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N. K. CHANEY ET AL

2,520,124

ROCK WOOL MASS

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FIG. 1.

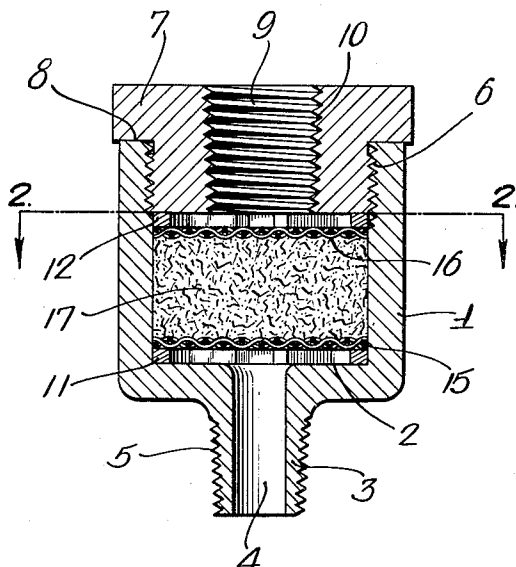
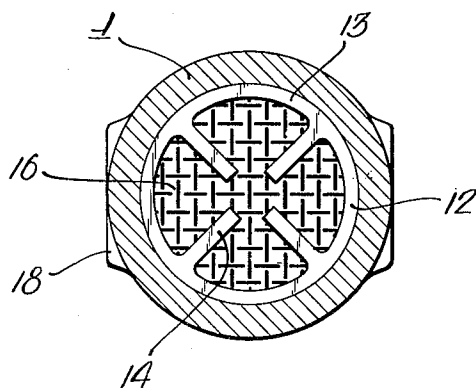


FIG. 2.



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ROCK WOOL MASS

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4 Claims. (Cl. 183—45)

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This invention pertains to new rock wool masses.

This invention pertains more particularly to the reprocessing of rock wool as ordinarily produced to make a new rock wool mass having fiber diameters falling within a selected range or ranges considerably narrower than is found in ordinary rock wool, and having fiber lengths falling within a selected range or ranges and considerably shorter than is found in ordinary rock wool.

The invention pertains more particularly to the production of rock wool masses having selected fiber diameters and lengths and which are substantially free from mineral dust and beads which are normally present in substantial proportion in ordinary rock wool.

The invention pertains still more particularly to the production of improved rock wool masses to be used in the filtration from a gas of extremely minute suspended particles including particles having diametric dimensions of the order of 1 micron and below, such as the extremely minute toxic particles occurring in toxic smokes used for military purposes, and the extremely minute vapor phase gum particles ordinarily occurring in combustible gas produced for distribution in gas mains and known variously as town gas or city gas, etc. It is also useful for the removal from air of pollens and of bacterial clumps of ultramicroscopic size, as well as other particles of similar extremely minute dimensions.

It is well known that in many instances such combustible gas, for example, carburetted water gas, or oil gas, or coal gas, has unavoidably present components which react with each other in the vapor phase to form extremely minute gum particles which remain suspended in the gas, and are known collectively as vapor phase gum. In typical cases, the number of gum particles may be of the order of from 20,000 to 100,000 per cc. The latter concentration is approximately 3,000,000,000 particles per cubic foot.

Many of these particles are so small that they cannot be observed even with the use of the ultra-microscope.

Combustible gas, of the character described, is used for many industrial and domestic purposes, such as, for burning in stoves, hot water heaters, house heaters, refrigerators, and other appliances. Such use of the combustible gas commonly involves burning of the gas in what is known in the art as a low rate appliance burner of which the burner on a refrigerator and the pilot

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light burners on gas stoves, hot water heaters and house heaters, are examples.

The gas flow to a low rate appliance burner is commonly regulated by a valve which has an extremely small opening. Unless the vapor phase gum is removed from the gas prior to its passing through such small valve opening, the gum will collect in the opening to eventually stop it up and extinguish the burner. This has been one of the greatest problems met with by the gas industry over the last 15 or 20 years, and particularly since automatic gas appliances, all of which require a continuous small pilot flame, have come into more general use.

The problem of removing extremely minute vapor phase gum particles from the gas prior to its passage through the extremely small valve openings is greatly complicated by the fact that the pressure on the gas in the distribution mains is very small, and at the appliance it is hardly more than 3 to 8 inches of water column.

