

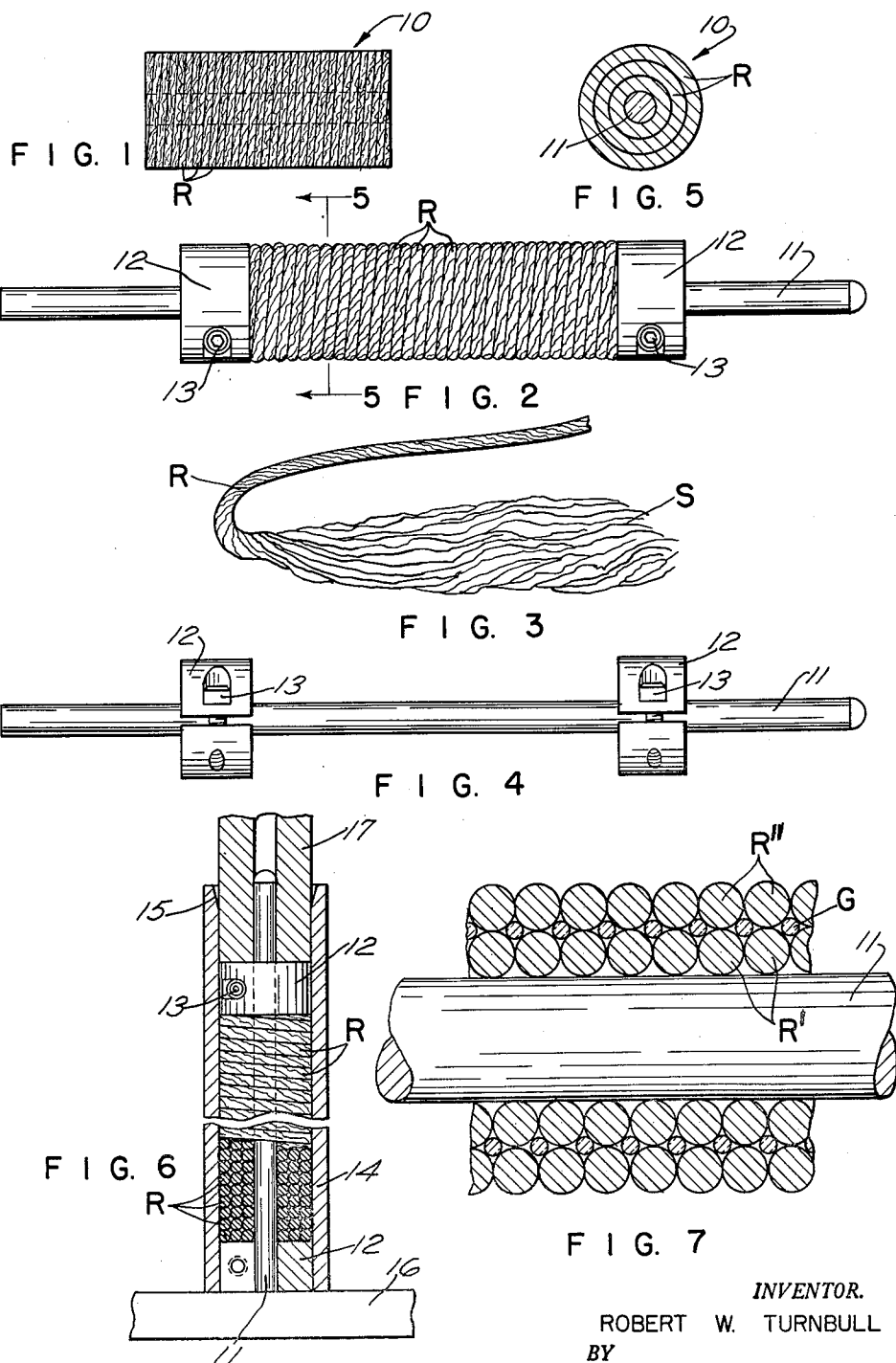
April 17, 1962

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3,030,302

FILTER OF SINTERED METAL FIBERS AND METHOD OF MAKING THE SAME

Filed April 25, 1960



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3,030,302

## FILTER OF SINTERED METAL FIBERS AND METHOD OF MAKING THE SAME

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Filed Apr. 25, 1960, Ser. No. 24,420  
3 Claims. (Cl. 210—510)

This invention relates to a high temperature filter made entirely, or primarily of metal fibers in the form of a roving disposed in spiral coils lying side by side in a plurality of cylindrical layers, and sintered to secure the fibers one to another in the form of porous cylinder.

