



This invention concerns a filter for the separation of solid particles from hot, gaseous or liquid media, in particular dust particles from hot flue gases in the temperature range between 120 and 800°C, consisting of a support material, which is permeable, inherently stable and including large pores, that is, a supporting body, whereby the support material is made heat resistant and, in particular, of non-corrosive materials, such as glass, ceramics, metals or compounds of these, and in which the support material of the filter can be formed by a closely packed partial bond of its heat-resistant particles, and that the support material is of a structure or size and shape, which suits a particular application or given volume.

It is commonly known, to use filters for the separation of particles from gaseous or liquid media and that these, depending on the application, are constructed as fabric, carbon fibre, felt, paper, plastic, metallic or ceramic filters.

While fabric, felt, paper and plastic filters are suitable for a low temperature range up to about 150°C, metallic and ceramic can cover the higher temperature range up to 800°C, so that the latter are suitable for use in the flue gas region of thermal plants. This is particularly desirable, since, with the increasing reduction of environmentally harmful emissions, the filtration of hot gases with temperatures above 250°C is steadily increasing in importance, because, on the one hand, the high enthalpy of the clean gas can be used without any further measures, and on the other hand, these flue gases constitute less of a problem for the environment.

The use of the above-mentioned materials as filters has shown that glass, ceramics and carbon fibre are susceptible to breakage due to brittleness, and with metal



wires or metal mesh, respectively, the gaps between the wires are too large to achieve adequate filter action for fine dusts. Also, the use of such heat resistant materials, such as sinter materials, or porous or fine-pored ceramic materials and similar is not useful, since the initially good separation action is continuously deteriorating, because fine dust enters the pores, which cannot dissolve any more, even with special cleaning measures and which finally leads to clogging of the filter.

Among those filters, which have established themselves in the socalled high temperature region, are those with filter cartridges, which frequently consists of clay or ceramic and which, for simplicity, are constructed as cylindrical tubes in the form of filter cartridges.

These filter cartridges, which are open on either end, are installed between holders within a housing for the filter and fixed in such a way that the medium to be filtered penetrates the casing of the filter cartridge and enters its internal space and leaves this internal space through an opening at the other end of the filter cartridge. This opening of the filter cartridge opens into a space for the filtered medium, whereby this medium leaves it through a discharge connector. The filter cartridges, which are rigidly connected to the holders, cannot move in relation to the loadings imposed on them due to the flow of the medium and particularly the loadings through the cleaning process of these filter cartridges by way of counterflow, whereby breakages, in particular near the neck of the filter cartridge, cannot be avoided (see DE-PS 30 17 851).

In particular, in order to avoid such damage to the filter cartridges, filter cartridges of this kind are mounted such that they can oscillate. This oscillating mounting of the respective filter cartridge is made possible in such a way that the mounting, which separates

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the clean room from the filter room, is arranged as an orifice plate, whereby the holes are formed such that those near the clean room are of larger diameter than those near the filter room. On the other hand, the filter
5 cartridge is provided with a flange-shaped shoulder at the end nearest to the clean room, with which this filter cartridge supports itself on the inwardly drawn bead of the hole in the mounting. For the better support of this filter cartridge on this bead, this bead can be formed as
10 a spherical ring shoulder and it is the wider cross section of this hole from this ring shoulder onward, increasing towards the filter room, which provides the necessary space for the oscillating motion. That end of the filter cartridge, which is opposite the neck, is
15 provided with a hole into which a bolt engages, which is then fastened to the mounting.

This bolt may be inserted into the hole with play or without play, whereby in the case of the play-free arrangement of the bolt, the bolt is supported on an
20 elastic bush against the filter cartridge. On the one hand, the spherical ring shoulder at the neck of the filter cartridge and the elastic support of the bolt at the other end facilitate the support of the bolt on the other end, and on the other hand, the oscillating
25 suspension of the filter cartridges in the mounting provide better protection against damage, compared to fixed filter cartridges. However, it is considered a disadvantage of these type of filters that the respective filter cartridge is mounted too unstable between the
30 supports, which on the one hand leads to sealing problems and thereby to contamination of the filtered medium and on the other hand, the removal is made more difficult, due to the spherical ring shoulders for the attachment of the filter cartridges (see DE-PS 35 15 365).

35 Thus there is a need to develop a filter of the



abovementioned type, which is suitable for the filtering of hot media, such as flue gas and similar, whereby, despite high temperature loading, for example, 600°C and possibly more, the filter retains its inherent stability and filter action and does not have a tendency to form cracks or cause spalling of material and, furthermore, that this filter sits absolutely tight on the mounting and that it can be mounted and dismounted without much effort and that it can be attached to this mounting in such a way, that it is not subject to damage even under mechanical loading, such as would occur during the cleaning of the filter cartridge.

Accordingly the invention provides a filter in which the structure of the support material, which is provided with larger pores, is covered on one of its casing surfaces with a fine-grained and also heat-resistant filler material, which enables the formation of finer pores, and that this filler material is applied as a thin film, at least on the outer surface, on the support material and that this filler material consists of the parts of a dispersed mixture, from which one part evaporates during the burn-in process, the other part, however, attaches to the larger pores of the support material and that this mixture is made up of an adhesive agent and a suspension fluid and that it can be applied in this aggregate state onto the support material, whereby it partly bonds within itself and partly with the support material and that these fine-grained components of the filler material, as well as the adhesive agent, consists of the same material, which have a linear thermal expansion coefficient, which is approximately equal to that of the support material, and also, that the material of the filler material is of such a grain size, that the size of the pores of the filler material is still below 10 um and that this filler material is embedded in the larger

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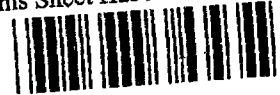
pores in the region of the casing of the support material and that it fills, at least partly, in particular the larger pores of the support material.

Such a filter not only satisfies the above stated
5 need but also the different structure of the filter, that is, that of the support material and the filler material, exhibit very similar thermal expansion characteristics, and that, even with special adhesion requirements, this
10 does not lead to damage of their structure or to widening of the pores, in particular of those of the filler material.

This particular concept of the filter ensures excellent filter action, even with strongly fluctuating temperatures of the media to be filtered, so that these
15 filters are particularly suitable for hot gases in the temperature range from 250°C up to 600-800°C. Since all materials and therefore all structures of the filter are able to follow temperature fluctuations without damage, it is hardly possible that cracks or spalling, in
20 particular in the cover layer, can occur, so that surface filtration takes place with this filter, too, which ensures the advantage of a largely clog-free filter action. This surface filter also avoids increasing pressure drop, so that the filter can be operated with
25 constant, minimal energy requirements.

The varying structures of the filter can be varied according to the demands on the filter, so that, for example, a greater or smaller pore width may be given to the support material. Analogous to this pore width, the
30 pore width of the filler material may also be formed larger or smaller, for example, in such a way that either coarse- or fine-grained filler material is deposited on the supporting material or that the supporting material is coated with more or less layers of the same. The filler
35 material may, for example consist of heat-resistant glass

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spheres, ceramic grains or powders, fibres, etc., which, after coating of the support material, cover this like a film.

Another advantageous form of construction of the invention is characterized in that the filter is constructed as an inherently stable filter cartridge and that this filter cartridge is spring loaded between the holders, clamped and sealed hermetically in these holders against the internal space of the filter housing and for the purpose of holding of each filter cartridge in its holder, each filter cartridge shows at its end, which is nearest to the clean room, an injector-shaped pipe flange and on that end, which is nearest to the base of the discharge duct, shows a spigot, whereby both, the pipe flange and the spigot show an annular shoulder, whereby a seal is provided between it and the holder on one hand and between it and the filter cartridge on the other hand and that additionally to these calibrating guidance and holding components for the filter cartridge, a spring is provided, which sits between the shoulder of the spigot and the holder and which presses the filter cartridge against all its seals and/or individual seals.

A further development of the invention is characterized in that the injector-shaped pipe flange shows a sleeve from its shoulder onward and that this sleeve penetrates into the filter cartridge and shows a collar at the opposite side of this shoulder and that this collar penetrates into the clean room through the opening in the holder.

Another advantageous form of construction can be seen, in that the spigot, at least in its section between its shoulder and the projecting extension, shown circular grooves and that this section penetrates into holes in the holder.

Further advantageous developments of the invention



can be seen in the remaining subclaims, for which independent protection is claimed within the framework of this application.

Some exemplary embodiments of the invention are now described with reference to the drawings in which:

- Fig.1 is a side elevation of a filter element shaped as a cylindrical tube,
- Fig.2 is a section through the filter element in the plane II-II in fig. 1,
- 10 Fig.3 is a side elevation of a filter element formed as a multiple disc pack,
- Fig.4 is a section through the filter element in the plane IV-IV in fig. 3,
- Fig.5 is an enlarged plan view onto a section of the cut
15 filter element according to fig. 1 or 3 with several spheres, which form the cover layer, for example, of equal diameter,
- Fig.6 is a similar, enlarged plan view as in fig.5, however, with spheres of varying diameters,
- 20 Fig.7 is a section through the filter element in the region of its covering layer with a row of spheres accumulated on to it and the powder particles embedded in the support material, according to section III,
- 25 Fig.8 is a longitudinal section through a filter housing with one filter element, which consists of several filter cartridges,
- Fig.9 is a cross section through the filter housing with two filter elements arranged in parallel, in the
30 plane II-II of fig. 1,
- Fig.10 is an enlarged view of a filter element constructed as a filter cartridge and a section of the support components, which are holding it there,
- Fig.11 is an enlarged longitudinal central section through
35 the head of the filter cartridge with the pipe flange,

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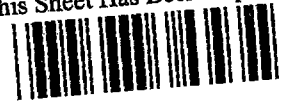


which supports it against its holder, and
Fig.12 is an enlarged longitudinal central section through
the foot of the filter cartridge with the spigot,
which supports it against its holder.

5 The filter element 1 according to figs. 1 to 7 is
hereby illustrated and described by way of two possible
configurations. A simple such configuration can be a
tubular filter element 1, as it is shown in figs. 1 and
2. This filter element is formed in such a way, that it
10 forms a cylindrical support body 2, which on one end shows
a flange-shaped head 3 and on the other end a bottom 4.
Whilst the flange-shaped head 3 shows in itself the
opening cross section 5 of the filter element 1, that is,
the support body 2, which at the same time corresponds to
15 the opening cross section 6 of the cylindrical support
body 2, the bottom 4 of the support body is formed as a
closure of it and is possibly provided with a foot 7, in
order to be able to fix the support body in a support
frame 8 of the filter housing 13. The support body 2
20 itself, which consists of a heat-resistant material, such
as ceramics, shows a large-pored structure, that is, large
pores 9, onto which a fine-pored structure in the form of
a covering layer 11, which consists of fine pores 10, is
applied. This covering layer 11 forms the filtering
25 surface of the filter element 1, onto which the particles
to be separated from the medium to be filtered, are
deposited.

The filter element 1 according to a further possible
configuration as per fig. 4 is constructed as a so-called
30 lamellar filter, as described in DE-OS 34 13 213, and
distinguishes itself essentially through the fact that its
support body 2, or its support material, respectively,
consists of a heat-resistant material, for example of the
ceramic origin described earlier and where its covering
35 layer 11 is formed from a multitude of preferably

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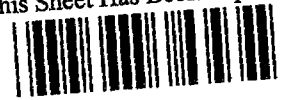
spherical and/or powdery bodies 12, which form a bond with the support body 2 and/or with each other, and which also consist of heat-resistant material.

The various parts of the filter element 1, that is, the support material 2 and its covering layer 11, show varying pore widths, whereby the pores 9 of the support material must be larger than the pores 10 of the covering layer, so that a filtration of the medium can take place at the surface of filter element 1.

Hereby, the support material 2 may consist of ceramics in the form of an aluminium oxide (Al_2O_3), a zinc oxide (ZnO_2) or silicon oxide (SiO_2), whereby its manufacture may occur in such a way that the respective chosen material is processed into a moulding material in the conventional manner, that is, extruded in the form of pipes and then fired, which results in wide-pored supporting bodies, that is, the supporting material 2. On the other hand, if the mass of the support material 2 is filled into moulds, which often may be of advantage, then the flange-shaped head 3 and the bottom 4, which closes the pipe, can be formed at the same time.

A fine-pored covering layer 11 is now applied to the outer casing of this coarse-pored support material 2, either in the form of an emulsion by way of spraying or brushing, whereby this emulsion settles primarily in the openings and holes of the support material and hereby covers the larger pores 9 with a multitude of openings or pores 10.

The smaller pores 10 in the covering layer 11 are produced when the material of the covering layer combines partially, that is, pointwise or in the form of lines, with each other, for example, in the form of larger or smaller bodies 12, such as spheres, and that the surfaces, which have not been bonded, retain the openings in the form of pores 10. To a large extent, these pores 10 can



be dimensioned arbitrarily in their size, so that this covering layer 11 or the coating, respectively, form a fine-pored layer, in the manner of a film, which still allows the transmission of the medium, which shows a small dimension of its pores 10.

A further possibility for the application of the covering layer 11 is, to prepare a coating sludge from the fine-grained powder, of similar consistency to that used in an enamelling process. The supporting body, that is, the support material 2 may be dipped into this coating sludge. This covering layer is then fired, together with the support material, which results in a fine- and open-pored engobe, similar to a glazing. As with the support material 2, here, too, the required open small pores 10 result from the evaporation of the suspension liquid.

In the manufacture of the filter element 1 from these heat-resistant materials, a starting point is, to use components of the same base material for the support material 2 and its covering layer 11, whereby the adhesive agent, which is also used, causes melting of these materials on the surface (for example, during the firing process), similar to a sintering process, which results in a homogeneous, firm bond.

This is the case and has been established with numerous experiments with support material 2 and covering material 11 out of aluminium oxide (Al_2O_3), as well as a ceramic adhesive of the same consistency.

