc, zirconium, tin, boron, aluminium or phosphorus are preferred in this case, it likewise being preferred for the corrosion protection material to be present in the form of an oxide and/or in the form of a salt.

Examples of this are aluminate, borate, zirconate, tin stannate, zinc stannate, zirconium stannate, phosphate or even aluminium oxide, boron oxide, tin oxide, phosphorus oxide, zinc oxide, zirconium oxide and borax or a mixture thereof.

As a result of adding these oxides and/or salts to the fire protection material an additional corrosion protection effect is produced, so that common contact faces of the room limiting face parts and the fire protection part are stable over a prolonged period and no material dissolution or network dissolution - caused by corrosion - of the room limiting face parts occurs.

It is preferable for the addition of the corrosion protection material to be carried out in the range of

from 0.01 to 10 % by weight, in a particularly preferred manner in the range of from 0.05 to 2 % by weight and in a particularly preferred manner in the range of from 0.1 to 1 % by weight, relative to the overall mass of the fire protection material.

In a further advantageous embodiment the acid of the fire protection material is selected from the group of hydrochloric acid, sulphuric acid, nitric acid, phosphoric acid, boric acid, acetic acid, formic acid, formic acid amide, methacrylic acid, methacrylic acid alkylester, preferably methacrylic acid methylester, maleic acid and/or acrylic acid or a mixture thereof. It is advantageous for the alkyl group of the methacrylic acid alkylester to be formed as methyl, ethyl, propyl or butyl, but not of course to be limited to them. Acid formers, i.e. compositions with an acid reaction, are also possible in addition to acids.

It is preferable for the acid to be added in the range of from 0.05 to 20 % by weight, preferably in the range of from 0.1 to 10 % by weight, and in a particularly preferred manner in the range of from 0.1 to 5 % by weight, relative to the overall mass of the fire protection material. A reduction in the pH value of the composition of the fire protection material is advantageously caused by the addition of the acid, as a result of which the fire protection material is stabilized and so has an improved suitability for storage. In addition, by lowering the pH value of the composition a germicidal effect is achieved upon bacteria and fungi, which are not able to multiply in particular in the acid medium.

Furthermore, the addition of the acid to the fire

protection material is advantageous, since the base attack upon the adjacent limiting faces of the room limiting face parts is prevented in this way, in particular when these room limiting face parts are made of glass. In this way, the corrosion of glass is prevented, as a result of which even very minor damage to the surface of the glass in the production process, for example in the float glass process, becomes visible and thus also impairs the quality in the case of transparent fire protection parts.

In the case of a further advantageous embodiment the surfactants contained in the fire protection material are made anionic, cationic and/or amphoteric. As a result of the addition of the surfactants, preferably in the range of from 0.05 to 10 % by weight, in a more preferred manner in the range of from 0.1 to 5 % by weight, and in a particularly preferred manner in the range of from 0.1 to 2 % by weight, relative to the overall mass of the fire protection material, the physical properties of the fire protection mass are altered in such a way that the adhesion of the fire protection part in the hardened state to the room limiting face parts is improved. The surfactants thus act advantageously as adhesion promoters.

In addition, the surface tension of the aqueous fire protection material is reduced before the hardening, and this results in an improved adhesion to the limiting face of the common room limiting face parts. In this way it is possible for example for the surfactants used to form a single or even a double limiting layer on the common limiting face of the fire protection part with the room limiting face parts. As a result of the corresponding anionic, cationic and/or amphoteric charging of the

surfactant molecules advantageously provided as a limiting layer, the adhesion of the fire protection material to the room limiting face part is improved, not only during the hardening but also in particular in the event of a fire. In addition, it is possible for the surfactant molecules to be arranged statistically in the fire protection material.

It has been found that in the event of a fire if a room limiting face part dissolves or fractures the hardened fire protection part foams and remains intact.