The metal fibers used are non-symmetrical in cross section and preferably have an irregular surface and fine barbs to which the particles of dirt in the fluid to be filtered can cling. These fibers are formed into a roving of considerable strength and which is laterally compressible, and the roving preferably is wound tightly upon a mandrel or form in a plurality of layers. The cylindrical mass thus produced is then compressed longitudinally to compact the fibers, and the mass is then sintered to bond the fibers one to another. In this manner a high temperature filter is produced that will remove all solids over a few microns in size, and which has good dirt retaining capacity.

The filter herein contemplated is of the depth type and has the form of a cylinder or other hollow annular body. It may be used to filter gases or liquids, but was developed primarily as a high temperature filter to filter lubricants in airplanes and in other fields where the temperature of the liquid to be filtered is too high to permit the use of paper or textile filtering material.

High temperature filters such as finely woven wire have been used heretofore, but such filters have low dirt holding capacity and therefore plug quickly. An important object of the present invention is to provide a high temperature filter made of tightly compacted non-symmetrical fibers bonded together so that the filter will have good filtering efficiency and good dirt holding capacity. The non-symmetrical metal fibers used to form the above mentioned rovings have much better dirt retaining properties than would rovings made of round, smooth, wire strands.

The high temperature filter of the present invention is made primarily of a roving formed of metal fibers because such roving can be wound tightly on supporting means to form a compact cylinder, and the density of the fibers can be increased as desired by compressing this fibrous cylindrical mass longitudinally, or if desired, both longitudinally and circumferentially.

The metal fibers forming the roving may vary in length from a fraction of an inch to several inches or more, and should form a laterally compressible and relatively strong roving which can be wound under considerable tension. The fibers, as above stated, preferably have relatively rough surfaces with fine barbs to which dirt will cling. Such fibers may be formed by cutting, shredding or tearing fine strands from metal sheets or bars. If, however, very fine irregular metal fibers are desired, they can be formed by metal coating fine glass strands or other fine strands. The non-metal strands may then be destroyed or otherwise removed to leave the fine non-symmetrical metal strands.

These fine, long metal fibers may be laid by any suitable means to form a mat or batt of the desired thickness with the fibers oriented to extend in the same general direction. This fibrous mat or batt is then divided longitudinally into narrow strips or slivers which are twisted one or more turns per inch to form relatively strong but laterally compressible rovings.

Such a roving is then wound in most cases under con-

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siderable tension in two or more rows on a mandrel, so that these windings are confined between two spaced collars on the mandrel. The hollow cylinder thus formed of a wound metal roving or rovings is then compressed longitudinally to reduce its length, and force the roving winding and metal fibers close together. This produces a compact cylinder of approximately uniform density throughout, so that there are no channels for the passage of large dirt particles. The fibrous cylinder is preferably confined in a surrounding sleeve while it is compressed longitudinally so that it will not swell in diameter.

This compressed cylinder is then removed from its mandrel and sintered to increase its strength and rigidity and anchor the metal fibers at various points. After sintering, the cylindrical mass may be returned to such sleeve or mold and again compressed slightly to give it more accurate dimensions.

This completes one concept of the method of the present invention and provides a strong, tough accurate shaped hollow cylinder made up of fine, relatively long, metal fibers that are sintered one to the other to provide an efficient high temperature filter having good dirt retaining capacity.

In another embodiment of the present invention a hollow cylindrical filter similar to that above described is formed of two types of roving, one being formed of metal fibers as above described, and the other formed of fine ceramic fibers such as spun glass. The rovings are so wound on a mandrel that the fiber glass roving overlies a layer of metal fibers roving. The advantages of this construction result from the fact that the glass fibers may be very fine and only a few microns in diameter while the metal fibers are from one to several thousandths of an inch in diameter. This filter will filter out much finer solids than will the all metal cylindrical filter above described, and even if the glass fibers are brittle and tend to break, migration of such broken fibers will be prevented by the downstream layer of metal roving.

The above and other features of the present invention will be further understood from the following description when read in connection with the accompanying drawing, wherein:

FIG. 1 is a side elevation of a sintered metal filter constructed in accordance with the present invention.

FIG. 2 is a side view of a supporting spindle having a roving of metal fibers wound thereon as a step in making the filter of FIG. 1.

