

May 23, 1944.

E. C. SLOAN

2,349,469

FILTER

Filed Aug. 14, 1941

2 Sheets-Sheet 1

Fig. 6.

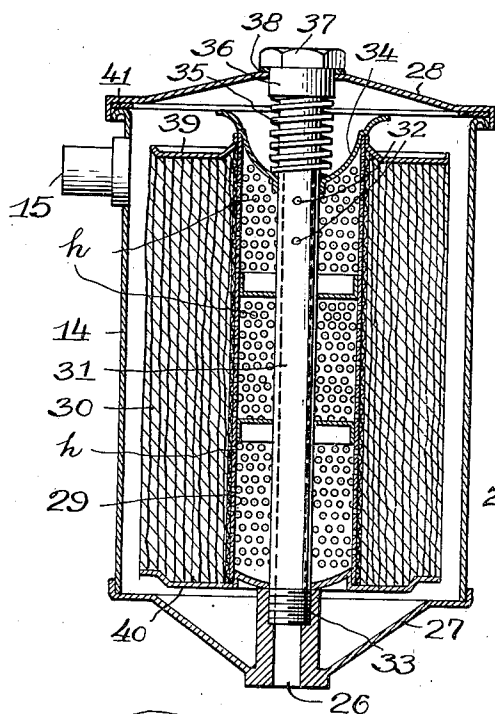


Fig. 4.

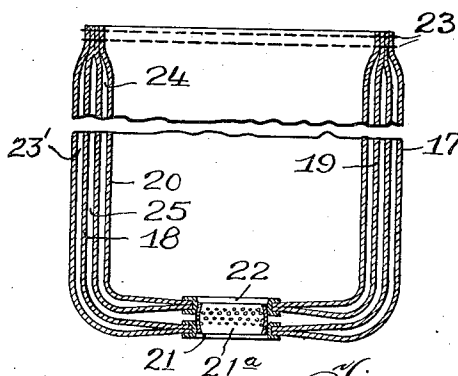
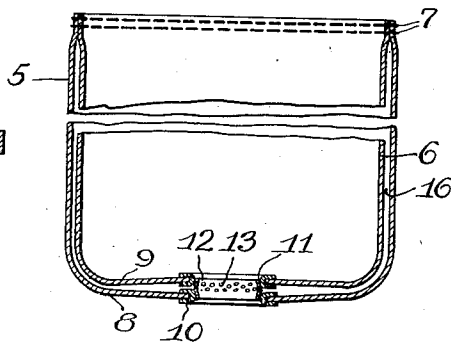


Fig. 5.

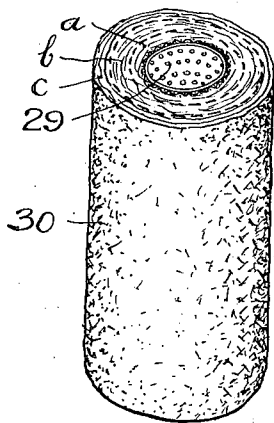


Fig. 7.

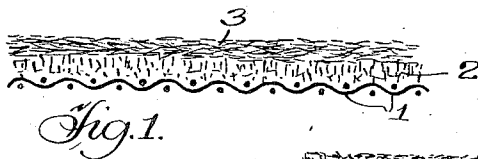


Fig. 1.



Fig. 2.

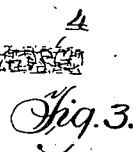


Fig. 3.