In addition, the concept of the present invention lies in a one-stage, continuous method of producing a fire protection part, which comprises the following steps:

- provision of two storage containers, wherein a first storage container is provided with the starting materials of the fire protection composition
 - 25 to 70 % by weight of SiO_2 (solid content)
 - 0.05 to 10 % by weight of surfactants
 - 0.1 to 25 % by weight of polyol
 - 0.05 to 2 % by weight of alkali-metal oxide
 - 0.05 to 20 % by weight of acid
 - 0.01 to 10 % by weight of corrosion protection material
 - distilled or de-ionized water,and these are mixed in the first storage container and a second storage container is provided with a basic starting material;
- provision of two conveying devices for the respective conveying of the starting materials from the

- storage container into a mixing device, wherein the mass of starting materials supplied to the mixing device is capable of being pre-determined;
- mixing the starting materials from the two storage containers to form a mixture of materials in the mixing device;
 - continuous de-gassing of the mixture of materials by rotation in a device acted upon with a vacuum;
 - conveying the de-gassed mixture of materials by means of a further conveying device to the processing;
 - processing the de-gassed mixture of materials in that the mixture of materials is filled into a hollow space which is spanned by two plate-like parts arranged substantially parallel to each other, wherein the two parts are sealed off circumferentially apart from an upwardly directed opening for filling the spanned hollow space, and
 - hardening the mixture of materials at an elevated temperature in the range of from 65 to 95°C.

In this way the starting materials of the fire protection material are introduced into a first storage container, in which case they are continuously mixed, for example by means of a suitable stirring tool. It is advantageously possible for seven supply means, which are installed separately from one another and by means of which the raw materials indicated - silica sol which preferably already contains the alkali-metal oxide, surfactants, polyol, acid, corrosion protection material and water - are capable of being supplied to the storage container, to be advantageously provided for this first storage container. Advantageously, this supply occurs permanently during the whole production process. It is preferable for the corre-

sponding supply of raw materials to be computer controlled and automated.

A basic starting material, for example in the aqueous form of an alkali or alkaline earth hydroxide, such as for example sodium or potassium hydroxide, is introduced into the second storage container. The basic solution in the second storage container is advantageously introduced as a 25 to 60 %, preferably as a 45 to 55 %, metal hydroxide solution in water. It is advantageous for this to correspond to from 10 to 20 % by weight, preferably from 12 to 15 % by weight, of pure metal hydroxide relative to the overall mass of the fire protection material. When the starting materials of the first storage container react with the starting materials of the second storage container, a reaction molar ratio of silicon dioxide to alkali-metal oxide of more than 4.5 : 1 and preferably of 5 to 6 : 1 occurs.

In addition, it is possible for at least one alkali silicate, for example sodium silicate or potassium silicate, to be provided instead of the basic metal hydroxide.

The two storage containers are permanently connected to a separate conveying device in each case for conveying the starting materials from the corresponding storage containers. The starting materials are supplied to a mixing device by means of these conveying devices, wherein the mass of the starting materials supplied to the mixing device is capable of being pre-determined in each case.

It is advantageous for the mixing device provided to be designed in the form of a static mixer, for example of

plastics material or high-grade steel. According to the invention the mixing device is designed in the manner of a tube. The supply of the starting materials from the first storage container and of the basic starting material of the second storage container is advantageously carried out at the start of the tube-like mixing device. The mixing of the two charges is carried out by the advantageous fixed arrangement of mixing parts inside the tube-like mixing device, so that the two storage containers are conveyed in the longitudinal direction of the mixing device by the permanent stressing with pressure by the supply of the starting materials from these two storage containers into the mixing device. In this case the mixing parts cause corresponding flow turbulences, so that an effective mixing procedure is produced inside the mixing device.

In the case of an advantageous embodiment of the method the mixing device is tempered higher during the supply of the respective starting materials from the two storage containers than at the outlet of the mixture of materials from the mixing device. It is preferable for a first portion of the mixing device to have an elevated temperature in the range of from 40 to 90°C, preferably between 50 and 80°C and in a particularly preferred manner between 60 and 70°C. This temperature increase of the mixing device and thus also of the mixture of materials of the starting materials conveyed therein results in a more rapid reaction time of the cross-linking procedure.

In a second portion of the mixing device which is arranged downstream of the first portion with a higher temperature in the longitudinal direction of the mixing device the mixed fire protection material is cooled down

to from 10 to 40°C, in particular to from 20 to 30°C, and in a particularly preferred manner to from 20 to 25°C. It is advantageous for the temperature of the fire protection material to be detected by means of suitable sensors, preferably automatically, both in the first heating portion of the mixing device and in the second cooling portion of the mixing device. In exceptional cases, the automatic re-adjustment of the temperature is possible in this way and can be set to the range capable of being pre-determined.