Similar stable forms result, if chemically not identical but related materials interact with each other, and which mix with each other during the liquid phase (at the eutectic point, for example, of Al_2O_3 and SiO_2 or ZnO_2 and SiO_2). Also, a chemical bond between the support material 2 and the covering layer 11 is possible, as long as its stable at the application temperature and



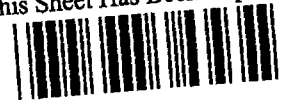
that it shows the same or better chemical resistance against structural changes as the support and covering material 2, 11. The partial bonding between the support and the covering material 2, 11 is facilitated through an adhesive agent 14, which may be applied, depending on the type of bonding during the firing operation, as a form of glazing or as an adhesive bond.

The thickness 15 of the coating, that is, the covering layer 11, can easily be made to suit the required degree of purity of the medium, in that more or less coating material is applied to the support material 2. With this measure, the filter action of the coating layer 11 can be increased correspondingly.

The bonding of the coating layer 11, that is, its filler material, with the support material 2 is preferably a homogeneous, intimate bond, which normally cannot be dissolved. This is of importance insofar as the coating layer 11 cannot be washed off the support material 2, which could otherwise easily be the case with filtration of liquid fluids.

The filter element 1 according to the invention, as shown in the form of construction according to figs. 8-12, distinguishes itself hardly from the filter element according to figs. 1-7 and is also used for the separation of particles from gaseous or liquid media. For better understanding, this filter element 1 is constructed as a tube and arranged in a filter housing 13 together with at least one other filter element in this housing. Housing 13 itself shows a clean room 16 for the filtered medium and a discharge shaft 17 for the particles, as well as an inlet and outlet connector 37 and 38 for the medium. The filter element 1, which is, according to the illustrative example, constructed as a tubular filter cartridge, is preferably manufactured from a ceramic material, which, for example, consists of a support material 2 with large

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pores 9 and a surface coating, that is, a coating layer 11 with fine pores 10. The mounting of this filter element 1, that is, the respective filter cartridge in the filter room of the filter housing 13 may occur horizontally or
5 vertically, whereby each filter cartridge shows at its respective end, that is, the cartridge head 18 and cartridge foot 19, special fastening components, with which they are fixed to holders 20, 21 in the filtering room. The fastening components at the cartridge head 18
10 are essentially formed by an injector-shaped pipe flange 22 and at least one seal 23, 24, whereby the pipe flange shows, apart from the annular shoulder 25, a collar, which penetrates into the clean room and a sleeve 27, which projects into the filter element 1. The annular shoulder
15 25, which approximately forms the equator of the pipe flange 22, has larger diameter than the casing of the filter element 1. This is the reason for the sufficiently large support surfaces of the pipe flange 22, with which the ends of the filter element, that is, the filter
20 cartridge, on the one hand, support themselves on the holder 21 and on the other hand, support themselves on the holder 20 at the end near the clean gas.

In order to make the sealing effective, it is recommended to provide seals 23, 24 on either side of the
25 annular shoulder, that is, coaxially to it, of which one is an annular seal 32 and the other seal 24 could, next to the annular surface, show a shroud-like enlargement. This shroud-like enlargement could in this case concentrically envelope the sleeve 27, which penetrates into the filter
30 element 1 and thereby affect a sealing function, as well as a radial, elastic support. Of course, it is conceivable to provide, instead of these shroud-like seals, an annular seal 32 at this point and support the filter cartridge and holder 20 only through this seal.

35 The other end of the filter element 1 is primarily



supported on the shoulder 28 of a spigot 29, whereby this
spigot shows similar to the pipe flange 22-also a collar
30 and an extension 31 into the opposite direction to it.
With this collar 30, the spigot 29 is inserted into the
5 free end of the filter element 1 up to the shoulder 28,
whereby this collar must show no play or only a small
amount of radial play between itself and the inner surface
of the filter element. The actual sealing of this end of
the filter element 1 at the foot of the cartridge 19
10 occurs, as with the cartridge head 18, through an annular
seal 32, against which the end of the filter element makes
sealing contact. The extension 31 of the spigot 29
penetrates into the hole 33 of the holder 21 and extends
deep enough into it, so that the filter element 1 is
15 guided in the borehole not only against radial movements,
but also remains guided in the borehole during axial
movements. In order to hermetically seal the respective
filter element 1 against the filtering room of the filter
housing 13, a coil spring 34 is inserted between the
20 shoulder 28 of the spigot 29 and the holder 21 around the
extension 31, which, on the one hand, supports itself on
the shoulder and, on the other hand, against the holder 21.

This helical spring 34 pushes this filter element 1,
that is, the filter cartridge against the seals 23, 24 at
25 the cartridge head 18, as well as the shoulder against the
annular seal 32, so that these seals make full contact.

The spigot 29 itself may be solid at its collar 30
and extension 31, or it may show circular grooves 35, as
illustrated in the drawing of fig. 10. Instead of the
30 spigot 29, an equivalent guidance part, such as a conical
spring or a spider may be used. But also, instead of a
helical spring 34, a disc spring or a disc spring stack,
respectively, may be used, which ensures the axial
preloading of the filter element 1.

35 The holder 20, 21 itself may be constructed in the

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form of U-shaped struts, which with their ends support themselves on brackets 36 of the filter housing 13, and at that point may be supported rigidly or elastically.

5 The medium to be filtered, which enters the filtering room of the filter housing 13 through the inlet connector 37, flows around the individual filter elements 1 and enters the clean room 16 through them, while its entrained particles deposit themselves on the casings of the filter elements. The medium, which in this manner enters the
10 clean room 16, leaves it through the outlet connector 38, in order to enter free atmosphere, or to be fed into a further process. The particles deposited on the filter elements are dislodged through the known method of reverse blowing, from the inside towards the outside, and enter
15 the discharge shaft 17, from where they are removed either continuously or intermittently. The reverse blowing device may be a known jet cleaner, the nozzles of which are inserted into the injector-shaped pipe flanges 22, in order to blow in the cleaning medium, such as compressed
20 air.

The mounting and disassembly of the filter element 1 or the filter cartridges, respectively, is made particularly easy with this form of cartridge-type construction, whereby, following the insertion of the
25 extension 31 of the spigot 29 into the borehole 33 of the holder 21 and pushing it against the force of the helical spring 34, the collar 30 of the pipe flange 22 at the head of the cartridge 18 is pushed first under the borehole of the holder 20 at this end, and, after releasing the
30 pressure slowly, this collar will engage in this hole and fix the filter cartridge in that position. Disassembly of the filter cartridge or the filter element 1, respectively, occurs in reverse sequence, if it is required to remove them from their holders 20, 21.

35 According to an advantageous material selection, the

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composition of the filler material, that is, the coating layer 11, which is applied to the support body 2, consists of the following components.

These components, which are dispersed as a mixture, are applied to the support body 2 by means of, for example, a brush, and this filler material is exposed to a temperature of 500°C for about an hour, together with the support body, whereby the filler material is burnt into the material or the pores of the support body 2, respectively.

The components of the filler material or the coating layer, respectively, could be composed as follows:

- 1 part by volume of sodium silicate
- 14 parts by volume of water
- 4 parts by volume of kaolin
- 2 parts by volume of feldspar
- 2 parts by volume of starch (cornflour)
- 0.2 parts by volume of sodium diphosphate

The filler material, which is produced in this manner and which is applied to the support body 2, deposits itself in the region of the casing surface of the pores 9 of the support body and fills them until a film-like layer appears on its surface. Hereby, the water is evaporated under the influence of the temperature, and at this temperature, the starch is also eliminated from the mixture by burning.

As already mentioned above, the filter elements 1 are manufactured from ceramic, heat-resistant material. This does, of course, not exclude the application of other filter elements 1, for example, of plastic, if the filter element is supposed to work in a different temperature range. It is also possible, to use other configurations of filter elements 1.

Here, the filter element 1 has been illustrated and explained by means of filtration of hot gases. Of course,

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5 this filter element 1 is also suitable for the filtration of hot liquids or for gases and liquids, which are not hot. This filter element 1 is of particular interest for aggressive media in the gaseous or liquid region, since it is hardly attacked by aggressive materials.

10 The heat-resistant filter element 1 has been illustrated and explained by means of pipes and the so-called lamellar filter, as shown in fig. 1-4. Of course, this filter element 1 can also show other configurations. Of advantage is a configuration, which shows the largest possible filter area.

15 Such a configuration could also be a combination of shapes, such as elliptical, triangular etc. The configuration is mainly dependent on the volume to be filtered, the durability of the filter element, that is, the filter cartridge, and the medium to be filtered. The latter also determines the pore width, which for the purpose of optimization of the pressure drops, is matched to the medium.

20 The function of the filter is here illustrated and described, relative to the jet-cleaning process, on an example of the deposition of particles from gaseous media. The separation of particles from liquids occurs in a similar manner, but in this case, the cleaning process is different, that is, through reverse flow of pure
25 liquids. If the liquid permits the use of air, compressed air may be used for the cleaning process.

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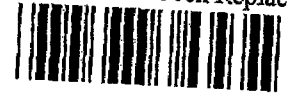


CLAIMS

1. A filter for the separation of solid particles from hot, gaseous or liquid media, in particular dust particles from hot flue gases in the temperature range between 120 and 800°C, consisting of a support material, which is permeable, inherently stable and equipped with large pores, i.e. a supporting body, the support material being heat resistant and comprising non-corrosive materials, such as glass, ceramics, metals or compounds of these, and in which the support material can be manufactured through an intimate, partial bond of its heat-resistant particles, the support material being of a structure, which suits the application or the given volume, characterized in that the structure of the support material (supporting body 2) is covered on the one casing surface, at least on the surface, with a filler material which makes it possible to use finer pores, is fine-grained and also heat-resistant, and the filler material (covering layer 11) is applied to the support material in particular as a thin coating, and that this filler material consists of parts of a dispersed mixture, of which one part is volatilizable during the firing process, another part, however, attachable to the larger pores of the support material and that this mixture is prepared by means of an adhesive agent (14) and a suspension liquid and in this aggregate state can be applied to the support material, whereby it is bondable partly amongst itself and partly with the support material and that these fine-grained components (bodies 12) of the filler material, as well as the adhesive agent, consist of a respective material, which has a linear thermal expansion coefficient, of approximately the same magnitude as that of the support material (supporting body 2), as well as that the material of the filler material has such a grain size, so that the pore size of this filler material is under 10 μm and that this filler material is embedded in the larger pores (9) of the support material in the region of the casing of the support material, in particular fills the larger pores of the support material at least partly.

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2. A filter according to claim 1, characterized in that the fine-grained filler material (covering layer 11) in powder form is suspended in a liquid (e.g. water) and, following the addition of the adhesive agent (14), is applied to the support material (supporting body 2) and that this filler material is bonded to the support material through the adhesive agent.
3. A filter according to claim 2, characterized in that the liquid for the suspension of the filler material (covering layer 11) is a volatizable material (water) under the action of heat, which, following the application of it onto the support material (supporting body 2), leaves the filler material behind, having formed fine pores (10) therein.
4. A filter according to claim 1, characterized in that the filler material (covering layer 11) forms a homogeneous, undetachable bond with the support material (supporting body 2) under the action of heat.
5. A filter according to claim 1, characterized in that the filler material (covering layer 11) applied to the support material (supporting body 2) is capable of being fired therewith at elevated temperature.
6. A filter according to claim 1 to 3, characterized in that the filler material (covering layer 11) is applied to the support material (supporting body 2) in at least one layer.
7. A filter according to claims 1 to 3, characterized in that the filler material (covering layer 11) is applied to the support material (supporting body 2) in two layers, whereby the first layer consists of relatively large particles, which, apart from narrowing the larger pores (9) of the support material, also form an additional support structure for the following, second layer, and that the second layer

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consists of fine particles, and that this second layer has the required small pores (10) for surface filtration.

- 5 8. A filter according to claim 1, characterized in that the filler material (covering layer 11) adapted to be applied to the support material (supporting body 2) material by way of spraying and that these materials together undergo an adhesion process, in particular a firing process.
- 10 9. A filter according to claim 1, characterized in that the filler material (covering layer 11) is provided as an emulsion in a bath and that the support material (supporting body 2) is coated with it by immersion into the emulsion and that these materials are then subjected to a firing process.
- 15 10. A filter according to claim 1, characterized in that the support material (supporting body 2) and the filler material (covering layer 11) consist of ceramics and that these materials are sintered together undetachably, but open-pored, under the influence of heat.
- 20 11. A filter according to claim 1, characterized in that the support material (supporting body 2) and the filler material (covering layer 11) form an eutectic mixture and that they are, following cooling-off, undetachably bonded to each other.
- 25 12. A filter according to claim 1, which is constructed in particular in tubular shape and which is inserted into a filter housing (13) with inlet and outlet connector (37, 38) for the medium to be filtered and the already filtered medium, as well as a discharge shaft (17) for the precipitated particles and through the casing of which the medium to be filtered can pass through from the outside to the inside and the casing surface of which can be passed through by a clean flow at intervals in reverse flow, for the purpose of cleaning, and where at the filter housing (13) in the region near the outlet
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- connector (38), a clean room (16) is provided for the collection and discharge of the filtered medium, as well as at least one device for the cleaning of the filter element, as well as that holders (20, 21) are provided between this device and the base of the discharge shaft (17) for at least one filter element (1), which is arranged inbetween, of which the holder (20) nearest to the clean room is additionally equipped with at least one opening between the filter element (1) and the clean room (16) and the holder nearest to the base is equipped with at least one support (cartridge foot 19) for the filter element (1), characterized in that the filter element (1) is constructed as an inherently stable filter cartridge and that this filter cartridge is clamped and spring-loaded between the holders (20, 21) and at these holders is sealed hermetically against the inside room of the filter housing (13) and that for the support of each filter cartridge at this holders, each filter cartridge has at its end nearest to the clean room (16) an injector-shaped pipe flange (22) and at the end nearest to the base of the discharge shaft (17) a spigot (29), of which both, the pipe flange and the spigot, show an annular shoulder (25, 28), whereby, on the one hand, a seal each is provided between it and the filter element (1) and, on the other hand, between it and the holder (20, 21) and that additionally to these calibrating guidance and holding devices for the filter cartridge, a spring (34) is provided between the shoulder (28) of the spigot (29) and the holder (21), which presses the filter element (1) against all its seals (23, 24, 32) and/or individual seals.
13. A filter according to claim 12, characterized in that the injector-shaped pipe flange (22) shows from its annular shoulder (25) onwards a sleeve (27), which penetrates into the filter element (1) and a protruding collar opposite to this shoulder and that this collar extends through the opening of the holder (20) into the clean room (16).