It is a well accepted rule in the industry that any device calculated to remove the gum must not result in a pressure drop in the gas of more than one inch of water column, and that such device must remove all of the gum from the gas, since in the case of a certain widely used pilot burner, as little as 0.000025 gram of gum is sufficient to completely stop up its valve opening.

It is also a well accepted rule in the industry that any such device must have a reasonably long useful life without diminution of gas flow due to collected gum, for otherwise, its failure would be merely substituted for that of the valve.

Although extensive efforts have been made to solve this problem involving many different approaches, including filtration and otherwise, the only successful and practicable solution of the problem of which we are aware has been made by Mr. Wilton E. Stackhouse, and is described and claimed in his copending application Serial No. 301,678, filed October 28, 1939, now Patent No. 2,400,719 issued May 21, 1946.

This solution involves the filtration of the gum particles from the gas by passage of the gas through a rock wool filter mass falling within a specified density range and having certain minimum depth specifications.

The filter of said copending application is not only capable of removing all of the vapor phase gum from a combustible gas, but is also capable of removing without undue pressure drop, other particles of similar minute dimensions from the same or any other gas, such as the removal from air for breathing purposes of toxic smoke parti-

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cles of pollens and of bacterial clumps of ultra-microscopic size.

Our new and improved rock wool may be used in a rock wool filter of the character referred to above with improved results from the standpoint of a substantially greater permissible flow of gas through a filter of given size or dimensions with complete filtration, and with a greater filter life expectancy.

In our new filter mass a certain percentage range of extremely fine rock wool fibers (but not too fine) and having high surface area relative to mass, are distributed upon and supported by a certain percentage range of coarser rock wool fibers (but not too coarse) of sufficient mechanical strength and resilience to provide our desired structural support and spatial distribution in the rock wool filter mass.

To obtain a filter mass in which the interstices between and formed by the fibers are more uniform as to size and spatial distribution, and in which the fibers are interlaced to a greater degree, we employ fiber lengths which are considerably shorter than the fiber lengths which usually occur in ordinary rock wool.

In accordance with our invention, we provide a new rock wool mass which is comprised of fibers which range in diameter approximately from 1 to 10 microns (expressed to the nearest 0.5 micron), and which preferably range in length approximately from 0.05 to 5 mm. As is well known, 1 mm. is equal to 1000 microns.

Referring now more particularly to fiber diameters, preferably, at least approximately 40% of the fibers present by numerical count have diameters falling in the range of approximately from 1 to 3.5 microns, and at least approximately 5% of the fibers present by numerical count have diameters falling in the range of approximately from 6 to 10 microns.

Excellent results are obtained when the numerical percentage of fibers falling in the diameter range of approximately from 1 to 3.5 microns is approximately from 50% to 85%, and when the numerical percentage of fibers falling in the diameter range of approximately from 6 microns to 10 microns is at least 5%.

Such results are further improved when the numerical percentage of fibers falling in the diameter range of approximately from 1 micron to 3.5 microns is approximately from 55% to 65%, and when the numerical percentage of fibers falling in the diameter range of approximately from 6 microns to 10 microns is at least approximately 5%, such as approximately from 5% to 25%.

When these preferred percentage range ratios of finer to coarser fibers obtain, then the numerical percentage of other fibers present in our new rock wool mass, that is, fibers having diameters which do not fall within either the diameter range of approximately from 1 micron to 3.5 microns or the diameter range of approximately from 6 to 10 microns, may vary approximately from 55% down to 0%. Such fibers obviously fall into a diameter range intermediate of those set forth above, that is, within a diameter range of approximately from 3.5 microns to 6 microns. The numerical percentage range of approximately from 55% to 0% for these fibers of intermediate diameter is, of course, narrowed to approximately from 45% to 0% and to approximately from 40% to 0% such as approximately from 40% to 10%, as the preferred percentage range ratios of finer fiber to coarser fiber become more specific as set forth above.

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Referring now to fiber lengths, at least approximately 80% and more preferably at least approximately 85% numerically of said fibers of our new rock wool mass preferably, but not necessarily, fall within the above mentioned preferred range for fiber lengths of approximately from 0.5 mm. to approximately 5 mm., within which an intermediate range of approximately from 0.1 mm. to approximately 2 mm. is still more preferred. A differently stated preference is that fiber lengths are at least approximately 0.05 mm. and more preferably at least approximately 0.1 mm.