After the mixture of materials in the mixing device has cooled down, the mixture of fire protection materials is continuously de-gassed by rotation in a device acted upon by a vacuum. It is preferable for this device acted upon by a vacuum to be designed in the form of a vacuum fan. Inside the device acted upon by a vacuum the mixture of fire protection materials is continuously moved onto a centrifuging plate which is arranged centrally and which is enclosed circumferentially by a sieve-like limiting portion. By the rotation of the centrifuging plate the material present on it is flung radially outwards and is flung through the corresponding sieve-like pores of the sieve-like limiting portion - which preferably has openings in the order of magnitude of from 5 to 500 μm , in particular in the order of from 25 to 100 μm - onto the inner wall of the device acted upon by a vacuum.

It is preferable for a vacuum in the range of from 10 to 150 mbar absolute, and in particular in the range of from 50 to 90 mbar absolute, to be applied to the device acted upon by a vacuum.

As a result of the radial flinging of the applied mixture

of fire protection materials onto the centrifuging plate and as a result of the associated radial passage through the sieve-like limiting portion, gas inclusions - such as for example air bubbles or other gas bubbles - contained in the mixture of fire protection material are advantageously removed.

In addition, it is possible, during the continuous de-gassing of the mixture of fire protection materials in the device acted upon by a vacuum, for additional inorganic substances to be supplied which are preferably selected from the group: pigments, metal oxides, mixed oxides, carbon fibres, ceramic fibres, glass fibres, glass powder, micro hollow glass spheres, sand, clay, bentonite or a mixture thereof. In this way it is possible to make the fire protection material according to the invention coloured for example. The addition of inorganic additives, preferably during or after the continuous de-gassing, to the fire protection material is preferably carried out in the range of from 0.01 to 10 % by weight, in particular from 0.1 to 5 % by weight, with respect to the overall mass of the fire protection mixture. As a result of the addition of these inorganic additives, the mechanical strength and the fire resistance of the hardened fire protection part are advantageously significantly improved.

In addition, the now de-gassed mixture of materials is conveyed by means of a further conveying device out of the device acted upon [by a] vacuum for processing. A processing of the de-gassed mixture of fire protection material can be carried out in numerous ways. It is advantageous for the fire protection material according to the invention to have a processing time in the region of

at least two hours, preferably at least four hours, and in a particularly preferred manner in the region of from six to twelve hours.

The mixture of fire protection materials according to the invention can be processed in different ways. In the simplest case it is possible for two room limiting face parts to be provided which are arranged parallel to each other but are arranged at a distance capable of being pre-determined from each other and which thus span a hollow space situated between them. This hollow space is advantageously closed circumferentially by suitable sealing materials, so that preferably at least one opening but preferably a plurality of openings which are directed upwards are provided. The filling of the de-gassed mixture of fire protection materials takes place through these openings in the peripheral limiting. It is advantageously possible for plate-like and/or screw-like means by which the filling of the de-gassed mixture of fire protection materials is facilitated to be provided at the corresponding openings. In this way, it is possible for example for a plate-like means arranged obliquely to convey the de-gassed fire protection material to be filled to at least one lateral face of the room limiting face part bounding the hollow space. This advantageously prevents the formation of bubbles during the filling. After the filling of the hollow cavity is complete, the corresponding filling openings are sealed off and closed. It is preferable for the closure of the filling openings to be carried out by means of at least one rapidly hardening polymer which is advantageously made resilient, such as for example a silicone. This is advantageous since the filling openings are thus closed in a sealed manner, so that no fire protection mass can

escape. It is advantageous for the de-gassed fire protection material to be filled in a bubble-free manner.

After that, there follows the hardening of the mixture of fire protection materials, which is now situated between the two room limiting face parts, at an elevated temperature, preferably in the range of from 50 to 110°C and in a particularly preferred manner in the range of from 65 to 95°C. As a result of the final hardening of the mixture of fire protection materials, the fire protection part is formed, which is arranged in a fixed manner, between the room limiting face parts. In addition, it is advantageous if, for hardening purposes, the fire protection part is hardened when mounted horizontally.

In addition, it is possible for the hardening of the fire protection part to be capable of being carried out, as well as by means of temperature stressing by convection, also by means of radiation, for example by means of infrared or microwave radiation. It is preferable for the hardening to take place in a period of time of from 27 to 30 hours, and in a particularly preferred manner in a period of from 22 to 26 hours.

