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(19)

(54) METHOD AND APPARATUS FOR FILTERING FLUIDS

(71) I, HANS MULLER, a Swiss citizen, of 8708 Männedorf, 415 Alte Landstrasse, Switzerland, do hereby declare the invention, for which I pray that a patent may be granted to me and the method by which it is to be performed to be particularly described in and by the following statement: —

This invention relates to a method and a device, more particularly a brush filter, for filtering liquids and gases.

A brush filter is known from German Gebrauchsmuster No. 1 963 821, which describes an insertable filter element consisting of a spiral shape brush provided with rows of bristles which become denser towards the outlet end of the filter. The bristles of the brush act as a filtering element. When it is required to regenerate the filter element the brush must be removed from the filter housing and cleaned.

In all other known types of filtration the filter layer also has to be cleaned repeatedly prior to re-use after filtration has taken place. This cleaning may be effected, for example, by reversing the direction of flow of a liquid or a gas through the filter element, by scraping or washing off the filter cake from the filter element or by centrifugal cleaning. When the cleaning has been completed, a new layer of filtering material has generally to be applied either by replacing the whole of the filter element or by recoating the surface of the filter element with a fresh layer of filter aid. Both processes, namely the removal of the filtering means and the renewal of the filter layer, are expensive and result in a heavy consumption of filter materials.

Moreover, methods of regenerating filter aids are also known in which, once filtration has taken place, the aid used, in dry or wet form, is freed from the contaminant which has become admixed therewith by screening, washing or decantation and is then used again. Such procedures also are complicated and expensive to perform.

The object of the present invention is to provide a method for filtering liquids and gases satisfactorily and for cleansing and regenerating the filtering means employed, and to provide a filtering device comprising a fibre filter for carrying out the method which can be cleaned and regenerated without opening up the filtering device, without replacing the filtering means and without the use of additional filter aids.

The present invention provides a method for filtering a fluid containing a solid contaminant which comprises passing said fluid from a first zone through a filter element into a second zone, said filter element comprising a mass of fibres comprising elongated fibres attached to a foraminated support, said elongated fibres each having at least one free end which initially extends into said first zone and has been pressed towards the adjoining surface of said support by the action of a fluid flowing from said first zone to said second zone and has thus formed a pressed filter layer in contact with said support and, after filtration of said fluid has been completed, passing a cleansing fluid from said second zone through said filter element into said first zone whereby said elongated fibres realign themselves along the direction of flow of said cleansing fluid and previously filtered contaminant becomes entrained in said cleansing fluid.

The present invention also provides a device for filtering a fluid containing a particulate solid contaminant which comprises a housing, a foraminated filter support fixedly mounted within said housing in such manner

as to divide said housing into two separate chambers, means for introducing into or for withdrawing a fluid from each of said two chambers and a mass of fibres mounted upon one side of said filter support, said fibres comprising elongated fibres each having at least one free end and said ends extending outwardly from one surface of said filter support into one of said chambers and being adapted to be pressed against that surface of said support when fluid is flowing in one direction through said chambers and to align with the direction of flow when this flow is reversed, and means for reversing the direction of flow of fluid through said two chambers.

Filtering means which have proved suitable include fibres in the form of a brush comprising elongated fibres which are attached to one side of a foraminated carrier. The fibres may be attached to one or both sides of a foraminated vertical or horizontal support which serves as a filter support. The fibres may be attached by being woven into position or attached by means of a textile technique, but they may also be attached to the foraminated support by being held in contact with one surface or bonded to the foraminated support. The individual fibres may be long or short or thick or thin filaments or a mixture of different filaments of these kinds. Preferably the fibres are a mixture of short and thick fibres with long and thin fibres. In this case the short thick fibres form a supporting layer for the long thin fibres which extend above them. The filtering fibres may be produced from natural fibres or spun plastics materials fibres of any kind or from special materials such as graphite, metal or glass fibres. The filtering fibres may all consist of the same material or may consist of a mixture of materials. Fabrics or foraminated plates to which the fibres are applied may be fitted in tubes or vessels, or to cylinders or drums or in strips, i.e. in all kinds of apparatus used in filtering techniques.