FIG. 3 shows a fragment of a metal sliver and of a metal fiber roving employed to make the filter of FIG. 1.

FIG. 4 is a side elevation of the mandrel upon which the roving of FIG. 3 is to be wound.

FIG. 5 is a sectional view taken on the line 5—5 of FIG. 2.

FIG. 6 is a vertical sectional view showing the parts of FIG. 2 inserted in a confining sleeve so that the wound rovings of FIG. 2 may be compressed; and

FIG. 7 on a larger scale shows a modification of the filter of the present invention.

The filtering properties of the filter of the present invention will depend largely upon the size and the cross sectional shape and surface characteristics of the individual metal fibers forming the filter. If such filter is required to remove all solid particles down to a few microns in size, then the individual metal fibers should be very small in cross section. These fibers should not have the form of fine round wire strands because a filter mass formed of round wire strands will have lower dirt holding capacity. The metal fibers used in the present filter should be non-symmetrical in cross section and may be somewhat kinky and have minute barbs or whiskers so that the filter mass formed of such fibers

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will have high dirt removing capacity and high dirt retaining properties in order that the filter will not become quickly plugged with dirt.

Such metal fibers may, as above stated, be formed by cutting, tearing, or shredding a metal bar or the like. If extremely fine metal fibers are desired, these may be formed by metal coating fine glass or other fibers. In some cases it may be desirable to melt or otherwise remove the fine non-metal fibers to leave fine, non-symmetrical metal strands, while in other cases the fine non-metal fibers need not be removed.

Different types of metals which can be sintered and which will not readily corrode or oxidize may be used, such as stainless steel or nickel. Such metal fibers may vary in length from a fraction of an inch to a number of inches long and the diameter of such fibers may be anywhere from about 0.0001 inch to several thousandths of an inch, and these fibers should have an unsmooth outer surface so as to present a rough, irregular surface to which dirt particles can readily cling.

These metal fibers are formed into a mat or batt by any suitable means, and the batt may be formed of both coarse and fine fibers within the cross sectional range above indicated, or all of these metal fibers may have approximately the same size in cross section. The fibers forming the batt should be oriented so that they lie in approximately parallel relation to each other. These metal fibers may be so arranged by subjecting them to the action of a magnetic field or they may be otherwise disposed in approximately parallel relation to each other. Each batt may be given any desired thickness and if the fibers are at all kinky, the batt will be soft and compressible.

The batt just described is divided into narrow strips or slivers, one of which is shown in FIG. 3 in the drawing and is indicated by S. This sliver is twisted one or more turns per inch to form a roving such as indicated by R in the different views of the drawing. This roving is more or less compressible transversely and may have a diameter when not compressed anywhere from a few hundredths of an inch to a quarter of an inch or more. The roving R should be relatively strong for reasons hereinafter pointed out.

The metal filter element which is shown in its finished form as a hollow cylinder in FIG. 1 and therein designated by the numeral 10 is made by winding a roving R or possibly more than one such roving onto a supporting mandrel 11. This mandrel has mounted thereon two split collars 12 and these collars are secured to the mandrel 11 the desired distance apart by tightening the collar clamping screw 13 of each collar. These collars, as will be apparent from FIG. 2, define the space where the roving R is to be wound on the mandrel 11 in two or more layers. Three such layers are shown in FIGS. 5 and 6. The roving R is readily wound on the mandrel 11 by placing this mandrel in a lathe to rotate it while the roving R is guided onto the mandrel under tension to form tightly wound spiral coils on the mandrel disposed in successive layers to thereby produce a hollow metal cylinder formed of the metal roving R. The roving may be wound on the mandrel under considerable tension so as to form a compact fibrous mass or under slight tension as desired.

In order to further compact this fibrous mass, the roving windings are compressed one against the other longitudinally of the cylindrical mass and at the same time the mass may be compressed circumferentially to force the roving coils closer together to fill all the voids between the windings and produce a uniform mass throughout its construction. This compressing of the roving windings can be effected without removing the windings from the mandrel 11. To this end there is preferably provided a metal sleeve 14 of greater length than the wound mass shown in FIG. 2. Such sleeve has an inside diameter equal to or smaller than the outer

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diameter of the wound mass of fibers shown in FIG. 2. The bore of the sleeve 14 is tapered somewhat at its upper end as indicated at 15 to facilitate the entrance of the wound mass into this sleeve.