Depending upon the use of the fire protection part, it can be arranged between transparent room limiting face parts or even non-transparent room limiting face parts.

It is advantageous for the corresponding room limiting face parts to be made transparent, for example of glass, PVC, PMMA (Plexiglas) or also non-transparent, such as for example from metal, plastics materials, plasterboard, ceramic materials, wood, stone, concrete or mineral composite materials.

Furthermore, it would be additionally possible for the hollow space spanned by the two room limiting face parts to have, as well as the fire protection material, further inorganic or organic materials, such as for example mineral wool, as well. It would thus be possible for organic or inorganic materials of this type to be impregnated, sprayed, coated or mixed with the fire protection material before the hardening, so as then to introduce these inorganic and/or organic materials into the corresponding hollow space between the two room limiting face parts and to harden them there. This is advantageous if for example non-transparent fire protection parts for example are required.

In addition, it is possible, instead of the basic metal hydroxide solution in the second storage container, to provide an alkali silicate solution. Advantageously the reaction of the stabilized fire protection material from the first storage container with the basic alkali silicate or basically reacting alkali silicate of the second storage container to be a reaction which requires a molar ratio of silicon dioxide to alkali-metal oxide of more than 4.5 : 1, in particular in the range of from 5 to 6 : 1.

Further advantageous embodiments are evident from the accompanying drawing. In the drawing

Figure 1 shows an apparatus according to the invention for producing the fire protection part according to the invention.

Figure 1 shows an apparatus 1 according to the invention for producing a fire protection part according to the in-

vention. A first storage container 2 is provided with the starting materials silica sol, surfactants, polyol, acid, corrosion protection material and distilled or de-ionized water, a setting of the pH value of the aforesaid aqueous solution being carried out by means of acids, oxides and salts. It is advantageous for the first storage container 2 to have a stirring apparatus 4, by means of which the added raw materials can be constantly mixed.

In addition, the apparatus 1 according to the invention has a second storage container 6 into which at least one basic starting material is capable of being introduced in a concentration capable of being pre-determined. In this case it is advantageous for an alkaline aqueous hydroxide solution, preferably a potassium hydroxide solution, or an aqueous alkali silicate solution to be introduced.

The two storage containers 2, 6 are permanently connected to a respective conveying device 8, 10, so that the starting materials introduced into the storage containers 2, 6 can be conveyed out of these storage containers 2, 6. It is advantageous for the conveying devices 8, 10 to be provided in the form of pump-like devices, for example in the form of metering pumps. In this way, it is possible for different quantities to be supplied out of the storage containers 2, 6 of the mixing device 12 by means of the metering device 8 and the metering device 10. Depending upon the production and the case of application the corresponding line of the respective conveying devices 8, 10 is capable of being pre-determined in a variable manner. It is preferable for the two conveying devices 8, 10 to be computer-controlled in an automatic manner and advantageously to have suitable flow measure-

ment sensor arrangements.

The mixing device 12 of the present invention has a first portion 14 and a second portion 16, a supply of the starting materials from the first storage container 2 and the second storage container 6 being continuously supplied in the starting region 18 of the first portion 14 of the tube-like mixing device 12. On account of the continuous re-conveying of the starting materials by means of the conveying devices 8 and 10 the supplied material is conveyed further inside the tube-like mixing device 12 by being acted upon with pressure in the longitudinal direction L. It is possible for the starting materials to be spatially separated out of the storage containers 2, 6 or to be already supplied as a mixture.

It is advantageous for the first portion 14 of the mixing device 12 to have a temperature-increasing device, so that the starting materials of the two storage containers 2, 6 conveyed inside the tube-like mixing device 12 are mixed with one another, for example by suitable static mixing parts 17. It is preferable for the continuously conveyed fire protection material to be tempered to a range of from 40 to 80°C, preferably to a range of from 50 to 70°C and in a particularly preferred manner to a range of from 60 to 65°C, in the first portion 14 of the mixing device 12. It is preferable for a suitable temperature control to be carried out automatically by means of suitable sensor arrangements. The first portion 14 should thus be understood as a heating portion.