The diameter of the filaments used in the filtering elements may be from a few microns to a few millimeters. The length of the filaments may be from a few millimeters but is preferably 1 cm to 30 cm, depending upon the medium to be filtered and the degree of filtration. The diameter of the filaments may be such that a sterile filtration is achieved.

The foraminated support carrying the fibres is suitable for fitting in conventional filtering apparatus. The individual bundles of fibres may be so arranged that the distance between adjoining bundles corresponds to the effective length of the fibres in any particular case. In the case of cylindrical filter elements the spacing between individual bundles of fibres is determined by the length of the fibres used.

The invention will now be described with reference to the accompanying drawings in which: —

Fig. 1 is a longitudinal section through a housing provided with filtering means shown at the time of cleansing,

Fig. 2 shows the apparatus of Fig. 1 during filtration,

Fig. 3 is a section through another kind of filter container provided with a single filter element,

Fig. 4A is a section through a third filter comprising a plate against which bundles of fibres are pressed,

Fig. 4B is a section through a fourth filter comprising a plate against which the bundles of fibres are pressed in channels,

Fig 4C is a cross-section through apparatus comprising the filters shown in Figs. 4A and 4B,

Fig. 5A is a cross-section through a cylindrical filter element shown at the time of reverse-flow cleaning,

Fig. 5B is a perspective view of a stack of the cylindrical filter elements shown in Fig. 5A,

Fig. 5C is a cross-section through the cylindrical filter element of Fig. 5A shown at the time of filtration,

Fig. 6 illustrates a filter element having upwardly directed fibres,

Fig. 7 illustrates a filter element having downwardly directed fibres,

Fig. 8 illustrates a modification of the filter element of Fig. 7 in which the lower part of the filter housing is conical in shape,

Fig. 9 illustrates a filter element according to the invention provided with the requisite inlets and outlets to the housing.

Fig. 1 illustrates an individual filter element at the time of reverse-flow cleaning following use as a fibrous filter and Fig. 2 shows the same element during filtration. In a tube 1, which may constitute the wall of a filter container, a foraminated plate 6 is secured in position between two flanges. The long fibres 8 are secured to the foraminated plate in the form of a brush. The particles 10 of contaminant are located in the space above the foraminated plate 6. During filtration, when the medium to be clarified flows in the direction of the arrows shown in Fig. 2, the fibres of the brush are compressed and thus form a filter layer which is of such density that the particles of contaminant present in the medium are prevented from passing through the layer and only the liquid or gas to be clarified is able to pass therethrough. When the direction of flow is reversed during the cleansing operation, the fibres 8 align themselves with the direction of the arrows shown in Fig. 1 and the particles 10 of contaminant become detached from the fibrous filter material, which now no longer exists as a layer and are entrained in the cleansing medium. When the direction

of flow is again reversed the requisite filter bed is at once reformed.

Fig. 3 is a sectional view of a filter element comprising a plurality of compartments. The housing 1 for the filter has an inlet 2 for introducing the medium to be filtered and an outlet 3 for the filtered medium. The foraminated plate 6 or the tube 3 divides the housing 1 into a first zone 4 which holds unclarified medium and a second zone 5 for the clarified medium. The state of the fibres 11' during filtration and the state of the fibres 11 during reverse-flow cleansing are both shown upon the same Figure.

In Fig. 4A the fibres 8 are held against the foraminated plate 6 by retaining partitions 13. In Fig. 4B bundles of fibres are pressed into corrugated metal sheets and may possibly be secured in the depressions in the corrugated sheet 8 by means of rods 18. Foraminations 17 are provided in the raised portions of the sheet 6 for the passage of liquid or gas. Fig. 4C is a plan view of a plurality of filter elements, i.e. foraminated plates 6, retained in position by partitions, fitted in a vessel.