The metal sleeve 14 is shown as resting upon a table or other support 16 and the entire construction of FIG. 2 is forced downwardly inside the sleeve 14 as shown in FIG. 6 so that the wound roving mass on the mandrel 11 will be compressed longitudinally any desired amount to force the coils close together. These roving coils are forced together by placing on the upper end of the mandrel 11 a metal sleeve 17, the outer diameter of which fits the inside diameter of the sleeve 14 as shown in FIG. 6. Then the sleeve 17 is forced downwardly by means of a press or other power applying mechanism to force the sleeve 17 downwardly upon the mandrel 11 and thereby compress the roving wound mass longitudinally as much as desired, for example to three-quarters or less of its length shown in FIG. 2. Before the mandrel 11 with the roving thereon is placed in the sleeve 14, collars 12 should be loosened on the mandrel so they can slide thereon to the position in which they are shown in FIG. 6.

This compressed fibrous mass is removed from the sleeve 14 and mandrel 11 and is sintered to bond the fibers of the roving coils one to the other and form a relatively cylindrical filter of compressed metal fibers. After sintering, the filter element may again be placed on the mandrel 11 and compressed longitudinally in the sleeve 14 to accurately reshape the filter element. The direction in which the liquid to be filtered flows through this hollow filter element 10 may be inside-out or outside-in as desired.

By arranging the metal fibers above described in the form of a relatively strong roving and then winding such roving tightly upon a mandrel, a compact fibrous cylinder is produced and the fibers forming the same will be disposed at approximately right angles to the radii and also at right angles to the direction of flow of the fluid through this filter which is desirable.

The all metal fibrous filter element just described has good dirt retaining capacity and good dirt removing properties, but a finer filter is produced by using the modified construction of FIG. 7 which will now be described. The filter of FIG. 7 is formed primarily of spirally wound metal roving or rovings such as above described, and to a minor degree of a roving formed of fine ceramic fibers. It is found that in the all metal construction above described there is a tendency for very fine dirt particles to pass through the filter mass apparently between the compressed abutting coils. If the construction shown in FIG. 7 is employed wherein roving windings G formed of fine glass or other fine ceramic fibers are laid between two rows R' and R'' of metal roving windings, all dirt particles can be removed down to a few microns in size. The roving R' and R'' may be similar to the roving R above described, but the glass or ceramic fibers forming the roving G are preferably much finer than the metal fibers of the rovings R, R' or R'' to remove very fine dirt particles. The fibers of the roving G may be somewhat brittle, but if they should break, such broken fibers cannot migrate because they are confined between the roving coils R' and R''. In every construction, to avoid fiber migration, a layer of metal roving fibers should be disposed downstream of the glass fiber rovings. While there is shown in FIG. 7 only one layer of the rovings R', G and R'', the number of such layers may be increased as desired provided the glass fiber windings G are confined between two layers of the metal roving windings R' and R''.

An annular or cylindrical filter construction as above described entirely or primarily of tightly compressed metal fibers that have a rough, non-symmetrical surface is found in practice to have good dirt removing properties and good dirt holding capacity, and such filter is strong and non-brittle. Its filtering efficiency can be substantially in-

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creased by using two different types of rovings as just described and shown in FIG. 7.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. A metal filter in the shape of a hollow annular body formed of strong twisted metal roving disposed in spiral coils placed side by side in contacting relation and in a plurality of layers disposed one over the other, each roving coil being sufficiently porous for the filtrate to pass through the interior thereof and formed of rough non-symmetrical metal fibers, and the coils being compressed axially of the annular body and sintered together to form a strong non-brittle filter having good dirt-holding capacity.

2. A high temperature filter having the shape of a hollow cylinder and formed of strong twisted metal roving disposed in spiral coils laid side by side in close contacting relation and in a plurality of layers disposed one over the other, each roving coil being sufficiently porous for the filtrate to pass through the interior thereof and formed of rough non-symmetrical metal fibers, and the coils being sintered together to form a firm, strong, non-brittle filter having good dirt-holding capacity.

3. A high temperature filter in the shape of a hollow cylinder and formed primarily of strong twisted metal roving disposed in spiral coils laid side by side in contact-

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ing relation one with the other and in a plurality of layers disposed one over the other and having disposed in the valleys between such roving coils a smaller ceramic strand wound about the cylinder in said valleys, each roving coil being sufficiently porous for the filtrate to pass through the interior thereof and formed of rough non-symmetrical metal fibers, and the metal coils being sintered together to form a firm, strong, non-brittle filter having good dirt-holding properties.

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