Our new rock wool mass is preferably composed substantially entirely of fibers falling within the above mentioned specifications stated generally, with the various degrees of preference given to the respective ranges or limits, as stated. However, we find that some allowance may be made for the possible presence of some of the undesired material present in ordinary rock wool, such as mineral dust, beads, extremely fine fiber, extremely short fiber, coarser fiber, longer fiber, etc. Accordingly, it may be stated that at least 95% by weight, such as at least 98% by weight, of the total rock wool mass should be composed of fibers, and that at least 95% numerically, such as at least 98%, of said fibers should fall within the generic diameter specifications above given, and that at least 80%, and more preferably at least 85%, such as at least 95% numerically of said fibers should fall within the generic length specifications above given. Should the rock wool fibers be coated with a resinous material the approximate average composite diameter of the coated fiber is considered. In connection with weight specifications, the weight of the total coated material applies if the fibers are coated. If uncoated, the uncoated weight, of course, applies.

A fiber, for the purposes of this specification, is to be considered as an element having a length at least 10 times its diameter.

Our new rock wool mass may be prepared as follows:

Example 1

A rock wool blanket or other rock wool mass is separated such as with a pointed instrument until broken down into separate fibers or small fiber bundles. A quantity such as 10 grams of this separated material and say 200 times its weight of water are placed in a container with a variable speed short bladed motor driven propeller type stirrer, such as the more or less conventional soda fountain mixer, and mixed first at low speeds until the fibers are completely wetted, and then at high speed until any fiber bundles are broken up and the material is more or less uniformly dispersed in the water. This may take from 5 to 15 minutes depending upon the mixing capacity of the stirrer. After complete dispersion the beating is continued until the desired reduction in average fiber length has been obtained as determined by sampling from time to time. With efficient beating this does not require as much time as the initial dispersion. The rapidity of dispersion and degree of fiber shortening may be increased by the insertion into the container out of the path of the propeller of a stationary knife edge baffle, slightly deflected from the direction of rotation to reduce the rotational speed of the suspension relative to the speed of the stirrer. The water suspension of fiber is now poured into a larger vessel containing say an equal volume of water, and the fiber kept in gentle agitation by

stirring at a rate sufficient to keep the fibrous material in suspension, while permitting the heavy beads and coarse aggregate to collect on the floor of the vessel. The suspension is now decanted from the heavy settlings into a second vessel, and the gentle agitation is repeated until substantial sedimentation of any remaining non-fibrous beads, or heavy fiber aggregate ceases. This is followed by decantation of the suspension, as before, leaving the settlings behind. This procedure may be repeated if, and as many times as, necessary to reduce the amount of fiber of 6 to 10 microns in diameter to any desired percentage.

The next stage is for the purpose of removing fines from the decanted suspension of the preceding stage. This comprises placing the decanted material in a container, and then letting the fibrous material settle without agitation for from one to several minutes, thus leaving a supernatant suspension of finely divided dust particles and very short and/or very fine fiber, which is removed by decanting the supernatant suspension. The fine dust particles and very short and/or very fine fiber have slower initial settling rates than the longer desired fiber, and may be easily decanted therefrom. This operation is repeated to remove any fines which may have become entangled in and carried down with the desired fiber. This procedure may be further repeated, if, and as many times as, necessary, in case there is an excessive percentage of fiber in the range of 1 to 3.5 microns diameter which it is desired to remove. Slight agitation, such as by stirring, may be resorted to, if necessary or desirable, to assist in floating or suspending fine fiber for separation purposes.

Agglomerates or small bundles of fiber have higher settling rates than the individual fibers, and while the accidental formation of such more rapidly falling bundles is continuously occurring throughout the suspension, the frequency of such occurrence is a function of the dilution. The greater the dilution the more effective is the separation of fines.

It will be obvious that the order of the two stages of decantation described above can be reversed, or under proper conditions carried on simultaneously.

The invention may be further illustrated in connection with the accompanying drawings in which:

Figure 1 shows a vertical cross-section of a filter adapted for use in conjunction with domestic gas range pilots; and

Figure 2 shows a horizontal cross-section along the line 2-2 of Figure 1.

Referring now to Figures 1 and 2, 1 indicates a generally circular filter chamber member, provided with an interior bore which constitutes the filter chamber. The member 1 is provided with the seat or shoulder 2 and with the lug 3, which is provided with the passage 4 for communicating with the filter chamber. The lug 3 is further provided with threads as indicated at 5. The interior bore of member 1 is shown threaded at 6 to engage the screw plug 7 which is adapted to be screwed into the bore and to fit in gas tight manner across the end of member 1 as indicated at 8. The screw plug is provided with the passage 9 which is shown with threads at 10, and which communicates with the filter chamber. 11 and 12 are spiders provided with rims as shown at 13 and arms as shown at 14 and are adapted to furnish support for screens 15 and 16. 17 is a filter element of rock wool. For convenience,

in assembly and connection, the member 1 may be provided with wrench grips as shown at 18, and the head of the screw plug 7 may be formed as a nut.