Figs. 5A, 5B and 5C show circular filter elements which themselves support a pile-like fabric during reverse-flow cleaning. Fig. 5B is a perspective view of a plurality of such filter elements arranged one upon another. Fig. 5C illustrates how the fibres arrange themselves during filtration whilst Fig. 5A illustrates their appearance during reverse-flow cleaning.

In Figs. 6 to 8 a mixture of short fibres 7 and long fibres 8 are mounted on a foraminated plate 6.

Fig. 6 shows the fibres in the state assumed when the filter element is being cleansed by reverse-flow. In this case cleansing medium is pumped into the zone 5 which is normally occupied by the clarified filtrate in use via the filtrate outlet line 3 and the fibres 7 and 8 are then extended in the direction of flow and are cleansed by the stream of liquid passing through from zone 5 and the eddy effect which it produces. The cleansing liquid leaves the filter element via inlet line 2 and carries the particles of solid material which have collected upon the filter element away with it.

Fig. 7, the zone 5 for the cleansed filtrate is located in the upper part of the filtrate housing 1 and the zone 4 for polluted medium in the lower part thereof. Thus, the fibres 7 and 8 are drawn out downwardly during a reverse-flow cleansing operation and the particles of contaminant upon the filter bed move downwardly. This is a particular advantage when the filter cake is dried, since the filtrant drops downwardly when dry and can easily be removed without additional mechanical aid.

In Fig. 8 the lower part of the container 1 is cone shaped as indicated at 9 and this assists in removing the separated material during the reverse-flow cleansing.

In the embodiment shown in Fig. 9, an inlet pipe 15 for cleansing medium and an outlet pipe 16 for medium which has been used in the reverse-flow cleansing are provided in addition to the inlet 2 for the medium to be clarified and the outlet 3 for the clarified filtrate.

During the operation of all the modifications of the apparatus according to the invention, liquid to be clarified or a gas having particles entrained therein is fed into the zone 4 along the inlet pipe 2, as a result of which the fibres 7 and/or 8 which are attached to the foraminated plate 6 become pressed together upon the surface of the foraminated plate by the initial powerful flow of fluid in the direction of filtration and in this way a more or less dense filter layer is formed depending upon the fineness of the fibres and the extent to which they are pressed. Filtration then takes place until saturation or clogging of the coated plate occurs. The cleansed liquids or gases which pass through the filter container 1 enter through the filter zone 5 and leave through the outlet pipe 3. To clean the filtration element, the normal liquid or gas flow is closed by means of a valve (not shown) in the inlet pipe 2 and a valve (not shown) in the outlet pipe 3. After this, cleansing medium, which may be a liquid or a gas, is introduced into the filter zone 5 via a cleansing pipe 15 (Fig. 9). As it passes through the foraminated plate 6, the matt of filter fibres 7 and 8 is forced open and the individual fibres extend in the general direction of flow of the cleansing medium. As a result the solid particles of matter which have collected upon the fibres are washed off and are drawn outwardly through the zone 4 and through the cleaning pipe 16 in suspension in the cleansing medium. Following the cleansing of the filtering medium, drying of the cleaned fibres may be performed by passage of a gas therethrough; preferably heated gas is used. After this cleansing and drying another filtration cycle may begin.

It will be appreciated that, in addition to the effect of the flow which compresses the fibres, a foraminated pressure plate may be used to press the filter layer to any desired degree. The fluid may have a pulsation superposed upon the normal flow thereof.

When the fibres used according to the present invention are used in the form of a plate filter, it is advantageous to divide up the surface of the plate into a plurality of individual segments, firstly in order to attach the pile-like fabric carrying the fibres to a large area underneath and secondly to provide the fibres with some lateral support when they are pressed down.

It is possible for a large number of foraminated plates to be fitted into a filter housing

to serve as a single filter element. If a plurality of plates are fitted into a vessel in this way, the inlet and outlet ducts to and from the filtering unit may be so arranged and disposed at to provide individual valves which enable the several foraminated plates to be acted on individually, for example to press down the filter layer, so as to achieve the highest possible pressure against the fibres on the individual elements.