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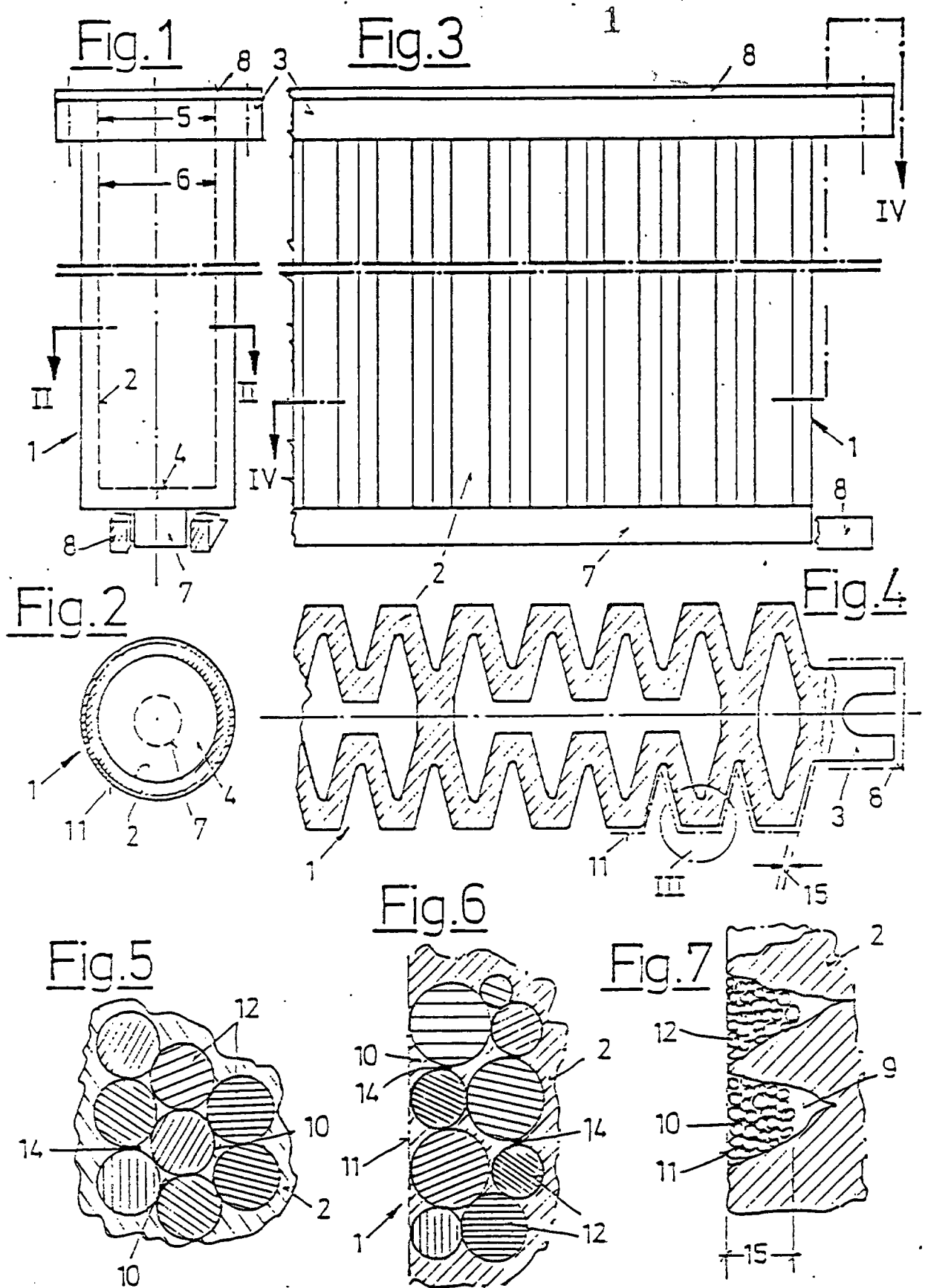
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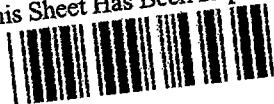
- 5 14. A filter according to claim 12, characterized in that the spigot (29) shows annular grooves (35), at least on its section between its annular shoulder (25) and its protruding extension (31) and that this section of each extension penetrates into boreholes (33) of the holder (21).
- 10 15. A filter according to claim 12, characterized in that each holder (20, 21) nearly extends from inside wall to inside wall of the filter housing (13) and that several filter elements (1) are clamped and spring-loaded between two corresponding holders.
- 15 16. A filter according to claim 12, characterized in that the clamping of each respective filter element (1) between its holders (20, 21) is carried out as a floating construction.
- 20 17. A filter according to claim 15, characterized in that each filter element (1) is clamped adjustably, at least in axial direction, between its holders (20, 21).
- 25 18. A filter according to claim 1, characterized in that its filler material (covering layer 11) is made up of a dispersed mixture of several components, and consists of 1 part by volume of sodium silicate, 14 parts by volume of water, 4 parts by volume of kaolin, 2 parts by volume of feldspar, 2 parts by volume of starch (cornflour) and 0.2 parts by volume of sodium diphosphate.
- 30 19. A filter according to claim 18, characterized in that, following the application of the filler material (covern layer 11) onto the suport material (supporting body 2) with the larger pores (9), these are together subjected to a firing process and the volume parts of water evaporate during this firing process and that the volume parts of starch are burned out.

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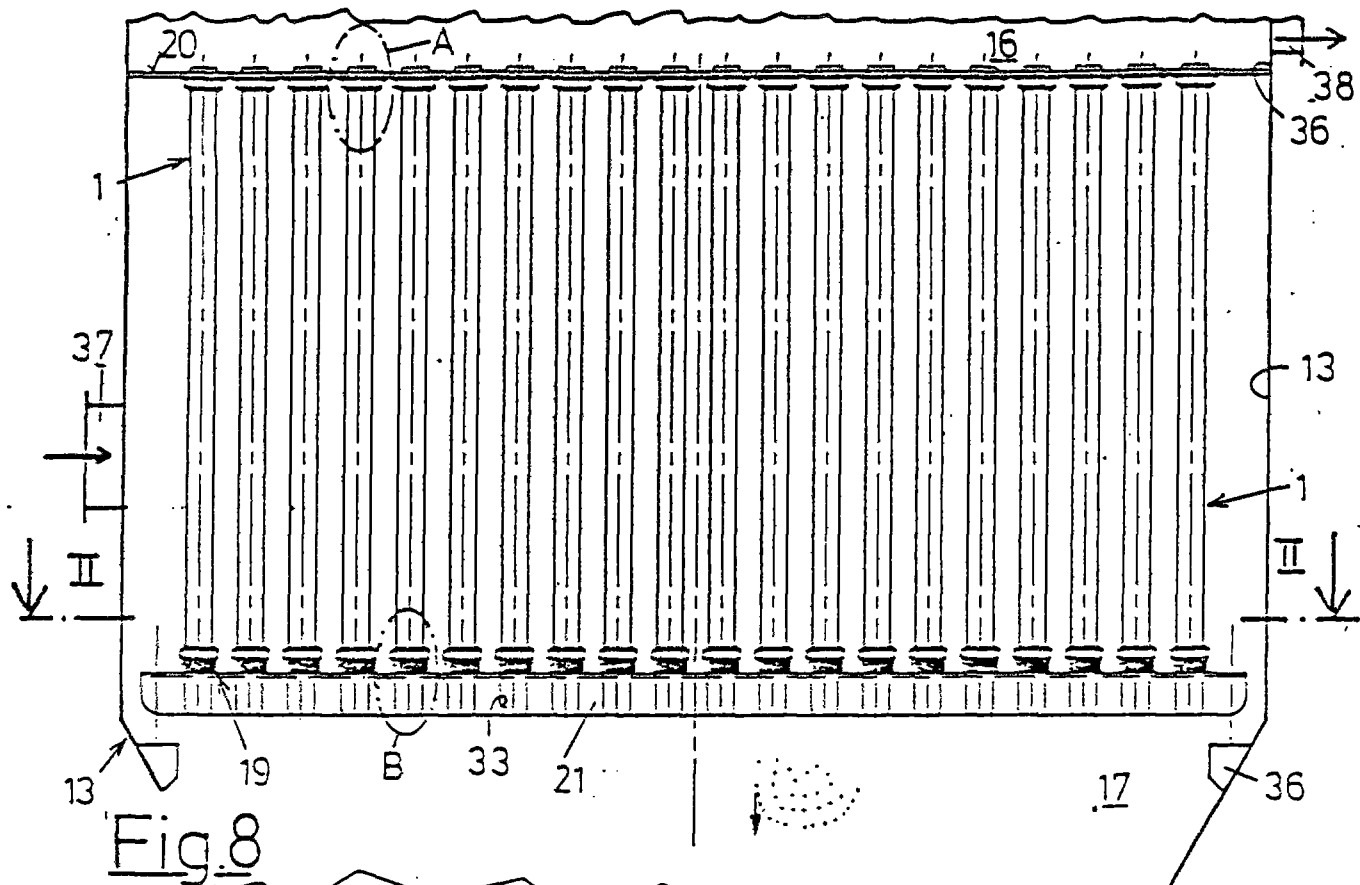


Fig. 8

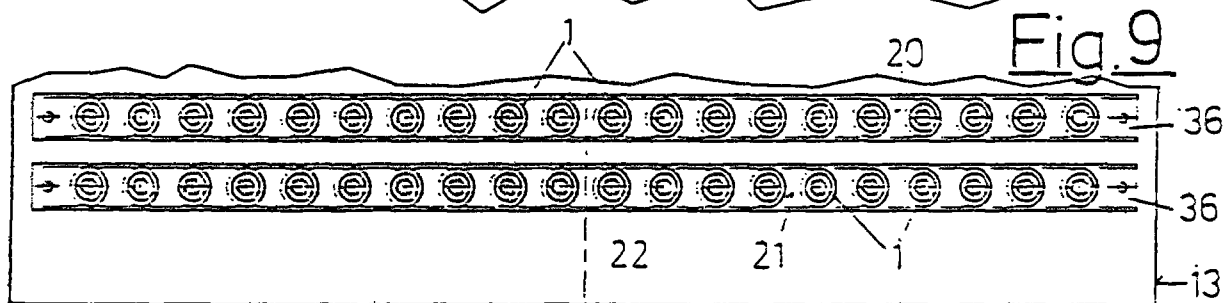


Fig. 9

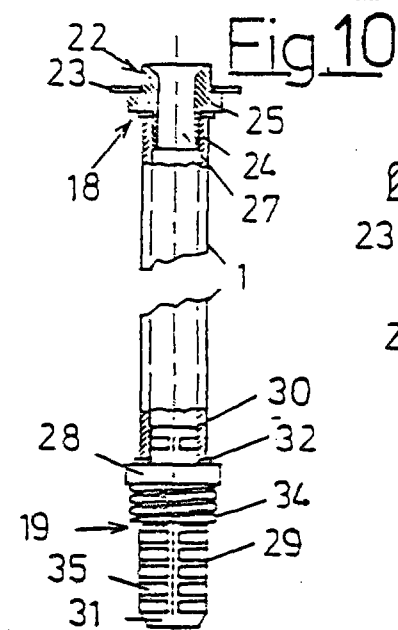


Fig. 10

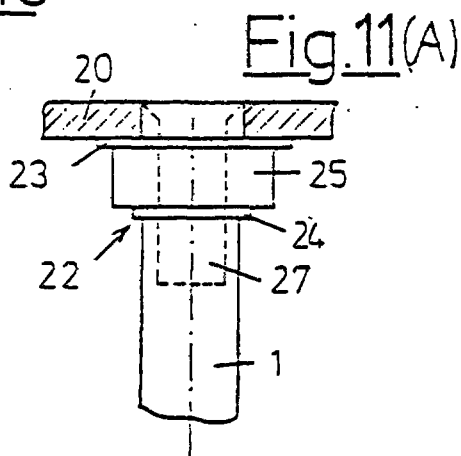


Fig. 11(A)

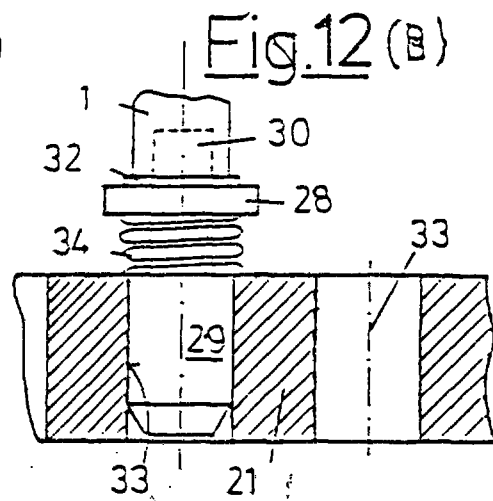
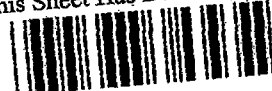


Fig. 12(B)

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FILTER FOR THE SEPARATION OF SOLID PARTICLES FROM HOT,
GASEOUS OR LIQUID MEDIA

This invention concerns a filter for the separation of solid particles from hot, gaseous or liquid media, in particular dust particles from hot flue gases in the temperature range between 120 and 800°C, consisting of a support material, which is permeable, inherently stable and including large pores, that is, a supporting body, whereby the support material is made heat resistant and, in particular, of non-corrosive materials, such as glass, ceramics, metals or compounds of these, and in which the support material of the filter can be formed by a closely packed partial bond of its heat-resistant particles, and that the support material is of a structure or size and shape, which suits a particular application or given volume.