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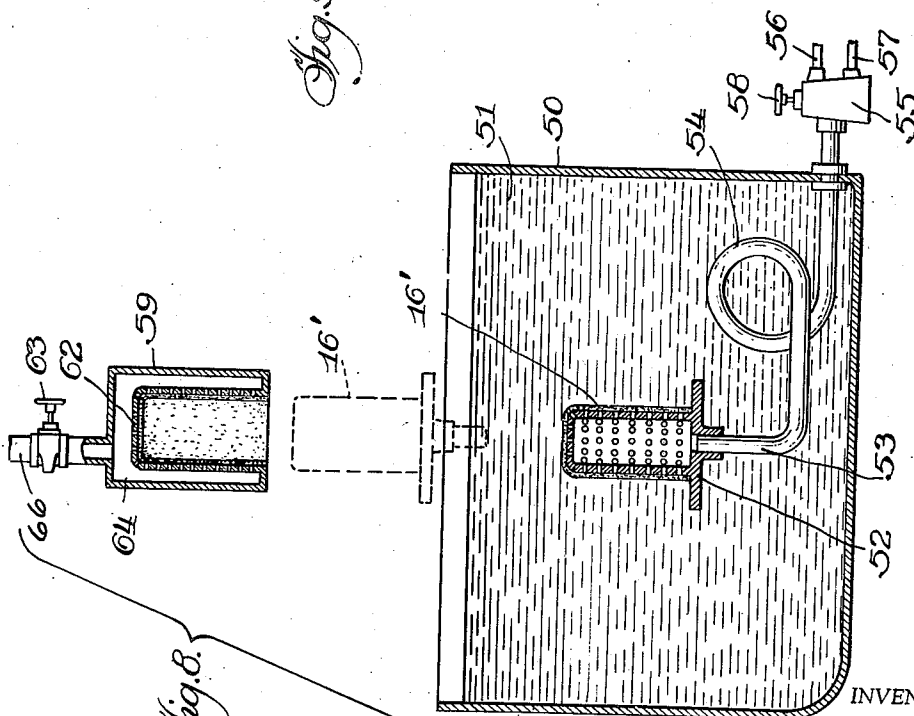
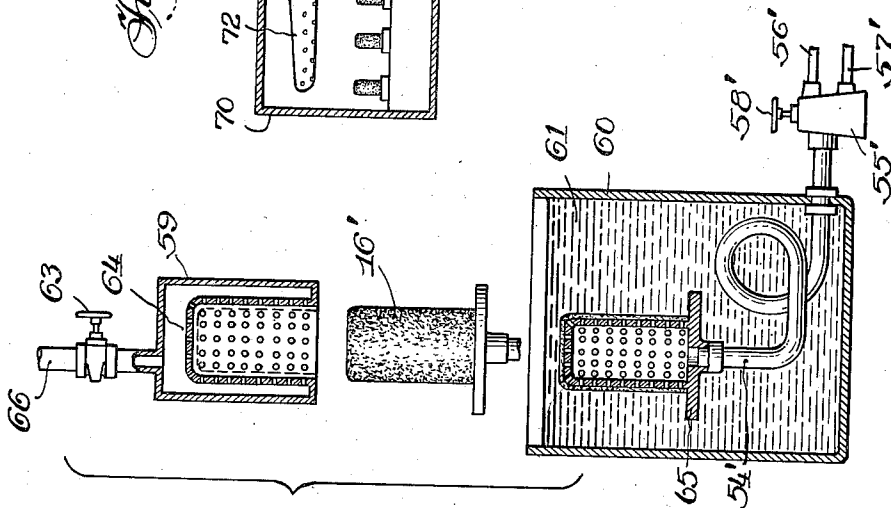
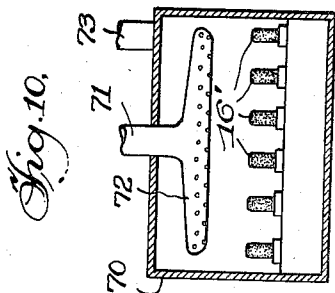
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Filed Aug. 14, 1941

2 Sheets-Sheet 2



Witness:
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UNITED STATES PATENT OFFICE

2,349,469

FILTER

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Application August 14, 1941, Serial No. 406,830

7 Claims. (Cl. 210-204)

This invention relates to a filter and more particularly to a filter of accreted fibrous material in which the degree of porosity is effectively controlled. This application is a division of my application Serial No. 350,491, filed August 3, 1940, for "Filter and method of producing same."

A further object is to accrete one at a time onto porous formers in a fibrous pulp bath a plurality of shell carcasses and so treating the fibers that the treating material will be uniformly distributed on the fibers throughout the carcass.

A still further object is to dissolve a resin in the bath of fibers and water, and accrete a shell carcass onto a former of the desired form, so that when the water is evaporated by drying, the resin will be uniformly distributed on the fibers throughout the carcass.

Another object is to add in suitable amount in the bath of fibers and water, diatomaceous earth thoroughly mixed in the bath, so that the diatomaceous earth will control the degree of porosity of a carcass accreted onto a former immersed in the bath.

Still another object is to mix in a fibrous pulp bath diatomaceous earth, and resin in solution, to cause the diatomaceous earth to remain uniformly distributed throughout the fibrous structure of a carcass accreted onto a former of the desired shape in the bath.