If extremely fine and, for example, heat-resistant fibres made of plastics material are used for the filtration process, the pressing down operation may be performed with steam, the filtering means thus being sterilised at the same time. With a filter treated in this way, sterilisation can be performed prior to the filtration of either liquids or gases.

When liquids are filtered from which the separated solid matter requires to be dried, the subsequent drying of the solids may be performed using hot gas. For the purposes of vacuum drying, the plates and housing may be so constructed as to be heatable. When drying has been completed, reverse-flow cleaning is carried out using a gas and the solid matter entrained therein may be collected.

A particular advantage which exists when thick and thin fibres are admixed is that during cleansing the fibres as a whole align themselves more satisfactorily to the direction of flow of the cleansing medium and as a result the spaces between the fibres are larger and the removal of contaminant material from the filter mat is made easier. Both thick and long fibres and also thin and long fibres may be used. When thick and long fibres are used for example, and they are compressed a kind of deep-bed filtration is achieved the effect of which is equivalent to that achieved by adding filter aids.

There are many possible uses for the method and the corresponding apparatus of the invention. Thus, not only can a large number of different kinds of filtering, drying, sterilising, and the like operations be performed, but the fibres may also be used to carry out a catalytic process if a catalyst or enzmye is affixed thereto utilising the first part of the process of the invention and the catalyst or enzyme subsequently cleaned off and regenerated in the container itself utilising a cleaning fluid in accordance with the latter part of the process of the invention.

A brush filter, preferably formed as shown in Fig. 4B, has also proved satisfactory as a safety filter in inspection windows in pipes. In this case the foraminated carrier plate occupies the centre of the field of the inspection window. A foraminated plate disposed in filter vessel level with an inspection window enables the state of the filter cake in filter to be directly inspected.

brush filter device according to the invention has also proved satisfactory for the filtering of radio-active and biologically contaminated exhaust gases and for removing the deposits which build up on the filter element. The fields of application are principally those of nuclear reactor technology and microbiological technology.

WHAT I CLAIM IS:—

1. A method of filtering a fluid containing a solid contaminant which comprises passing said fluid from a first zone through a filter element into a second zone, said filter element comprising a mass of fibres comprising elongated fibres attached to a foraminated support, said elongated fibres each having at least one free end which initially extends into said first zone and has been pressed towards and adjoining surface of said support by the action of a fluid flowing from said first zone to said second zone and has thus formed a pressed filter layer in contact with said support and, after filtration of said fluid has been completed, passing a cleansing fluid from said second zone through said filter element into said first zone whereby said elongated fibres realign themselves along the direction of flow of said cleansing fluid and previously filtered contaminant becomes entrained in said cleansing fluid.

2. A method as claimed in claim 1 in which after passage of said cleansing fluid the realigned fibres are dried by passage of a dry gas therethrough.

3. A method as claimed in either of the preceding claims in which a pulsation is superposed upon the normal flow of said contaminated fluid.

4. A method as claimed in any of the preceding claims in which said pressed filter layer is formed by the passage of steam from said first zone to said second zone and the whole filter is simultaneously sterilised.

5. A method of filtering a fluid containing a solid contaminant according to claim 1 and substantially as hereinbefore described.

6. A device for filtering a fluid containing a particulate solid contaminant which comprises a housing, a foraminated filter support fixedly mounted within said housing in such manner as to divide said housing into two separate chambers, means for introducing into or for withdrawing a fluid from each of said two chambers and a mass of fibres mounted upon one side of said filter support, said fibres comprising elongated fibres each having at least one free end and said ends extending outwardly from one surface of said filter support into one of said chambers and being adapted to be pressed against that surface of said support when fluid is flowing in one direction through said chambers and to align with the direction of flow when this flow is reversed, and means for reversing the direction of flow of fluid through said two chambers.

7. A device as claimed in claim 6 in which said elongated fibres are natural fibres, spun plastics materials fibres, glass fibres, graphite fibres or metal fibres.