It is commonly known, to use filters for the separation of particles from gaseous or liquid media and that these, depending on the application, are constructed as fabric, carbon fibre, felt, paper, plastic, metallic or ceramic filters.

While fabric, felt, paper and plastic filters are suitable for a low temperature range up to about 150°C, metallic and ceramic can cover the higher temperature range up to 800°C, so that the latter are suitable for use in the flue gas region of thermal plants. This is particularly desirable, since, with the increasing reduction of environmentally harmful emissions, the filtration of hot gases with temperatures above 250°C is steadily increasing in importance, because, on the one hand, the high enthalpy of the clean gas can be used without any further measures, and on the other hand, these flue gases constitute less of a problem for the environment.

The use of the above-mentioned materials as filters has shown that glass, ceramics and carbon fibre are susceptible to breakage due to brittleness, and with metal

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wires or metal mesh, respectively, the gaps between the wires are too large to achieve adequate filter action for fine dusts. Also, the use of such heat resistant materials, such as sinter materials, or porous or fine-pored ceramic materials and similar is not useful, since the initially good separation action is continuously deteriorating, because fine dust enters the pores, which cannot dissolve any more, even with special cleaning measures and which finally leads to clogging of the filter.

10 Among those filters, which have established themselves in the so-called high temperature region, are those with filter cartridges, which frequently consists of clay or ceramic and which, for simplicity, are constructed as cylindrical tubes in the form of filter cartridges.

15 These filter cartridges, which are open on either end, are installed between holders within a housing for the filter and fixed in such a way that the medium to be filtered penetrates the casing of the filter cartridge and enters its internal space and leaves this internal space through an opening at the other end of the filter cartridge. This opening of the filter cartridge opens into a space for the filtered medium, whereby this medium leaves it through a discharge connector. The filter cartridges, which are rigidly connected to the holders, cannot move in relation to the loadings imposed on them due to the flow of the medium and particularly the loadings through the cleaning process of these filter cartridges by way of counterflow, whereby breakages, in particular near the neck of the filter cartridge, cannot be avoided (see DE-PS 30 17 851).

25 In particular, in order to avoid such damage to the filter cartridges, filter cartridges of this kind are mounted such that they can oscillate. This oscillating mounting of the respective filter cartridge is made possible in such a way that the mounting, which separates

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the clean room from the filter room, is arranged as an orifice plate, whereby the holes are formed such that those near the clean room are of larger diameter than those near the filter room. On the other hand, the filter
5 cartridge is provided with a flange-shaped shoulder at the end nearest to the clean room, with which this filter cartridge supports itself on the inwardly drawn bead of the hole in the mounting. For the better support of this filter cartridge on this bead, this bead can be formed as
10 a spherical ring shoulder and it is the wider cross section of this hole from this ring shoulder onward, increasing towards the filter room, which provides the necessary space for the oscillating motion. That end of the filter cartridge, which is opposite the neck, is
15 provided with a hole into which a bolt engages, which is then fastened to the mounting.

This bolt may be inserted into the hole with play or without play, whereby in the case of the play-free arrangement of the bolt, the bolt is supported on an
20 elastic bush against the filter cartridge. On the one hand, the spherical ring shoulder at the neck of the filter cartridge and the elastic support of the bolt at the other end facilitate the support of the bolt on the other end, and on the other hand, the oscillating
25 suspension of the filter cartridges in the mounting provide better protection against damage, compared to fixed filter cartridges. However, it is considered a disadvantage of these type of filters that the respective filter cartridge is mounted too unstable between the
30 supports, which on the one hand leads to sealing problems and thereby to contamination of the filtered medium and on the other hand, the removal is made more difficult, due to the spherical ring shoulders for the attachment of the filter cartridges (see DE-PS 35 15 365).

35 Thus there is a need to develop a filter of the

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abovementioned type, which is suitable for the filtering of hot media, such as flue gas and similar, whereby, despite high temperature loading, for example, 600°C and possibly more, the filter retains its inherent stability and filter action and does not have a tendency to form cracks or cause spalling of material and, furthermore, that this filter sits absolutely tight on the mounting and that it can be mounted and dismounted without much effort and that it can be attached to this mounting in such a way, that it is not subject to damage even under mechanical loading, such as would occur during the cleaning of the filter cartridge.

Accordingly the invention provides a filter in which the structure of the support material, which is provided with larger pores, is covered on one of its casing surfaces with a fine-grained and also heat-resistant filler material, which enables the formation of finer pores, and that this filler material is applied as a thin film, at least on the outer surface, on the support material and that this filler material consists of the parts of a dispersed mixture, from which one part evaporates during the burn-in process, the other part, however, attaches to the larger pores of the support material and that this mixture is made up of an adhesive agent and a suspension fluid and that it can be applied in this aggregate state onto the support material, whereby it partly bonds within itself and partly with the support material and that these fine-grained components of the filler material, as well as the adhesive agent, consists of the same material, which have a linear thermal expansion coefficient, which is approximately equal to that of the support material, and also, that the material of the filler material is of such a grain size, that the size of the pores of the filler material is still below 10 um and that this filler material is embedded in the larger

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pores in the region of the casing of the support material and that it fills, at least partly, in particular the larger pores of the support material.

Such a filter not only satisfies the above stated
5 need but also the different structure of the filter, that is, that of the support material and the filler material, exhibit very similar thermal expansion characteristics, and that, even with special adhesion requirements, this does not lead to damage of their structure or to widening
10 of the pores, in particular of those of the filler material.

This particular concept of the filter ensures excellent filter action, even with strongly fluctuating temperatures of the media to be filtered, so that these
15 filters are particularly suitable for hot gases in the temperature range from 250°C up to 600-800°C. Since all materials and therefore all structures of the filter are able to follow temperature fluctuations without damage, it is hardly possible that cracks or spalling, in
20 particular in the cover layer, can occur, so that surface filtration takes place with this filter, too, which ensures the advantage of a largely clog-free filter action. This surface filter also avoids increasing pressure drop, so that the filter can be operated with
25 constant, minimal energy requirements.

The varying structures of the filter can be varied according to the demands on the filter, so that, for example, a greater or smaller pore width may be given to the support material. Analogous to this pore width, the
30 pore width of the filler material may also be formed larger or smaller, for example, in such a way that either coarse- or fine-grained filler material is deposited on the supporting material or that the supporting material is coated with more or less layers of the same. The filler
35 material may, for example consist of heat-resistant glass

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spheres, ceramic grains or powders, fibres, etc., which, after coating of the support material, cover this like a film.

Another advantageous form of construction of the invention is characterized in that the filter is constructed as an inherently stable filter cartridge and that this filter cartridge is spring loaded between the holders, clamped and sealed hermetically in these holders against the internal space of the filter housing and for the purpose of holding of each filter cartridge in its holder, each filter cartridge shows at its end, which is nearest to the clean room, an injector-shaped pipe flange and on that end, which is nearest to the base of the discharge duct, shows a spigot, whereby both, the pipe flange and the spigot show an annular shoulder, whereby a seal is provided between it and the holder on one hand and between it and the filter cartridge on the other hand and that additionally to these calibrating guidance and holding components for the filter cartridge, a spring is provided, which sits between the shoulder of the spigot and the holder and which presses the filter cartridge against all its seals and/or individual seals.

A further development of the invention is characterized in that the injector-shaped pipe flange shows a sleeve from its shoulder onward and that this sleeve penetrates into the filter cartridge and shows a collar at the opposite side of this shoulder and that this collar penetrates into the clean room through the opening in the holder.

Another advantageous form of construction can be seen, in that the spigot, at least in its section between its shoulder and the projecting extension, shown circular grooves and that this section penetrates into holes in the holder.

Further advantageous developments of the invention

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can be seen in the remaining subclaims, for which independent protection is claimed within the framework of this application.

Some exemplary embodiments of the invention are now
5 described with reference to the drawings in which:

- Fig.1 is a side elevation of a filter element shaped as a cylindrical tube,
Fig.2 is a section through the filter element in the plane II-II in fig. 1,
10 Fig.3 is a side elevation of a filter element formed as a multiple disc pack,
Fig.4 is a section through the filter element in the plane IV-IV in fig. 3,
Fig.5 is an enlarged plan view onto a section of the cut
15 filter element according to fig. 1 or 3 with several spheres, which form the cover layer, for example, of equal diameter,
Fig.6 is a similar, enlarged plan view as in fig.5, however, with spheres of varying diameters,
20 Fig.7 is a section through the filter element in the region of its covering layer with a row of spheres accumulated on to it and the powder particles embedded in the support material, according to section III,
25 Fig.8 is a longitudinal section through a filter housing with one filter element, which consists of several filter cartridges,
Fig.9 is a cross section through the filter housing with two filter elements arranged in parallel, in the
30 plane II-II of fig. 1,
Fig.10 is an enlarged view of a filter element constructed as a filter cartridge and a section of the support components, which are holding it there,
Fig.11 is an enlarged longitudinal central section through
35 the head of the filter cartridge with the pipe flange,

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which supports it against its holder, and
Fig.12 is an enlarged longitudinal central section through
the foot of the filter cartridge with the spigot,
which supports it against its holder.

5 The filter element 1 according to figs. 1 to 7 is
hereby illustrated and described by way of two possible
configurations. A simple such configuration can be a
tubular filter element 1, as it is shown in figs. 1 and
2. This filter element is formed in such a way, that it
10 forms a cylindrical support body 2, which on one end shows
a flange-shaped head 3 and on the other end a bottom 4.
Whilst the flange-shaped head 3 shows in itself the
opening cross section 5 of the filter element 1, that is,
the support body 2, which at the same time corresponds to
15 the opening cross section 6 of the cylindrical support
body 2, the bottom 4 of the support body is formed as a
closure of it and is possibly provided with a foot 7, in
order to be able to fix the support body in a support
frame 8 of the filter housing 13. The support body 2
20 itself, which consists of a heat-resistant material, such
as ceramics, shows a large-pored structure, that is, large
pores 9, onto which a fine-pored structure in the form of
a covering layer 11, which consists of fine pores 10, is
applied. This covering layer 11 forms the filtering
25 surface of the filter element 1, onto which the particles
to be separated from the medium to be filtered, are
deposited.

The filter element 1 according to a further possible
configuration as per fig. 4 is constructed as a so-called
30 lamellar filter, as described in DE-OS 34 13 213, and
distinguishes itself essentially through the fact that its
support body 2, or its support material, respectively,
consists of a heat-resistant material, for example of the
ceramic origin described earlier and where its covering
35 layer 11 is formed from a multitude of preferably

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spherical and/or powdery bodies 12, which form a bond with the support body 2 and/or with each other, and which also consist of heat-resistant material.

The various parts of the filter element 1, that is, the support material 2 and its covering layer 11, show varying pore widths, whereby the pores 9 of the support material must be larger than the pores 10 of the covering layer, so that a filtration of the medium can take place at the surface of filter element 1.

Hereby, the support material 2 may consist of ceramics in the form of an aluminium oxide (Al_2O_3), a zinc oxide (ZnO_2) or silicon oxide (SiO_2), whereby its manufacture may occur in such a way that the respective chosen material is processed into a moulding material in the conventional manner, that is, extruded in the form of pipes and then fired, which results in wide-pored supporting bodies, that is, the supporting material 2. On the other hand, if the mass of the support material 2 is filled into moulds, which often may be of advantage, then the flange-shaped head 3 and the bottom 4, which closes the pipe, can be formed at the same time.

A fine-pored covering layer 11 is now applied to the outer casing of this coarse-pored support material 2, either in the form of an emulsion by way of spraying or brushing, whereby this emulsion settles primarily in the openings and holes of the support material and hereby covers the larger pores 9 with a multitude of openings or pores 10.

The smaller pores 10 in the covering layer 11 are produced when the material of the covering layer combines partially, that is, pointwise or in the form of lines, with each other, for example, in the form of larger or smaller bodies 12, such as spheres, and that the surfaces, which have not been bonded, retain the openings in the form of pores 10. To a large extent, these pores 10 can

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be dimensioned arbitrarily in their size, so that this covering layer 11 or the coating, respectively, form a fine-pored layer, in the manner of a film, which still allows the transmission of the medium, which shows a small
5 dimension of its pores 10.

A further possibility for the application of the covering layer 11 is, to prepare a coating sludge from the fine-grained powder, of similar consistency to that used in an enamelling process. The supporting body, that is,
10 the support material 2 may be dipped into this coating sludge. This covering layer is then fired, together with the support material, which results in a fine- and open-pored engobe, similar to a glazing. As with the support material 2, here, too, the required open small
15 pores 10 result from the evaporation of the suspension liquid.

In the manufacture of the filter element 1 from these heat-resistant materials, a starting point is, to use components of the same base material for the support
20 material 2 and its covering layer 11, whereby the adhesive agent, which is also used, causes melting of these materials on the surface (for example, during the firing process), similar to a sintering process, which results in a homogeneous, firm bond.

25 This is the case and has been established with numerous experiments with support material 2 and covering material 11 out of aluminium oxide (Al_2O_3), as well as a ceramic adhesive of the same consistency.