Since the filter particularly illustrated and described is designed more particularly for use in connection with a pilot burner on a domestic gas stove, all metal parts are preferably of a material or materials which do not corrode in the presence of manufactured gas. As an example, the filter chamber 1, the screw plug 7 and spiders 11 and 12 may be of brass which preferably has a copper content not greater than 68% and still more preferably not substantially greater than 63%, and screens 15 and 16 may be of stainless steel. A 16-mesh screen is very satisfactory, although other suitable mesh screen may be employed.

The interior bore is preferably accurately dimensioned in diameter and length as is also the screw plug. The screens and spiders are preferably more or less accurately formed in thickness. Such accurate dimensioning facilitates the securing of the desired rock wool arrangement in assembling the filter, as in such case a predetermined quantity of rock wool may be merely compressed to the desired cross-sectional area, depth and density.

In so assembling the filter the spider 11 is positioned against the seat 2 and the screen 15 placed abutting the spider. A weighed or otherwise previously determined quantity of rock wool may be then placed in the filter chamber and the screen 16 and spider 12 positioned on the other side of it. The screw plug 7 is then introduced and tightened until it fits in gas-tight contact with the end of member 1 as at 8, compressing the rock wool within the chamber.

Accurate dimensioning of the parts predetermines the cross-section, density and depth of the rock wool after compression. The quantity of rock wool selected by weighing or punching or otherwise forms a mass of predetermined thickness which will give the desired density to the filter mass after its compression to the predetermined volume.

The filter may be connected at either end to the pipe leading from the gas supply and at the opposite end to the pipe leading to the pilot or other low rate gas consuming device.

In use, the gas flows through the filter element depositing therein the gum particles and other suspended solids, the screens and spiders serving to retain the rock wool without unduly impeding the flow of the gas.

The spiders with their arms 14 serve to support the screens and prevent their bulging while holding the filter mass in place and further serve to provide gas spaces for distributing the gas across the area of the filter element.

Example 2

A filter similar to that shown in Figure 1 having a chamber bore of 0.75 inch in diameter and an overall chamber length of 0.75 inch, provided with a screw plug, screens and spiders dimensioned to provide a space for rock wool 0.50 inch depth. This filter was filled with 1.06 grams of our new rock wool mass and, after assembly and installation, efficiently filtered heavily gummed gas at a rate of 1.98 cubic feet of gas per hour at a pressure drop of one inch of water column across the filter. The density of our new rock wool filter element after compression was approximately 4.80 grams per cubic inch.

The rock wool filter element of Example 2 was substantially free from non-fibrous materials such as beads and mineral dust. The numerical percentage of fibers present having diameters within the range of from 1 to 3.5 microns was 44%, the numerical percentage of fibers present having diameters within the range of from 3.5 to 6 microns was 27%, the numerical percentage of fibers having diameters within the range of from 6 to 10 microns was 25%, and the numerical percentage of fibers present having diameters greater than 10 microns was 4%, all figures being reasonable approximations.

Substantially all of the fibers present had lengths falling within the range of from 0.05 to 5 mm. with at least 90% numerically of the fibers present having lengths falling within the range of from 0.1 to 2 mm., all figures being reasonable approximations.

Example 3

A filter having the dimensions of the filter of Example 2 was filled with 0.68 gram of another embodiment of our new rock wool mass, and after assembly and test, was found capable of efficiently filtering heavily gummed gas at a rate of 2.04 cubic feet of gas per hour at a pressure drop of 1 inch of water column across the filter. The density of the rock wool filter element was approximately 3.08 grams per cubic inch.

The rock wool filter mass of Example 3 had a numerical percentage of fibers having diameters within the range of from 1 to 3.5 microns of 83%, a numerical percentage of fibers having diameters falling in the range of from 3.5 to 6 microns of 8.5%, a numerical percentage of fibers having diameters falling in the range of from 6 to 10 microns of 8.5% and no fibers present having diameters greater than 10 microns, all figures being reasonable approximations. The filter mass was also substantially free from non-fibrous material such as beads and mineral dust. Substantially all of the fibers present had lengths falling within the range of from 0.05 to 5 mm. with at least 90% numerically of the fibers present having lengths falling within the range of from 0.1 to 2 mm., all figures being reasonable approximations.