In a second portion 16 of the mixing device 12 the continuously conveyed fire protection material is cooled, preferably to a range of from 15 to 20°C. The tempera-

ture is also automatically monitored and possibly corrected in the cooling portion 16 by means of suitable sensor arrangements in a manner corresponding to the heating portion 14.

The mixture of fire protection materials, which preferably has a processing temperature in the range of from 15 to 20°C, is supplied by way of a further conveying line 20 to a device 22 which is acted upon by a vacuum and is preferably designed at the bottom in the form of a funnel and which is continuously acted upon by a vacuum with a vacuum pump 24.

It is advantageous for further preferably mineral fillers or additives, such as for example pigments, to be able to be added to the mixture of fire protection materials in the device 22 acted upon by a vacuum. A mixing is carried out by means of conventional stirring or mixing tools.

After the de-gassing of the mixture of materials the latter is removed from the device 22 which is preferably in the form of a funnel and which is acted upon by a vacuum and it is processed by means of a metering device 26. Two room limiting face parts 28, 30 arranged at a distance from each other span a hollow space 32 which is filled with fire protection material according to the invention by the metering device 26. After the filling is complete the filling opening 34 is closed. In order to harden the fire protection part 35 the resulting composite element 36 is preferably rotated about 90° and is mounted horizontally at elevated temperature.

The following embodiments serve for explanation but are

not limited thereto:

Example 1

Provision of 1,114.8 kg of a 50 % silica sol solution in a first storage container, where 78 kg of anhydrous glycerol, 4.8 kg of acrylic acid, 1.2 kg of borax and 1.2 kg of a surfactant mixture of anionic and cationic surfactants is added by constant stirring. The fire protection material from this first storage container 2 is added by means of a conveying device 8, for example a metering pump which is capable of being set to a conveying quantity of 338 litres per hour.

1,200 kg of a 50 % KOH mixture are provided in a second storage container 6. A second conveying device 10, for example designed in the form of a metering pump, is set to a conveying volume of 112 litres per hour.

A first portion 14 of the mixing device 12, which is preferably designed in the form of a static mixer, is pre-heated to 70°C and a second portion 16 of the mixing device 12 is tempered to 20°C. In this way, a temperature gradient is formed inside the mixing device 12.

In addition, a device 22 acted upon by a vacuum is acted upon with approximately from 50 to 100 mbar absolute by a vacuum pump 24.

When all these prepared items have been dealt with, the conveying devices 8 and 10 as well as the conveying device 26 are started.

In this example two room limiting face parts 28 and 30,

in this case high-grade steel plates, with a thickness of 1 mm and a size of 1.2 m x 0.8 m in each case are arranged in such a way that a hollow space 32 of approximately 5 mm situated between these two high-grade steel plates is formed. After this hollow space 32 has been sealed off circumferentially, it is then filled with the mixture of fire protection material formed and is hardened in a horizontal orientation at 85°C for 24 hours in a heating cabinet. As a result of the hardening, a composite element 36 comprising the fire protection part 35 and the two room limiting face parts 28, 30 is produced.

After the hardening this composite element 36 comprising the high-grade steel plates and the hardened fire protection part 35 was installed in a furnace and was tested for fire resistance in accordance with the Regulation DIN 1363. Amazingly, it is found that the composite element withstands this standard for 42 minutes and can thus be used as a fire protection element of class DIN, EI, BS.

In another experiment two room limiting face parts 28, 30 of glass, in this case float glass plates, were filled and hardened in accordance with the method described above. After that an ageing test in accordance with EN ISO 12543-4 was undergone with respect to temperature, moisture and UV radiation. No negative effects in the form of white spots were found, which are caused by corrosion on the glass face and which are known from the prior art. In addition, no turbidity of the fire protection part as a result of ageing was evident.

After this ageing test the composite element 36 produced

was installed in a furnace and was tested for fire resistance in accordance with the Regulation DIN 1363. It was found that the composite element withstands this standard for 36 minutes and can thus be used as a fire protection element of class DIN, EI, BS.

Example 2

1,114.8 kg of a 50 % silica sol solution are introduced into a first storage container 2, and 78 kg of anhydrous glycerol, 4.8 kg of acrylic acid, 1.2 kg of borax and 1.2 kg of a surfactant mixture comprising anionic and cationic surfactants are supplied and thoroughly mixed with constant stirring by a stirring tool. The conveying device 8, which in this case is again designed in the form of a metering pump, is set to a conveying volume of 195 litres per hour.