Similar stable forms result, if chemically not
30 identical but related materials interact with each other, and which mix with each other during the liquid phase (at the eutectic point, for example, of Al_2O_3 and SiO_2 or ZnO_2 and SiO_2). Also, a chemical bond between the support material 2 and the covering layer 11 is possible,
35 as long as its stable at the application temperature and

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that it shows the same or better chemical resistance against structural changes as the support and covering material 2, 11. The partial bonding between the support and the covering material 2, 11 is facilitated through an adhesive agent 14, which may be applied, depending on the type of bonding during the firing operation, as a form of glazing or as an adhesive bond.

The thickness 15 of the coating, that is, the covering layer 11, can easily be made to suit the required degree of purity of the medium, in that more or less coating material is applied to the support material 2. With this measure, the filter action of the coating layer 11 can be increased correspondingly.

The bonding of the coating layer 11, that is, its filler material, with the support material 2 is preferably a homogeneous, intimate bond, which normally cannot be dissolved. This is of importance insofar as the coating layer 11 cannot be wahsed off the support material 2, which could otherwise easily be the case with filtration of liquid fluids.

The filter element 1 according to the invention, as shown in the form of construction according to figs. 8-12, distinguishes itself hardly from the filter element according to figs. 1-7 and is also used for the separation of particles from gaseous or liquid media. For better understanding, this filter element 1 is constructed as a tube and arranged in a filter housing 13 together with at least one other filter element in this housing. Housing 13 itself shows a clean room 16 for the filtered medium and a discharge shaft 17 for the particles, as well as an inlet and outlet connector 37 and 38 for the medium. The filter element 1, which is, according to the illustrative example, constructed as a tubular filter cartridge, is preferably manufactured from a ceramic material, which, for example, consists of a support material 2 with large

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pores 9 and a surface coating, that is, a coating layer 11 with fine pores 10. The mounting of this filter element 1, that is, the respective filter cartridge in the filter room of the filter housing 13 may occur horizontally or
5 vertically, whereby each filter cartridge shows at its respective end, that is, the cartridge head 18 and cartridge foot 19, special fastening components, with which they are fixed to holders 20, 21 in the filtering room. The fastening components at the cartridge head 18
10 are essentially formed by an injector-shaped pipe flange 22 and at least one seal 23, 24, whereby the pipe flange shows, apart from the annular shoulder 25, a collar, which penetrates into the clean room and a sleeve 27, which projects into the filter element 1. The annular shoulder
15 25, which approximately forms the equator of the pipe flange 22, has larger diameter than the casing of the filter element 1. This is the reason for the sufficiently large support surfaces of the pipe flange 22, with which the ends of the filter element, that is, the filter
20 cartridge, on the one hand, support themselves on the holder 21 and on the other hand, support themselves on the holder 20 at the end near the clean gas.

In order to make the sealing effective, it is recommended to provide seals 23, 24 on either side of the
25 annular shoulder, that is, coaxially to it, of which one is an annular seal 32 and the other seal 24 could, next to the annular surface, show a shroud-like enlargement. This shroud-like enlargement could in this case concentrically envelope the sleeve 27, which penetrates into the filter
30 element 1 and thereby affect a sealing function, as well as a radial, elastic support. Of course, it is conceivable to provide, instead of these shroud-like seals, an annular seal 32 at this point and support the filter cartridge and holder 20 only through this seal.

35 The other end of the filter element 1 is primarily

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supported on the shoulder 28 of a spigot 29, whereby this
spigot shows similar to the pipe flange 22-also a collar
30 and an extension 31 into the opposite direction to it.
With this collar 30, the spigot 29 is inserted into the
5 free end of the filter element 1 up to the shoulder 28,
whereby this collar must show no play or only a small
amount of radial play between itself and the inner surface
of the filter element. The actual sealing of this end of
the filter element 1 at the foot of the cartridge 19
10 occurs, as with the cartridge head 18, through an annular
seal 32, against which the end of the filter element makes
sealing contact. The extension 31 of the spigot 29
penetrates into the hole 33 of the holder 21 and extends
deep enough into it, so that the filter element 1 is
15 guided in the borehole not only against radial movements,
but also remains guided in the borehole during axial
movements. In order to hermetically seal the respective
filter element 1 against the filtering room of the filter
housing 13, a coil spring 34 is inserted between the
20 shoulder 28 of the spigot 29 and the holder 21 around the
extension 31, which, on the one hand, supports itself on
the shoulder and, on the other hand, against the holder 21.

This helical spring 34 pushes this filter element 1,
that is, the filter cartridge against the seals 23, 24 at
25 the cartridge head 18, as well as the shoulder against the
annular seal 32, so that these seals make full contact.

The spigot 29 itself may be solid at its collar 30
and extension 31, or it may show circular grooves 35, as
illustrated in the drawing of fig. 10. Instead of the
30 spigot 29, an equivalent guidance part, such as a conical
spring or a spider may be used. But also, instead of a
helical spring 34, a disc spring or a disc spring stack,
respectively, may be used, which ensures the axial
preloading of the filter element 1.

35 The holder 20, 21 itself may be constructed in the

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form of U-shaped struts, which with their ends support themselves on brackets 36 of the filter housing 13, and at that point may be supported rigidly or elastically.

5 The medium to be filtered, which enters the filtering room of the filter housing 13 through the inlet connector 37, flows around the individual filter elements 1 and enters the clean room 16 through them, while its entrained particles deposit themselves on the casings of the filter elements. The medium, which in this manner enters the
10 clean room 16, leaves it through the outlet connector 38, in order to enter free atmosphere, or to be fed into a further process. The particles deposited on the filter elements are dislodged through the known method of reverse blowing, from the inside towards the outside, and enter
15 the discharge shaft 17, from where they are removed either continuously or intermittently. The reverse blowing device may be a known jet cleaner, the nozzles of which are inserted into the injector-shaped pipe flanges 22, in order to blow in the cleaning medium, such as compressed
20 air.

The mounting and disassembly of the filter element 1 or the filter cartridges, respectively, is made particularly easy with this form of cartridge-type construction, whereby, following the insertion of the
25 extension 31 of the spigot 29 into the borehole 33 of the holder 21 and pushing it against the force of the helical spring 34, the collar 30 of the pipe flange 22 at the head of the cartridge 18 is pushed first under the borehole of the holder 20 at this end, and, after releasing the
30 pressure slowly, this collar will engage in this hole and fix the filter cartridge in that position. Disassembly of the filter cartridge or the filter element 1, respectively, occurs in reverse sequence, if it is required to remove them from their holders 20, 21.

35 According to an advantageous material selection, the

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composition of the filler material, that is, the coating layer 11, which is applied to the support body 2, consists of the following components.

These components, which are dispersed as a mixture, are applied to the support body 2 by means of, for example, a brush, and this filler material is exposed to a temperature of 500°C for about an hour, together with the support body, whereby the filler material is burnt into the material or the pores of the support body 2, respectively.

The components of the filler material or the coating layer, respectively, could be composed as follows:

1 part by volume of sodium silicate
14 parts by volume of water
4 parts by volume of kaolin
2 parts by volume of feldspar
2 parts by volume of starch (cornflour)
0.2 parts by volume of sodium diphosphate

The filler material, which is produced in this manner and which is applied to the support body 2, deposits itself in the region of the casing surface of the pores 9 of the support body and fills them until a film-like layer appears on its surface. Hereby, the water is evaporated under the influence of the temperature, and at this temperature, the starch is also eliminated from the mixture by burning.

As already mentioned above, the filter elements 1 are manufactured from ceramic, heat-resistant material. This does, of course, not exclude the application of other filter elements 1, for example, of plastic, if the filter element is supposed to work in a different temperature range. It is also possible, to use other configurations of filter elements 1.

Here, the filter element 1 has been illustrated and explained by means of filtration of hot gases. Of course,

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5 this filter element 1 is also suitable for the filtration of hot liquids or for gases and liquids, which are not hot. This filter element 1 is of particular interest for aggressive media in the gaseous or liquid region, since it is hardly attacked by aggressive materials.

10 The heat-resistant filter element 1 has been illustrated and explained by means of pipes and the so-called lamellar filter, as shown in fig. 1-4. Of course, this filter element 1 can also show other configurations. Of advantage is a configuration, which shows the largest possible filter area.

15 Such a configuration could also be a combination of shapes, such as elliptical, triangular etc. The configuration is mainly dependent on the volume to be filtered, the durability of the filter element, that is, the filter cartridge, and the medium to be filtered. The latter also determines the pore width, which for the purpose of optimization of the pressure drops, is matched to the medium.

20 The function of the filter is here illustrated and described, relative to the jet-cleaning process, on an example of the deposition of particles from gaseous media. The separation of particles from liquids occurs in a similar manner, but in this case, the cleaning process is different, that is, through reverse flow of pure
25 liquids. If the liquid permits the use of air, compressed air may be used for the cleaning process.

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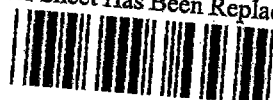
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CLAIMS

1. A filter for the separation of solid particles from hot, gaseous or liquid media, in particular dust particles from hot flue gases in the temperature range between 120 and 800°C, consisting of a support material, which is permeable, inherently stable and equipped with large pores, i.e. a supporting body, the support material being heat resistant and comprising non-corrosive materials, such as glass, ceramics, metals or compounds of these, and in which the support material can be manufactured through an intimate, partial bond of its heat-resistant particles, the support material being of a structure, which suits the application or the given volume, characterized in that the structure of the support material (supporting body 2) is covered on the one casing surface, at least on the surface, with a filler material which makes it possible to use finer pores, is fine-grained and also heat-resistant, and the filler material (covering layer 11) is applied to the support material in particular as a thin coating, and that this filler material consists of parts of a dispersed mixture, of which one part is volatilizable during the firing process, another part, however, attachable to the larger pores of the support material and that this mixture is prepared by means of an adhesive agent (14) and a suspension liquid and in this aggregate state can be applied to the support material, whereby it is bondable partly amongst itself and partly with the support material and that these fine-grained components (bodies 12) of the filler material, as well as the adhesive agent, consist of a respective material, which has a linear thermal expansion coefficient, of approximately the same magnitude as that of the support material (supporting body 2), as well as that the material of the filler material has such a grain size, so that the pore size of this filler material is under 10 μm and that this filler material is embedded in the larger pores (9) of the support material in the region of the casing of the support material, in particular fills the larger pores of the support material at least partly.



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- 5 2. A filter according to claim 1, characterized in that the fine-grained filler material (covering layer 11) in powder form is suspended in a liquid (e.g. water) and, following the addition of the adhesive agent (14), is applied to the support material (supporting body 2) and that this filler material is bonded to the support material through the adhesive agent.
- 10 3. A filter according to claim 2, characterized in that the liquid for the suspension of the filler material (covering layer 11) is a volatizable material (water) under the action of heat, which, following the application of it onto the support material (supporting body 2), leaves the filler material behind, having formed fine pores (10) therein.
- 15 4. A filter according to claim 1, characterized in that the filler material (covering layer 11) forms a homogeneous, undetachable bond with the support material (supporting body 2) under the action of heat.
- 20 5. A filter according to claim 1, characterized in that the filler material (covering layer 11) applied to the support material (supporting body 2) is capable of being fired therewith at elevated temperature.
- 25 6. A filter according to claim 1 to 3, characterized in that the filler material (covering layer 11) is applied to the support material (supporting body 2) in at least one layer.
- 30 7. A filter according to claims 1 to 3, characterized in that the filler material (covering layer 11) is applied to the support material (supporting body 2) in two layers, whereby the first layer consists of relatively large particles, which, apart from narrowing the larger pores (9) of the support material, also form an additional support structure for the following, second layer, and that the second layer



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consists of fine particles, and that this second layer has the required small pores (10) for surface filtration.

- 5
8. A filter according to claim 1, characterized in that the filler material (covering layer 11) adapted to be applied to the support material (supporting body 2) material by way of spraying and that these materials together undergo an adhesion process, in particular a firing process.
- 10
9. A filter according to claim 1, characterized in that the filler material (covering layer 11) is provided as an emulsion in a bath and that the support material (supporting body 2) is coated with it by immersion into the emulsion and that these materials are then subjected to a firing process.
- 15
10. A filter according to claim 1, characterized in that the support material (supporting body 2) and the filler material (covering layer 11) consist of ceramics and that these materials are sintered together undetachably, but open-pored, under the influence of heat.
- 20
11. A filter according to claim 1, characterized in that the support material (supporting body 2) and the filler material (covering layer 11) form an eutectic mixture and that they are, following cooling-off, undetachably bonded to each other.
- 25
12. A filter according to claim 1, which is constructed in particular in tubular shape and which is inserted into a filter housing (13) with inlet and outlet connector (37, 38) for the medium to be filtered and the already filtered medium, as well as a discharge shaft (17) for the precipitated particles and through the casing of which the medium to be filtered can pass through from the outside to the inside and the casing surface of which can be passed through by a clean flow at intervals in reverse flow, for the purpose of cleaning, and where at the filter housing (13) in the region near the outlet
- 30



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5 connector (38), a clean room (16) is provided for the collection and
discharge of the filtered medium, as well as at least one device for
the cleaning of the filter element, as well as that holders (20, 21)
are provided between this device and the base of the discharge shaft
10 (17) for at least one filter element (1), which is arranged inbetween,
of which the holder (20) nearest to the clean room is additionally
equipped with at least one opening between the filter element (1)
and the clean room (16) and the holder nearest to the base is
equipped with at least one support (cartridge foot 19) for the filter
15 element (1), characterized in that the filter element (1) is
constructed as an inherently stable filter cartridge and that this filter
cartridge is clamped and spring-loaded between the holders (20, 21)
and at these holders is sealed hermetically against the inside room
of the filter housing (13) and that for the support of each filter
20 cartridge at this holders, each filter cartridge has at its end nearest
to the clean room (16) an injector-shaped pipe flange (22) and at the
end nearest to the base of the discharge shaft (17) a spigot (29), of
which both, the pipe flange and the spigot, show an annular
shoulder (25, 28), whereby, on the one hand, a seal each is
25 provided between it and the filter element (1) and, on the other
hand, between it and the holder (20, 21) and that additionally to
these calibrating guidance and holding devices for the filter
cartridge, a spring (34) is provided between the shoulder (28) of the
spigot (29) and the holder (21), which presses the filter element (1)
against all its seals (23, 24, 32) and/or individual seals.