Example 4

A filter having the dimensions of the filters of Examples 2 and 3 was filled with 0.80 gram of another embodiment of my new rock wool mass and after assembly and test, was capable of efficiently filtering heavily gummed gas at a rate of 2.37 cubic feet of gas per hour at a pressure drop of one inch of water column across the filter. The density of the rock wool was approximately 3.62 grams per cubic inch.

The numerical percentage of fibers present in the rock wool mass having diameters falling within the range of from 1 to 3.5 microns was 61%, the numerical percentage of fibers falling within the range of from 3.5 to 6 microns was 15%, the numerical percentage of fibers falling in the range of from 6 to 10 microns was 23%, and the numerical percentage of fibers having diameters of more than 10 microns was 1%, all figures being reasonable approximations.

Substantially all of the rock wool mass was fibrous in character and substantially all of the fibers had lengths falling within the range of from 0.05 to 5 mm. with at least 90% numerically of the fibers having lengths falling within the

range of from 0.1 to 2 mm., all figures being reasonable approximations.

The "density" of rock wool when referred to herein and in the claims means apparent density as distinguished from absolute density, apparent density being equal to the weight in grams of a given fibrous mass divided by the volume in cubic inches of the space occupied by it. Because of variations within the material itself this density is obviously average.

The rock wool filter element may have any desired density suitable for the purpose, such as between 3 grams per cubic inch and 16 grams per cubic inch, and more particularly between 3 grams per cubic inch and 10 grams per cubic inch. The depth, density and cross-sectional area of the filter element are usually adjusted with respect to each other so that the desired filtration is obtained with the desired rate of flow. A filter mass depth of at least $\frac{1}{4}$ inch is usually preferred, for example, a depth of approximately $\frac{1}{2}$ inch.

While the invention has been more particularly described in connection with water as the elutriating medium, it is to be understood that any other suitable liquid medium may be substituted. Examples are preferably of low viscosity and low vapor pressure hydrocarbon oils such as kerosene, solvent naphthas, xylene, etc., higher boiling alcohols, and glycols, or their water solutions, ketones, esters, etc., and water solutions of soluble inorganic salts.

From the foregoing examples, the efficiency of our new rock wool mass for the removal of vapor phase gum becomes readily apparent. Our invention is likewise applicable to the removal from air of toxic smokes, of pollens, of bacterial clumps, as well as of other particles of ultramicroscopic dimensions.

Therefore, having more particularly described our invention, it is to be understood that this is by way of illustration, and that changes, omissions, additions, substitutions and/or modifications may be made within the scope of the claims without departing from the spirit of the invention.

We claim:

1. A new rock wool mass at least 95% by weight of which is composed of fibres whose lengths are at least ten times their diameters, of which fibres at least approximately 40% numerically range in diameter approximately from 1 to 3.5 microns, at least approximately 5% numerically range in diameter approximately from 6 to 10 microns, and at least approximately 95% numerically range in diameter approximately from 1 to 10 microns.

2. A new rock wool mass at least 95% by weight of which is composed of fibres whose lengths are at least ten times their diameters, of which fibres at least approximately 40% numerically range in diameter approximately from 1 to 3.5 microns, at least approximately 5% numerically range in diameter approximately from 6 to 10 microns, at least approximately 95% numerically range in diameter approximately from 1 to 10 microns, and at approximately 95% numerically range in length approximately from 0.05 to 5 mm.

3. A new rock wool mass at least 95% by weight of which is composed of fibres whose lengths are at least ten times their diameters, of which fibres approximately from 50 to 85% numerically range in diameter approximately from 1 to 3.5 microns, at least approximately 5% nu-

merically range in diameter approximately from 6 to 10 microns, at least approximately 95% numerically range in diameter approximately from 1 to 10 microns, at least approximately 80% numerically range in length approximately from 0.05 to 5 mm., and approximately all have lengths greater than approximately 0.05 mm.

4. A new rock wool mass which is substantially entirely composed of fibres whose lengths are at least ten times their diameters, of which fibres approximately from 55 to 65% numerically range in diameter approximately from 1 to 3.5 microns, approximately from 5% to 25% numerically range in diameter approximately from 6 to 10 microns, at least approximately 98% numerically range in diameter approximately from 1 to 10 microns, at least approximately 85% numerically range in length approximately from 0.1 to

2 mm., and at least approximately 95% numerically range in length approximately from 0.05 to 5 mm.

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