1,200 kg of a potassium silicate solution are introduced into the second storage container 6, the second conveying device 10 being set to a conveying volume of 255 litres per hour.

The mixing device 12 has a first portion 14 which is pre-tempered to 70°C and a second portion 16 which is pre-tempered to 20°C. The device 22 provided for the further course of the conveying and acted upon by a vacuum is acted upon by a vacuum in the range of from 50 mbar to 100 mbar absolute by way of a vacuum pump 24.

After that, the conveying devices 8, 10 as well as 26 are started. In this example two room limiting face parts 28 and 30, in this case high-grade steel plates, with a thickness of 1 mm and a size of 1.2 m x 0.8 m in each

case are arranged in such a way that a hollow space 32 of 5 mm which is situated between them and which is preferably sealed off circumferentially apart from an opening directed upwards is formed. This hollow space 32 is then filled with the ready fire protection material and is hardened in a level / horizontal orientation at 85°C for 24 hours in a heating cabinet.

After the hardening a composite element 36 comprising the fire protection part 35 as well as the two room limiting face parts 28, 30 which are designed in this case in the form of the two high-grade steel plates is formed. The composite element 36 is installed in a furnace and is tested for fire resistance in accordance with the Regulation DIN 1363. It is found that the composite element withstands this standard for 41 minutes and can thus be used as a fire protection element of class DIN, EI, BS.

In addition, instead of the two high-grade steel plates, glass plates, such as for example float glass plates, were used and were filled and hardened as described above. After that the composite element 36 was subjected to an ageing test in accordance with EN ISO 12543-4 with respect to temperature, moisture and UV radiation. No changes - caused by corrosion - to the glass surface in the form of white spots were found, as are known from the prior art. In addition, a lasting transparency of the fire protection part as a result of the ageing was evident. After this ageing test the composite element 36 produced was installed in a furnace and was tested for fire resistance in accordance with the Regulation DIN 1363. It was found that the composite element withstands this standard for 37 minutes and can thus be used as a

fire protection device of class DIN, EI, BS.

The flow rates of the metering pumps are not of course limited to the values specified, but can also be capable of being set in a variable manner. It is advantageous for the metering pumps to have conveying rates in the range of from 150 to 300 l and preferably in the range of from 190 to 260 l.

In addition, it is possible for two mixing devices to be provided, in which case a first mixing device is used for heating the fire protection material and a second mixing device is used for cooling the fire protection material. It is advantageous for the two mixing devices to be permanently joined to each other.

In addition, it is advantageous for a plurality of valves, which are capable of being regulated and closed manually or automatically, to be attached to the supply lines.

The Applicants reserve the right to claim all the features disclosed in the application documents as being essential to the invention, insofar as they are novel either individually or in combination as compared with the prior art.

List of References

- 1 apparatus
- 2 first storage container
- 4 stirring apparatus
- 6 second storage container
- 8 conveying device / metering device
- 10 conveying device / metering device
- 12 mixing device
- 14 first portion
- 16 second portion / cooling portion
- 18 starting region
- 22 device
- 24 vacuum pump
- 26 metering device
- 28 first room limiting face part
- 30 second room limiting face part
- 32 hollow space
- 34 filling opening
- 35 fire protection part
- 36 composite element
- L longitudinal direction

Claims

1. A fire protection part (35) of planar-like design which is connected to at least one room limiting face part (28), wherein the fire protection part (35) is formed from fire protection material based upon an inorganic sol and the composition of the fire protection material comprises the following:
 - 25 to 70 % by weight of SiO_2 (solid content)
 - 0.05 to 10 % by weight of surfactants
 - 0.01 to 25 % by weight of polyol
 - 0.05 to 2 % by weight of alkali-metal oxide
 - 0.05 to 20 % by weight of acid
 - 0.01 to 10 % by weight of corrosion protection material
 - distilled or de-ionized water,wherein the composition of the fire protection material is capable of being poured during the production and is capable of being hardened by the addition of a base.
2. A fire protection part according to claim 1, characterized in that before the addition of the base the composition of the fire protection material has a pH value in the range of from 2 to 7, preferably in the range of from 3 to 5.
3. A fire protection part according to claims 1 and 2, characterized in that the corrosion protection material has a composition wherein at least one or more elements are from the group of transition metals,

non-metals, semi-metals or metals, in particular zinc, zirconium, tin, boron, phosphorus, aluminium, and the corrosion protection material is present in the form of an oxide and/or in the form of a salt.