13. A filter according to claim 12, characterized in that the injector-
shaped pipe flange (22) shows from its annular shoulder (25)
onwards a sleeve (27), which penetrates into the filter element (1)
30 and a protruding collar opposite to this shoulder and that this collar
extends through the opening of the holder (20) into the clean room
(16).



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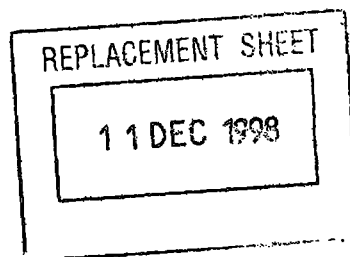
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- 5 14. A filter according to claim 12, characterized in that the spigot (29) shows annular grooves (35), at least on its section between its annular shoulder (25) and its protruding extension (31) and that this section of each extension penetrates into boreholes (33) of the holder (21).
- 10 15. A filter according to claim 12, characterized in that each holder (20, 21) nearly extends from inside wall to inside wall of the filter housing (13) and that several filter elements (1) are clamped and spring-loaded between two corresponding holders.
- 15 16. A filter according to claim 12, characterized in that the clamping of each respective filter element (1) between its holders (20, 21) is carried out as a floating construction.
- 20 17. A filter according to claim 15, characterized in that each filter element (1) is clamped adjustably, at least in axial direction, between its holders (20, 21).
- 25 18. A filter according to claim 1, characterized in that its filler material (covering layer 11) is made up of a dispersed mixture of several components, and consists of 1 part by volume of sodium silicate, 14 parts by volume of water, 4 parts by volume of kaolin, 2 parts by volume of feldspar, 2 parts by volume of starch (cornflour) and 0.2 parts by volume of sodium diphosphate.
- 30 19. A filter according to claim 18, characterized in that, following the application of the filler material (covern layer 11) onto the suport material (supporting body 2) with the larger pores (9), these are together subjected to a firing process and the volume parts of water evaporate during this firing process and that the volume parts of starch are burned out.



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Abstract

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Filter for the separation of solid particles from hot, gaseous or liquid media

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The invention refers to a filter for the separation of solid particles from hot, gaseous or liquid media comprising a heat-resistant support material including larger pores, and an also heat-resistant material of finer pores forming a covering layer for the support material.

15

While for example ceramic may be used for the support material, the covering layer is formed from a plurality of particles of a material similar to the support material, wherein a bond of identical or similar materials or an eutectic mixture of mixable materials may be formed between the covering layer and the support material during a subsequent heating process.

20

(Fig. 8)

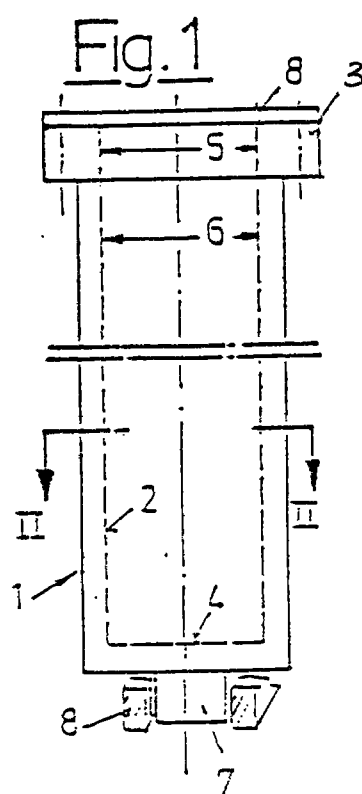
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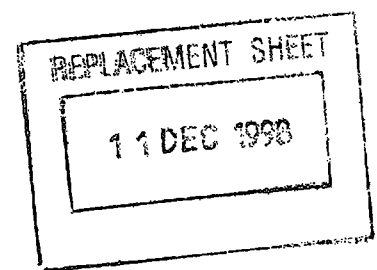


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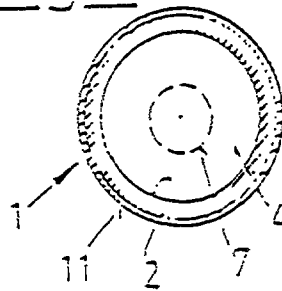
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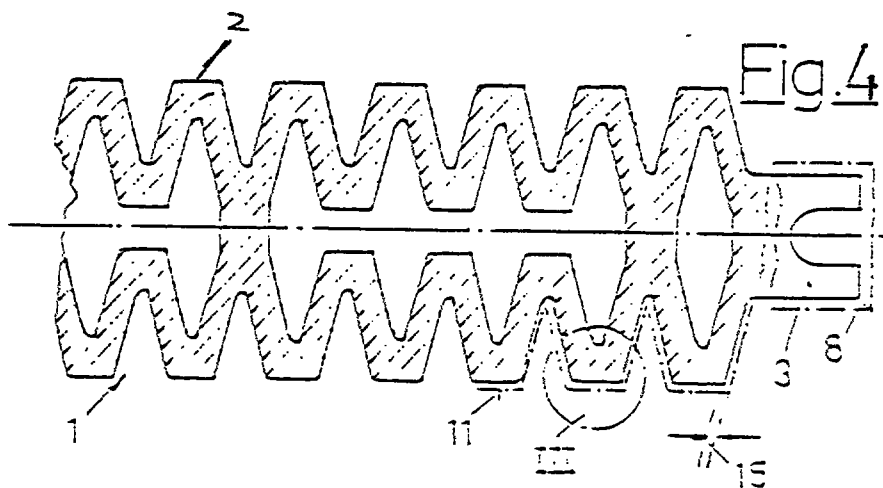
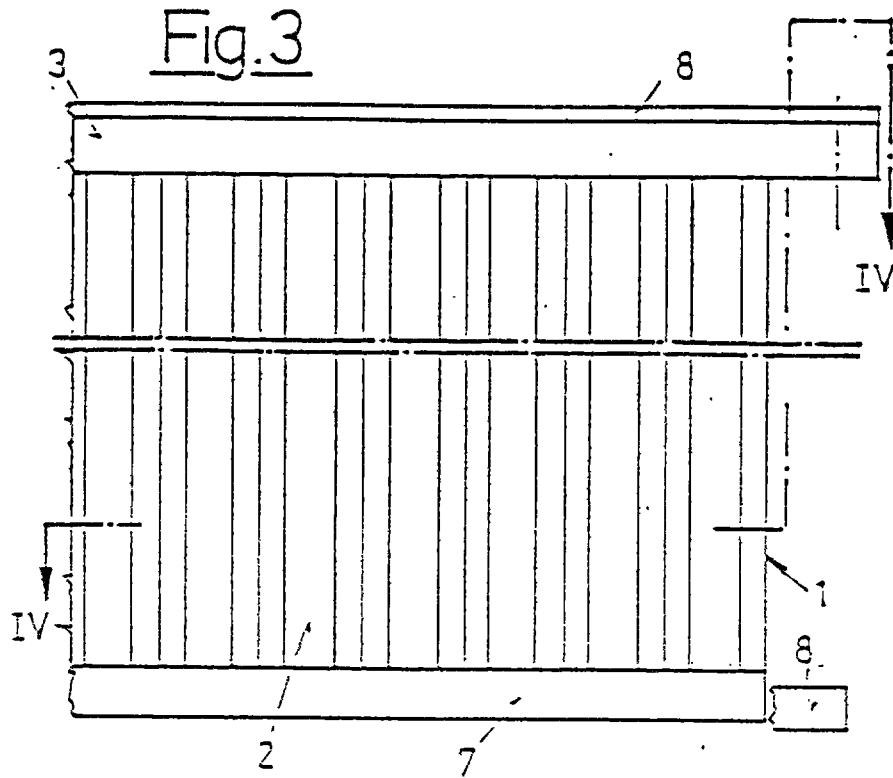
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Fig.2



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Fig. 5

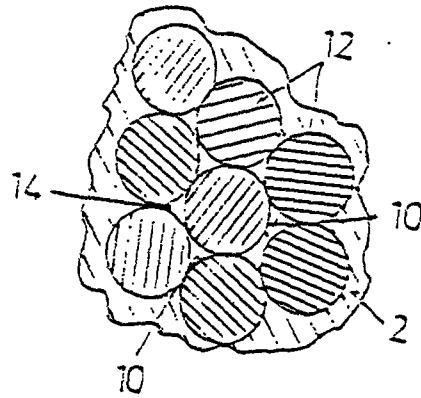


Fig. 6

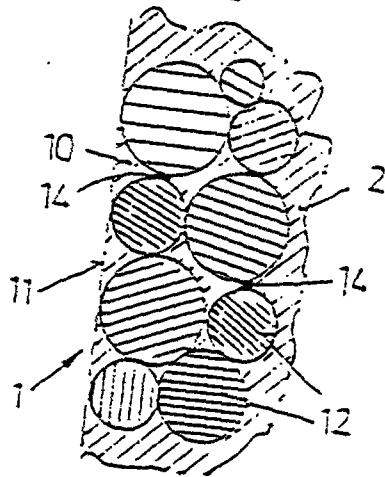
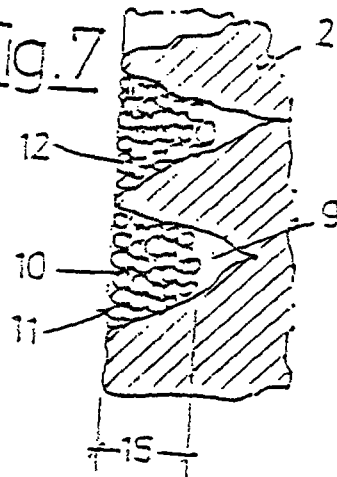
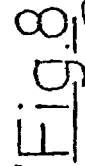
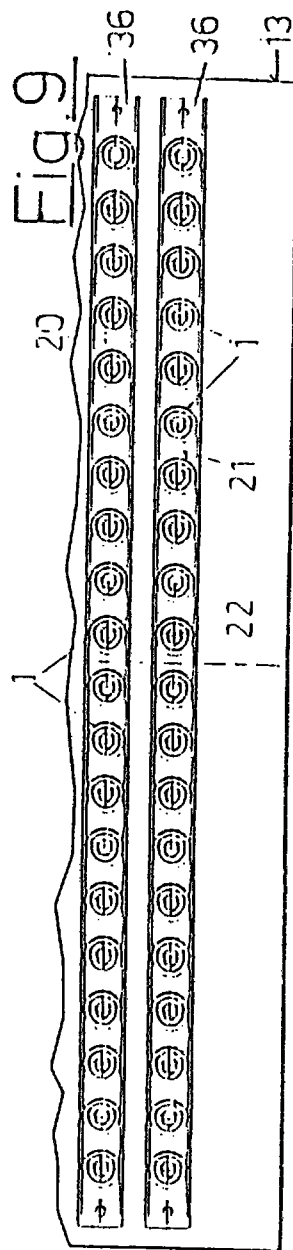


Fig. 7





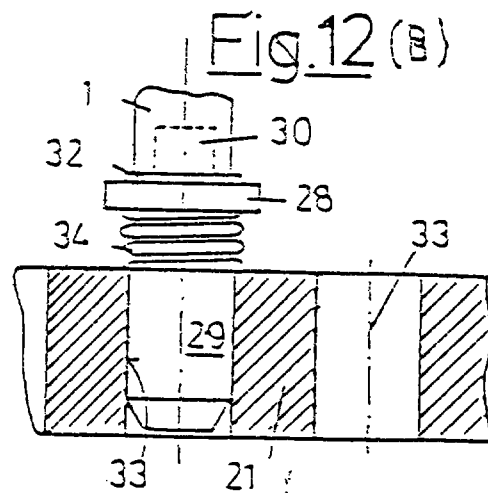
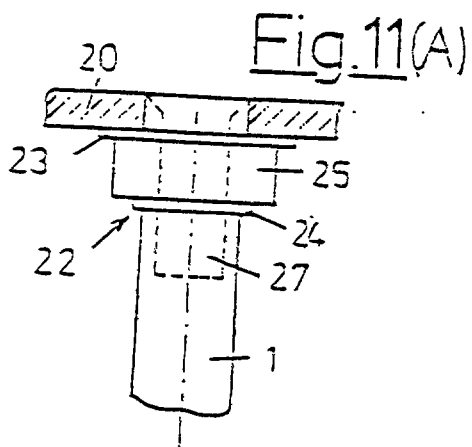
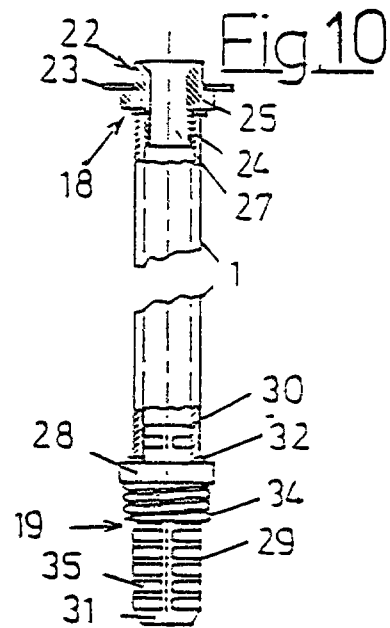


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FILTER FOR THE SEPARATION OF SOLID PARTICLES FROM
HOT, GASEOUS OR LIQUID MEDIA

- 5 According to claim 1, a first subject matter of the invention consists in a hot fluid filter element, in particular for separating solid particles from hot flue gases in the temperature range between 120 and 800°C, consisting of:
- 10 (a) a refractory, permeably porous supporting body of inherent stability and made of bonded together particles of ceramics and/or glass;
- (b) and a refractory, permeably porous coating on the surface of the filter element to be acted upon by the hot fluid, said coating containing particles of ceramics and/or glass as well as an inorganic binder and being produced by baking an applied coating mass;
- 15 (c) said coating having a smaller pore size than the supporting body and the coefficients of linear thermal expansion of the supporting body, the coating particles and of the binder being substantially the same;
- 20 characterized in
- 25 (d) that the porous coating consists of the coating particles bonded to each other and to the supporting body by means of said binder, the porosity of the coating being the result of the evaporation of a suspending liquid and of a burning-out component of the coating mass during baking thereof;
- 30 (e) that the pores of the supporting body at the coating surface thereof are filled, to at least part of their depth, by the coating particles bonded together by the binder;

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(f) and in that the pore size of the coating is smaller than 10 μm .