8. A device as claimed in either of claims 6 or 7 in which said elongated fibres are held in position upon said support by means of retaining partitions.

9. A device as claimed in either of claims 6 or 7 in which said elongated fibres are pressed into position between the corrugations of a foraminated filter support in corrugated form and are secured in position by means of rods.

10. A device as claimed in any of claims 6—9 in which said housing is provided with at least one inspection window.

11. A device for filtering a fluid containing a solid contaminant substantially as hereinbefore described with reference to Figs. 1 and 2, Fig. 3, Fig. 4A, Fig. 4B, Figs. 5A—5C, Fig. 6, Fig. 7, Fig. 8 or Fig. 9 of the accompanying drawings.

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1574878 COMPLETE SPECIFICATION

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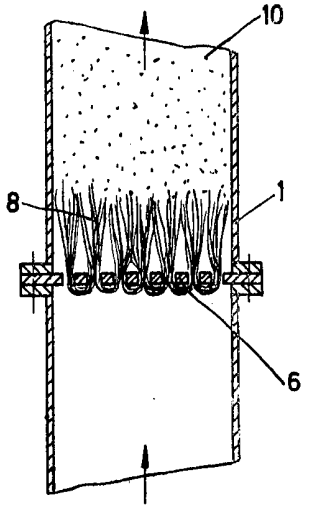

Fig.1

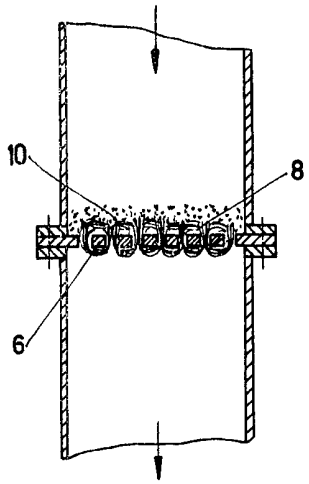

Fig.2

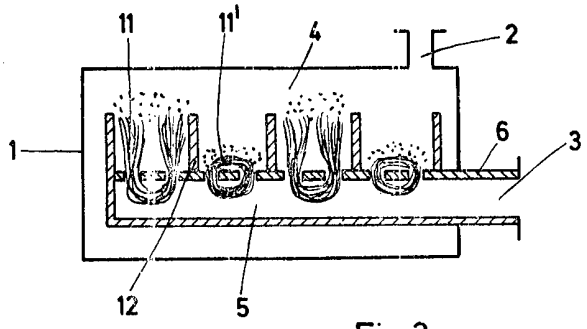

Fig.3

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Sheet 2

Fig.4A

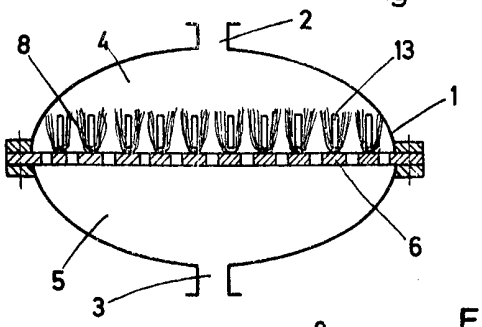
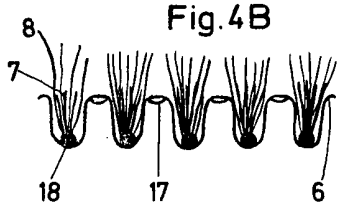