4. A fire protection part according to claim 1, characterized in that the acid is selected from the group of hydrochloric acid, sulphuric acid, nitric acid, phosphoric acid, boric acid, acetic acid, formic acid, formic acid amide, methacrylic acid, methacrylic acid alkylester, maleic acid and/or acrylic acid or a mixture thereof.
5. A fire protection part according to claim 4, characterized in that from 0.05 to 20 % by weight, preferably from 0.1 to 10 % by weight, and in a particularly preferred manner from 0.1 to 5 % by weight, of acid relative to the overall mass is contained.
6. A fire protection part according to claim 1, characterized in that the surfactants are made anionic, cationic and/or amphoteric.
7. A fire protection part according to claim 6, characterized in that from 0.05 to 10 % by weight, preferably from 0.1 to 5 % by weight, and in a particularly preferred manner from 0.1 to 2 % by weight, of surfactants relative to the overall mass is contained.
8. A one-stage, continuous method of producing a fire protection part (35), comprising the following steps:
 - provision of two storage containers (2, 6), wherein a first storage container (2) is provided with the starting materials of the

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fire protection composition

- 25 to 70 % by weight of SiO_2 (solid content)
- 0.05 to 10 % by weight of surfactants
- 0.1 to 25 % by weight of polyol
- 0.05 to 2 % by weight of alkali-metal oxide
- 0.05 to 20 % by weight of acid
- 0.01 to 10 % by weight of corrosion

protection material

- distilled or de-ionized water,

and these are mixed in the first storage container (2) and a second storage container (6) is provided with a basic starting material;

- provision of two conveying devices (8, 10) for the conveying of the starting materials from the respective storage container (2, 6) into a mixing device (12), wherein the mass of starting materials supplied to the mixing device (12) is capable of being pre-determined;
- mixing the starting materials from the two storage containers (2, 6) to form a mixture of materials in the mixing device (12);
- continuous de-gassing of the mixture of materials by rotation in a device (22) acted upon with a vacuum;
- conveying the de-gassed mixture of materials by means of a further conveying device (26) to the processing;
- processing the de-gassed mixture of materials in that the mixture of materials is filled into a hollow space (32) which is spanned by two plate-like room limiting face parts (28, 30) arranged substantially parallel to each other, wherein the two room limiting face parts (28,

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30) are sealed off circumferentially apart from an upwardly directed opening (34) for filling the spanned hollow space (32), and

- hardening the mixture of materials at an elevated temperature in the range of from 65 to 95°C.

9. A method of producing a fire protection part according to claim 8, characterized in that the mixing device (12) is tempered higher during the supply of the starting materials from the two storage containers (2, 6) than at the outlet of the mixture of materials from the mixing device (12).
10. A method of producing a fire protection part according to claims 8 and 9, characterized in that during the supply of the starting materials from the two storage containers (2, 6) the mixing device (12) is set at a temperature of from 40 to 80°C, preferably to from 50 to 70°C and in a particularly preferred manner to from 60 to 65°C.
11. A method of producing a fire protection part according to claims 8 to 10, characterized in that the temperature of the mixture of materials decreases in the longitudinal direction (L) inside the mixing device (12).
12. A method of producing a fire protection part according to claims 8 to 11, characterized in that during the continuous de-gassing inorganic substances are supplied which are preferably selected from the group of pigments, metal oxides, mixed oxides, carbon fibres, ceramic fibres, glass fibres, glass powder,

micro hollow glass spheres, sand, clay, bentonite or a mixture thereof.

13. A method of producing a fire protection part according to claims 8 to 11, characterized in that the hardening of the fire protection part (35) is carried out by means of temperature, preferably by means of convection, or radiation, preferably by means of infrared radiation or microwave radiation, in a range of from 20 to 30 h, preferably in a range of from 22 to 26 h.
14. Use of a fire protection part (35) according to any of the claims 1 - 7 between transparent room limiting face parts.
15. Use of a fire protection part (35) according to any of the claims 1 - 7 between non-transparent room limiting face parts.