5 Preferred developments of the filter element are defined in dependent claims 2 to 7.

10 According to claim 8, a second subject matter of the invention consists in a hot fluid filter device, in particular for separating solid particles from hot flue gases in the temperature range between 120 and 800°C, comprising:

- (a) a housing subdivided by a first support into a filtering space and a clean space;
- 15 (b) and a plurality of tubular filter elements resiliently mounted in the filtering space between the first support and a second support, characterized in
- (c) that the filter elements are designed as indicated in any one of claims 1 to 7.

20

Preferred developments of the filter device are defined in dependent claims 9 to 17.

25 According to claim 18, a third subject matter of the invention consists in a method of making a hot fluid filter element, in particular for separating solid particles from hot flue gases in the temperature range between 120 and 800°C, comprising the following steps:

- 30 (a) producing a refractory, permeably porous supporting body of inherent stability and made of bonded together particles of ceramics and/or glass;
- (b) applying a coating mass, containing particles of ceramics and/or glass as well as an inorganic binder, to the supporting body on the surface of
- 35

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the filter element to be acted upon by the hot fluid;

(c) and baking the applied coating mass, thereby forming a refractory, permeably porous coating of the supporting body of smaller pore size than the supporting body, with the coefficients of linear thermal expansion of the supporting body, the coating particles and of the binder being substantially the same;

characterized in

(d) that the applied coating mass contains the coating particles, the binder, a suspending liquid and a component adapted to be burnt out;

(e) and that, by baking of the coating mass, the suspending liquid as well as the burning-out component are caused to evaporate and the porous coating is formed of the coating particles bonded to each other and to the supporting body by means of the binder, the pores of the supporting body at the coating surface thereof being filled, to at least part of their depth, by the coating particles bonded together by the binder, and the pore side of the coating being smaller than 10 μm .

Preferred developments of the method are defined in dependent claims 19 to 25.

The object met by the invention consists in providing a filter element suitable for hot fluids which, despite high temperature loads, retains its inherent stability and filter action and has no tendency to cracks or spalling of material parts. The filter elements may be attached in completely tight manner to their holders and may be mounted and detached therefrom without great expenditure. The filter elements remain abutted to the holders such that they are not

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even damaged by mechanical loads, in particular by cleaning thereof.

5 A hot fluid filter element comprising the features of the generic clause of claim 1 and a method of making a hot fluid filter element comprising the features of claim 18 are known from document WO-A-87/01610. With this filter element, the coating is provided in the form of a thin diaphragm comprising, in addition to 10 the particles of ceramics and/or glass and inorganic binder, fibres for anchoring the coating particles to the supporting body. The coating particles are bonded primarily to the fibres and the supporting body particles. Sections of the fibres between those locations 15 where they are mutually connected via coating particles, are supposed to permit elastic deformation so as to provide micro-movability of the diaphragm.

Document WO-A-85/04595 reveals a filter element comprising a permeably porous supporting body e.g. of 20 glass particles and a porous coating e.g. of small glass particles. There are no fibres for anchoring the coating particles. The pores of the supporting body, at the coating surface thereof, are filled to part of 25 their depth by the coating particles, and the pore size of the coating particles may be less than 10 μm . The coating mass may be an aqueous suspension of the coating particles, comprising furthermore an adhesion promoter. A burning-out component is not contained in 30 the coating mass. The known filter element is not designed as a hot fluid filter element, and document WO-A-85/04595 does not describe aspects to be considered for a design suitable for hot fluid filtration.

35 The filtration of hot gases having temperatures of more than 250°C is gaining increasing significance

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since the high enthalpy of the cleaned gas may then be utilized without further measures and since filtered flue gases entail less environmental problems. The filter elements according to the invention are suitable for filtering gaseous or liquid fluids.

In the finished filter element, the coating particles are bonded, by the bonding agent, partly to each other and partly to the supporting body. The supporting body and the coating have the same or approximately the same behaviour of thermal expansion, so that the filter element neither tends to damage nor to expansion of the pores, in particular of the coating. This particular conception of the filter element ensures an excellent filter action, even in case of highly fluctuating temperatures of the fluid to be filtered so that the filter element is ideally suited in particular for hot gases in the temperature range starting from 250 °C to up to 600 to 800 °C. Due to the fact that all materials and thus also all structures of the filter element can follow the temperature fluctuations without damage, it is hardly possible that cracks or spalling, in particular in the coating, occur so that the filter element provides for surface filtration which ensures the advantage of a largely clogging-free filter action. The surface filtration avoids increasing pressure drops so that the filter element can be operated with constant, minimum energy requirements.

The different structures of the filter element can also be varied in accordance with the demands on the filter element, so that, for example, a greater or smaller pore width may be given to the supporting body. Analogous to this pore width, the pore width of the coating may also be formed larger or smaller, for

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example in such a way that either coarse- or fine-grained filler material is deposited on the supporting body or the supporting body has more or less layers of the filler material adhered thereto. The filler material may consist e.g. of refractory glass spheres, ceramic grains or ceramic powder, which upon application thereof cover the supporting body in film-like manner.

10 The drawings show some of the possible embodiments of the invention in schematic manner, wherein

Fig. 1 is a side elevation of a filter element in the form of a cylindrical tube,

15

Fig. 2 is a section through the filter element in the plane II-II in Fig. 1,

Fig. 3 is a side elevation of a filter element in the form of a lamellar package,

20

Fig. 4 is a section through the filter element in the plane IV-IV in Fig. 3,

25 Fig. 5 is an enlarged plan view onto a section of the cut filter element according to Fig. 1 or 3 with several spheres of equal diameter, which form the covering layer thereof,

30 Fig. 6 is an enlarged plan view onto the filter element similar to Fig. 5, but with spheres of different diameter,

35 Fig. 7 is a section through the filter element in the region of its covering layer with a series of spheres accumulated on it, and with powder

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particles embedded in the supporting material,
according to section III,

5 Fig. 8 is a longitudinal central section through a
filter housing comprising several filter
cartridges,

10 Fig. 9 is a cross section through the filter housing
with two filter cartridge rows arranged in
parallel, as seen in the plane II-II in Fig.
1,

15 Fig. 10 is an enlarged view of a filter element in the
form of a filter cartridge, and a section of
the supporting means holding said filter
cartridge there,

20 Fig. 11 is an enlarged longitudinal central section
through the head of the filter cartridge along
with the tubular bush supporting it to its
holder, and

25 fig. 12 is an enlarged longitudinal central section
through the foot of the filter cartridge along
with the round bolt supporting it to its
holder.

30 The filter element 1 according to Figs. 1 to 7 will be
illustrated and described herein by way of two of the
possible configurations. A simple such configuration
may be a tubular filter element 1, as it is shown in
Figs. 1 and 2. This filter element 1 is designed such
that it forms a cylindrical supporting body 2 having
on one end a flange-shaped head 3 and on its other end
35 a bottom 4. While the flange-shaped head 3 as such has
the opening cross section 5 of the filter element 1,

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i.e. of supporting body 2, which at the same time corresponds approximately to the opening cross section 6 of the cylindrical supporting body 2, the bottom 4 of the supporting body 2 is formed as a closure thereof and is possibly provided with a foot 7 there in order to be able to fix the supporting body 2 in a supporting frame 8 of a filter housing 13. The supporting body 2 itself, which consists of a heat-resistant material, e.g. ceramics, has a large-pore structure, i.e. large pores 9, onto which is applied a fine-pore structure in the form of a covering layer 11 having fine pores 10. This covering layer 11 forms the filtering surface of the filter element 1, onto which the particles to be separated from the medium to be filtered are deposited.

The filter element 1 according to the further possible configuration according to Fig. 4 is based on a so-called lamellar filter as shown e.g. in DE-OS 34 13 213, and differs therefrom in essence in that the supporting body 2 thereof is made of a heat-resistant material, i.e. of ceramic origin, and that the covering layer 11 thereof is formed of a multiplicity of preferably spherical and/or powdery particles 12 which are bonded to the supporting body 2 and/or mutually bonded and also consist of refractory material.

The various parts of the filter element 1, i.e. the supporting body 2 and its covering layer 11, display different pore widths, wherein the pores 9 of the supporting body 2 must be larger than the pores 10 of the covering layer 11 so that a filtration of the medium can take place at the surface of the filter element 1.

The supporting body 2 may consist of ceramics in the form of an aluminium oxide (Al_2O_3), zinc oxide (ZnO_2)

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or silicon oxide (SiO_2), and it may be manufactured in such a manner that the particular material chosen is processed in conventional manner to a moulding material, e.g. extruded in the form of tubes, and then fired, which results in the supporting body 2 with open pores, i.e. large pores. If, in contrast thereto, the mass of the material for the supporting body 2 is filled into moulds, which may often be more advantageous, the flange-shaped head 3 and the bottom 4 closing the tube may be moulded at the same time.

The outer shell surface of this supporting body 2 with coarse pores then has deposited thereon the fine-pore covering layer 11 either in the form of an emulsion by spraying or brushing, with this emulsion settling primarily in the openings or holes of the supporting body 2 and thus covering the larger pores 9 with a multiplicity of small openings or pores 10. The small pores 10 of the covering layer 11 are produced in that the material of the covering layer 11, e.g. in the form of larger and smaller bodies 12, e.g. spheres, is partially bonded to each other, e.g. in punctiform or linear manner, and the non-bonded surfaces retain the openings in the form of pores 10. These pores 10 or openings may be dimensioned to a large extent in arbitrary manner in their size, so that the covering layer 11 or the coating, respectively, forms a layer with fine pores, of the type of a film that still permits the passage of a medium and has a small dimension of its pores 10.

A further possibility for applying the covering layer 11 is to prepare from the fine-grained powder for the covering layer 11 a sludge of similar consistency to that used for enamelling. The supporting body 2 may be immersed in this sludge. The covering layer 11 is then

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fired together with the material of the supporting body 2, thereby producing a fine- and open-porous engobe, similar to a glazing.

5 For producing the filter element 1 from these refractory materials, a starting point consists in using for the material of the supporting body 2 and its covering layer 11 components of the same base material, wherein the adhesion promoter or binder used therein, during
10 heating of these materials (e.g. during baking), causes melting together of these material on the surface thereof, similar to a sintering process, which results in a homogeneous, firm bond.

15 This is the case and has also been established with numerous experiments with material for the supporting body 2 and the covering layer 11 of aluminium oxide (Al_2O_3) as well as a ceramic adhesive of similar consistency.

20 Structures of similar stability result when chemically not identical but similar substances are used in combination and these mix with each other in the liquid phase (eutectic e.g. of Al_2O_3 and SiO_2 or ZnO_2 and
25 SiO_2). A chemical bond of material for the supporting body 2 and the covering layer 11 is possible as well, provided that it is stable at the temperature of use and has approximately the same or a better chemical resistance against structural changes as the sup-
30 porting body and covering layer material. The partial bonding between the supporting body and covering layer material is effected by a bonding agent or adhesion promoter 14 which, depending on the type of bonding during the baking operation, may be made similar to
35 the application of a glazing or as an adhesive bond.

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5 The thickness 15 of the coating, i.e. of the covering layer 11 can easily be made to suit the particular requirements to the degree of purity of the medium, in that more or less covering material is applied to the supporting body 2. With this measure, the filter action of the coating layer 11 can be enhanced correspondingly.

10 The bonding of the covering layer 11, i.e. the filler material thereof, with the supporting body material is preferably a homogeneous, intimate bond which normally cannot be dissolved. This is important in so far as the covering layer 11 cannot be washed off from the supporting body material, which otherwise could easily
15 be the case with the filtration of liquids.

The filter element 1 according to the invention, as exemplified in the embodiment according to Figs. 8 to 12, is hardly different from the filter element according to Figs. 1 to 7 and also serves for separating
20 particles from gaseous or liquid media. For better understanding, this filter element 1 is in the form of a tube or filter cartridge and is disposed in a filter housing 13 together with at least one additional
25 filter element 1. The housing 13 itself comprises a clean room 16 for the filtered medium and a discharge shaft 17 for the particles, as well as an inlet and outlet connector 37 and 38 for the medium. The filter element 1 is preferably also made from a ceramic material, consisting e.g. of a supporting body 2 with
30 larger pores and a surface coating, i.e. covering layer 11 with fine pores 10. Mounting of the filter element 1, i.e. the particular filter cartridge, in the filtering space of the filter housing 13 may be
35 made in vertical or horizontal manner, with each filter cartridge having, at its respective ends, i.e.

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cartridge head 18 and cartridge foot 19, special fastening members through which it is fixed to holders 20, 21 in the filtering space. The fastening members at the cartridge head 18 are formed in essence by an injector-shaped tubular bush 22 and at least one sealing member 23, 24, with the tubular flange 22 thereof having, apart from an annular shoulder 25, a collar 26 projecting into the clean room 16 and a skirt 27 penetrating into the filter element 1. The annular shoulder 25, forming approximately the waist-line of the tubular bush 22, is of larger diameter than the shell of the filter element. The tubular bush 22 thus has sufficiently large supporting areas, on the one hand for an end of the filter element 1 and on the other hand for support thereof against the holder 20 at the end on the side of the clean gas.