Fig.4B



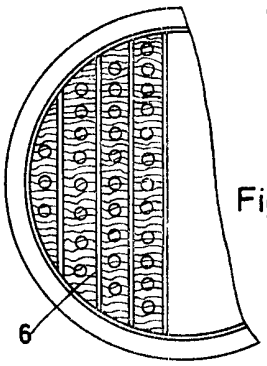


Fig.4C

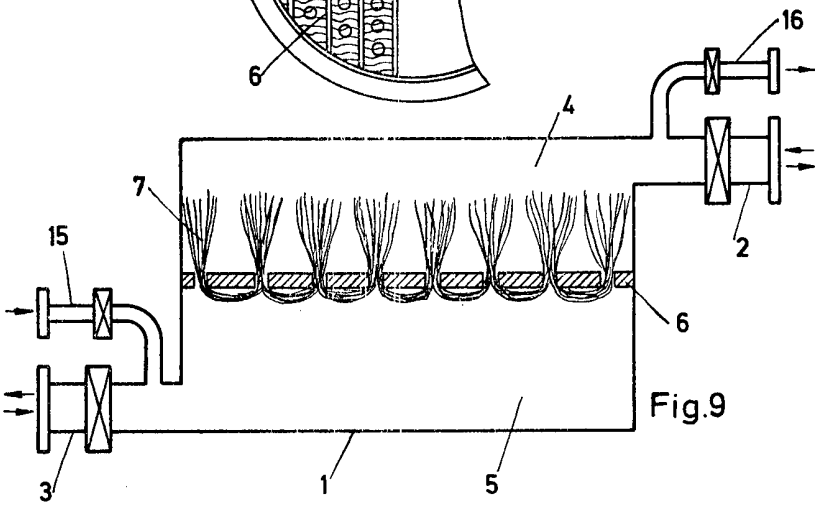


Fig.9

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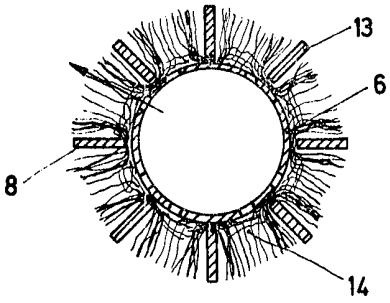

Fig.5A

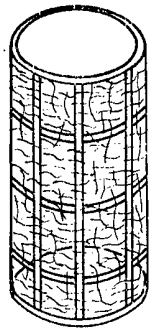

Fig.5B

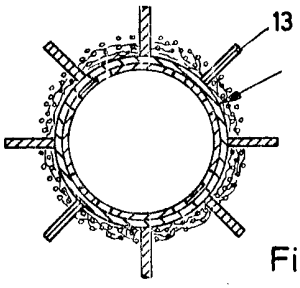

Fig.5C

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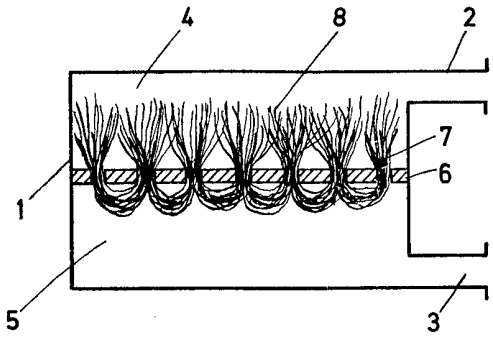

Fig.6

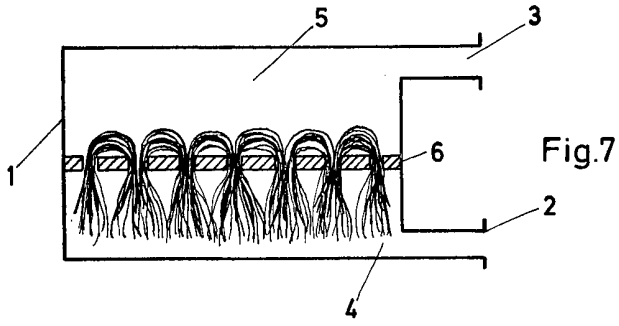

Fig.7

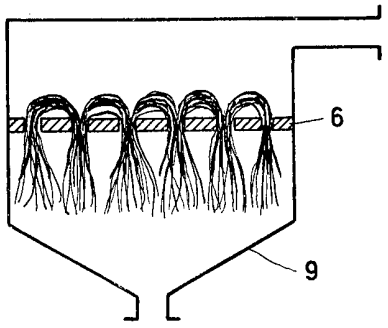

Fig.8