In order to make the sealing effect very effective, it is recommended to provide sealing members 23, 24 on both sides of the annular shoulder 25 coaxially with the same, one thereof being in the form of an annular sealing member 23, and the other sealing member 24, beside the annular surface, having possibly a shroud-like enlargement. The shroud-like enlargement would in this case concentrically enclose the skirt 27 penetrating into filter element 1, thereby having both a sealing function and a radial, elastic supporting function there. Of course, it is also conceivable to provide, instead of said shroud-like sealing member, an annular sealing member 32 at this location as well and to mutually support the filter cartridge and the holder 20 only through this sealing member.

The other end of the filter element 1 is supported primarily on the shoulder 28 of a round bolt 29, with this bolt - similar to tubular bush 22 - having also a

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collar 30 and an extension 31 directed oppositely thereto. With this collar 30, the round bolt 29 is inserted in the free end of the filter element 1 up to shoulder 28, and this collar 30 may have no play or just little radial play between the collar and the inner circumference of the filter element 1. The sealing effect proper of this end of the filter element 1 on cartridge foot 19 is obtained, just as in case of cartridge head 18, via an annular sealing member 32 on which the end of the filter element 1 sealingly abuts. The extension 31 proper of the round bolt 29 enters a bore 33 of holder 21 and extends deep enough into it that the filter element 1 is guided in the bore not only against radial movements, but also against axial movements. In order to hermetically seal the respective filter element 1 with respect to the filtering space of the filter housing 13, a helical spring 34 is placed around extension 31 between the collar 28 of the round bolt 29 and the holder 21, said spring being supported on the one hand on the shoulder 28 and on the other hand on the holder 21. This helical spring 34 pushes the filter element 1 also against the sealing members 23, 24 on cartridge head 18 and pushes the shoulder 28 against the annular sealing member 32, so that these sealing members are fully abutting there.

The round bolt 29 itself may be solid at its collar 30 and extension 31, or it may have annular grooves 35 as shown in drawing Fig. 10. Instead of round bolt 29, an equivalent guiding member, such as e.g. a conical spring or a spider, could be used as well. Instead of helical spring 34, a Belleville spring or a Belleville spring package could be used, ensuring the axial bias of the filter element 1.

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The holders 20, 21 themselves, which can be in the form e.g. of U-shaped struts, have their ends supported on brackets 36 of the filter housing 13 and may be supported there rigidly or elastically.

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The medium to be filtered, which enters the filtering space of the filter housing 13 through the inlet connector, flows around the individual filter elements 1 and through the latter enters the clean room 16, while its entrained particles deposit on the shells of the filter elements 1. The medium having thus reached the clean room 16 leaves the same through the outlet connector 38 in order to reach the outer atmosphere or to be fed to a further process. The particles deposited on the filter cartridges are dislodged by means of a known per se reverse blowing process on the filter cartridges, from the inside towards the outside, and are fed to a discharge shaft 17 from where they are discharged continuously or intermittently. The reverse blowing means may be a known per se jet cleaner whose nozzles blow their cleaning medium, e. g. compressed air, into the openings of the injector-shaped round bushes 22.

Mounting and unmounting of the filter elements 1 is made particularly easy with this cartridge-type construction in that, following insertion of the extension 31 of the round bolt 29 into the bore 33 of the holder 21 and pushing the same against the force of helical spring 34, the collar 26 of the tubular bush 22 at the cartridge head 18 is pushed first under the bore of holder 20 at this end and, thereafter, releasing the pressure slowly, this collar 26 will engage in the hole and fix the filter cartridge there. Detaching of the filter cartridge takes place in re-

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verse sequence, if the same is to be detached from its holders 20, 21.

5 According to an advantageous material selection, the filler material, i.e. coating layer 11, applied to the supporting body 2, consists of the following components.

10 These components, which are dispersed as a mixture, are applied to the supporting body 2, e.g. by means of a brush, and this filler material together with the supporting body is exposed to a temperature of about 500 °C for approx. 1 hour, whereby the filler material is burnt into the material or the pores 9 of the supporting body 2.

The components of the filler material or covering layer 11 may have the following composition:

20 1 part by volume soda water glass
 14 parts by volume water
 4 parts by volume kaolin
 2 parts by volume feldspar
 2 parts by volume starch (starch flour)
25 0.2 parts by volume sodium dyphosphate.

30 The filler material produced in this manner and applied to the supporting body 2, is deposited in the region of the shell surface in the pores 9 of supporting body 2 and fills them until a film-like surface appears on the surface of supporting body 2. During this process, the water is evaporated under the influence of the temperature, and at this temperature the starch is also eliminated from the mixture by
35 burning.

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As already mentioned hereinbefore, the filter elements 1 are made from ceramic, refractory material.

5 The filter element has been illustrated and elucidated herein for the filtration of hot gases. It is of course also possible to use the filter element 1 for filtering hot liquids or for gases or liquids that are not hot. The filter element 1 is of particular interest for aggressive media in the gaseous or liquid
10 phase, since it is hardly attacked by aggressive materials.

The refractory filter element 1 has been illustrated and described herein by way of tubes and the so-called
15 lamellar filter as shown in Figs. 1 to 4. Of course, this filter element may also have other configurations. It is advantageous to select the configuration having the largest possible filter area. Such a configuration may also be a combination of shapes,
20 such as oval, triangular, etc. The configuration will be dependent mainly on the volume to be filtered, the durability of the filter element 1, i.e. the filter cartridge, and the medium to be filtered. The latter also determines the pore width, which for optimization
25 of the pressure losses, is matched to the medium.

The function of the filter is illustrated and described herein in relation to jet cleaning, by way of the example of the deposition of particles from
30 gaseous media. The separation of particles from liquids occurs in a similar manner, but in that case the cleaning process must be effected in a different manner, i.e. by reverse flow of a clean liquid. If the liquid permits blowing-in of air, it is also possible
35 to use pressurized air for the cleaning process.

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Claims

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1. A hot fluid filter element (1), in particular for separating solid particles from hot flue gases in the temperature range between 120 and 800°C, consisting of:

(a) a refractory, permeably porous supporting body (2) of inherent stability and made of bonded together particles (12) of ceramics and/or glass;

(b) and a refractory, permeably porous coating (11) on the surface of the filter element (1) to be acted upon by the hot fluid, said coating (11) containing particles of ceramics and/or glass as well as an inorganic binder (14) and being produced by baking an applied coating mass;

(c) said coating (11) having a smaller pore size than the supporting body (2) and the coefficients of linear thermal expansion of the supporting body (2), the coating particles and of the binder (14) being substantially the same; characterized in

(d) that the porous coating (11) consists of the coating particles bonded to each other and to the supporting body (2) by means of said binder (14), the porosity of the coating (11) being the result of the evaporation of a suspending liquid and of a burning-out component of the coating mass during baking thereof;

(e) that the pores (9) of the supporting body (2) at the coating surface thereof are filled, to



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at least part of their depth, by the coating particles bonded together by the binder (14);
(f) and in that the pore size of the coating (11) is smaller than 10 μm .

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2. A filter element (1) according to claim 1, characterized in that the particles (12) of the supporting body (2) consist of aluminium oxide and/or zinc oxide and/or silicon oxide.

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3. A filter element (1) according to claim 1 or 2, characterized in that the particles of the coating (11) consist of aluminium oxide and/or zinc oxide and/or silicon oxide.

15

4. A filter element (1) according to any one of claims 1 to 3, characterized in that the binder (14) is soda water glass.

20

5. A filter element (1) according to any one of claims 1 to 4, characterized in that the suspending liquid is water.

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6. A filter element (1) according to any one of claims 1 to 5, characterized in that the coating mass has the following composition:

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14 parts by volume water
4 parts by volume kaolin
2 parts by volume feldspar
2 parts by volume starch flour
1 part by volume soda water glass
0.2 parts by volume sodium dyphosphate.

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7. A filter element (1) according to any one of claims 1 to 6,
characterized in that the coating (11) consists of two layers, the outer layer being of finer porosity than the inner layer.
8. A hot fluid filter device, in particular for separating solid particles from hot flue gases in the temperature range between 120 and 800°C, comprising:
- (a) a housing (13) subdivided by a first support (20) into a filtering space and a clean space (16);
 - (b) and a plurality of tubular filter elements (1) resiliently mounted in the filtering space between the first support (20) and a second support (21),
- characterized in
- (c) that the filter elements (1) are designed as indicated in any one of claims 1 to 7.
9. A filter device according to claim 8, characterized in
- (a) that the filter elements (1) are each fixed to the first support (20) by means of an injector-shaped tubular bush (22),
 - (b) the tubular bush (22) having a collar (25), and a seal (23) being provided between the collar (25) and the first support (20) as well as a seal (24) being provided between the collar (25) and the filter element (1);
 - (c) that the filter elements (1) are each fixed to the second support (21) by means of a round bolt (29),



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- (d) the round bolt (29) having a collar (28) and a seal (32) being provided between the collar (28) and the filter element (1);
- (e) and in that a spring (34) for resiliently clamping the filter element (1) between the first support (20) and the second support (21) and for pressing the same against the seals (23, 24, 32) is disposed between the collar (28) of the round bolt (29) and the second support (21).
10. A filter device according to claim 9, characterized in that the tubular bush (22) comprises a portion (27) projecting beyond the collar (25) and protruding into the filter element (1) as well as a portion (26) projecting in the opposite direction beyond the collar (25) and reaching into the clean space (16) through an opening in the first support (20).
11. A filter device according to claim 9 or 10, characterized in that the round bolt (29) has a portion (30) projecting beyond the collar (28) and protruding into the filter element (1), as well as a portion (31) projecting in the opposite direction beyond the collar (28) and protruding into a bore (33) in the second support (21).
12. A filter device according to claim 11, characterized in that the oppositely projecting portion (31) of the round bolt (29) has annular grooves (35).
13. A filter device according to any one of claims 8 to 12,



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characterized in that the first support (20) and/or the second support (21) is formed as a U-shaped brace.

5 14. A filter device according to any one of claims 8 to 13,

characterized in that several supports (20, 21) are provided in juxtaposed manner for one filter element row each.

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15 15. A filter device according to any one of claims 8 to 14,

characterized in that both the first support (20) and the second support (21) extend substantially from one wall to an opposite wall of the filter housing (13).

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16. A filter device according to any one of claims 8 to 15,

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characterized in that clamping of the filter elements (1) between the first and second supports (20, 21) is effected in floating fashion.

17. A filter device according to any one of claims 9 to 16,

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characterized in that the filter element (1) is slidable in axial direction against the action of the spring (34), to such an extent that the projecting portion (26) of the tubular bush (22) comes free from the opening of the first support (20).

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18. A method of making a hot fluid filter element (1), in particular for separating solid particles from hot flue gases in the temperature range between 120 and 800°C, comprising the following steps:

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- 5 (a) producing a refractory, permeably porous supporting body (2) of inherent stability and made of bonded together particles (12) of ceramics and/or glass;
- 10 (b) applying a coating mass, containing particles of ceramics and/or glass as well as an inorganic binder (14), to the supporting body (2) on the surface of the filter element (1) to be acted upon by the hot fluid;
- 15 (c) and baking the applied coating mass, thereby forming a refractory, permeably porous coating (11) of the supporting body (2) of smaller pore size than the supporting body (2), with the coefficients of linear thermal expansion of the supporting body (2), the coating particles and of the binder (14) being substantially the same;
- characterized in
- 20 (d) that the applied coating mass contains the coating particles, the binder (14), a suspending liquid and a component adapted to be burnt out;
- 25 (e) and that, by baking of the coating mass, the suspending liquid as well as the burning-out component are caused to evaporate and the porous coating (11) is formed of the coating particles bonded to each other and to the supporting body (2) by means of the binder (14), the pores (9) of the supporting body (2) at the coating surface thereof being filled, to
- 30 at least part of their depth, by the coating particles bonded together by the binder (14), and the pore side of the coating (11) being smaller than 10 μm .
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19. A method according to claim 18,



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characterized in that aluminium oxide and/or zinc oxide and/or silicon oxide is used for the particles (12) of the supporting body (2).

- 5 20. A method according to claim 18 or 19,
characterized in that aluminium oxide and/or zinc
oxide and/or silicon oxide is used for the par-
ticles of the coating (11).
- 10 21. A method according to any one of claims 18 to 20,
characterized in that the binder (14) used is soda
water glass.
- 15 22. A method according to any one of claims 18 to 21,
characterized in that the suspending liquid used
is water.
- 20 23. A method according to any one of claims 18 to 22,
characterized in that a coating mass with the
following composition is used:
14 parts by volume water
4 parts by volume kaolin
2 parts by volume feldspar
2 parts by volume starch flour
25 1 part by volume soda water glass
0.2 parts by volume sodium dyphosphate.
- 30 24. A method according to any one of claims 18 to 23,
characterized in that the coating (11) is applied
in two layers, the outer layer being of finer
porosity than the inner layer.
- 35 25. A method according to any one of claims 18 to 24,
characterized in that the coating mass is applied
by spraying on, spread-coating or immersion of the
supporting body (2).



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Abstract

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Filter for the separation of solid particles from hot, gaseous or liquid media

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The invention refers to a filter for the separation of solid particles from hot, gaseous or liquid media comprising a heat-resistant support material including larger pores, and an also heat-resistant material of finer pores forming a covering layer for the support material.

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While for example ceramic may be used for the support material, the covering layer is formed from a plurality of particles of a material similar to the support material, wherein a bond of identical or similar materials or an eutectic mixture of mixable materials may be formed between the covering layer and the support material during a subsequent heating process.

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(Fig. 8)