An additional object is to add, in the desired manner resin of the desired kind, to a fibrous pulp bath, so that in a carcass accreted onto a porous former in said bath, and when dried, the resin will stabilize the fibers and the structure and keep the fibers from softening or swelling in the presence of water, thus waterproofing the fibers. Such softening or swelling would be undesirable because it would decrease the porosity of the structure. By the present invention the resin will add to the rigidity of the fiber structure, thus further waterproofing the fibers and causing the corrugations or other roughened surfaces to remain stiff and effective in the presence of water, and further will keep the structure from rupturing under pressure.

A further object is to so treat the fibers as such in the bath and thus afford the opportunity to stiffen the fibers by the use of the proper and desirable resins so that the accreted dried structure will have a decidedly indefinite, irregular, indeterminate, rough and shaggy surface to lessen the possibility of a coating or film being formed to close off the porosity.

A still further object is to provide a multiple

stage filter in which the various stages each comprise a pair of fibrous shells for effecting a certain selected stage of filtering.

A further object is to provide a filter in which a large mass of fibers is accreted in a bath, either with or without resin, onto a perforated core, spool or the like to enable such filter to be easily inserted within a filter casing and readily removed therefrom for renewal when desired and, if desired, such filter may have a plurality of layers of different porosity.

Another object is to first accrete onto a porous former a fibrous article in a bath not containing resin, and then remove the article thus accreted to a second bath containing resin, and by suction or pressure cause some of the liquid in the resin bath to pass through the interstices of the fibrous article to supplant the water among the fibers of said article.

Other objects, advantages and capabilities will later more fully appear.

My invention further resides in the combination, construction and arrangement of parts illustrated in the accompanying drawings, and while I have shown therein preferred embodiments, I wish it understood that the same are susceptible of modification and change without departing from the spirit of my invention.

In the drawings:

Figure 1 is a fragmentary longitudinal section of a portion of a filter member embodying my invention.

Fig. 2 is a similar view of another form of my invention.

Fig. 3 is a similar view of still another form of my invention.

Fig. 4 is a vertical longitudinal section showing a single stage filter member with parts broken away for convenience.

Fig. 5 is a view similar to Fig. 4, but showing a multiple stage filter member embodying my invention.

Fig. 6 is a vertical longitudinal section through a filter casing and filter member therein, the filter member being of the mass type instead of the shell type shown in the preceding views.

Fig. 7 is a perspective view of the filter member of the type shown in Fig. 6.

Fig. 8 is a transverse, vertical section through a tank containing a felting bath and a porous felting former, and a transferer thereabove for carrying an accreted carcass from the first bath to a second bath for further treatment.

Fig. 9 is a view similar to Fig. 8 but showing a second bath containing resin or the like, a porous

felted former in the second bath, and the transfer thereabove.

Fig. 10 is a reduced transverse, vertical section of an oven or the like for drying the wet carcasses.

Referring more in detail to the drawings, Fig. 1 shows in section a fragment of a wall of a filter member embodying one form of my invention. In this form the filter member is preferably formed by accreting it in a fibrous pulp bath onto a porous former of the desired shape by a differential of pressure which may be applied as a partial suction or otherwise as desired. In Fig. 1 the first layer of the filter member may be a screen 1 of metallic or textile material as desired placed against the porous outer surface of the former in the pulp bath; or this inner screen may be omitted if desired. As any shape or type of porous former desired may be used, and as the suction of fibers onto a porous former in a pulp bath is well known, I have shown in Fig. 8 a simple form of apparatus for the general operation of felted or accreting a fibrous pulp carcass or shell in a bath, but without limiting the present invention to the particular shapes shown. In producing the filter wall shown in Fig. 1 inert material such as diatomaceous earth is mixed into the fibrous pulp bath, without the addition into the bath of any resin. As the fibers and diatomaceous earth are sucked or otherwise forced against the surface of the porous former the earth particles 2 will pass through the interstices of the deposited fibers and become more or less concentrated near the inside surface of the filter carcass being formed, leaving the fibers 3 of the outside portion of the carcass more porous, and those on and near the inside surface less porous. In a filter of this type the outer, more porous portion of the filter wall will filter out the larger suspended matter in the fluid being filtered, while the less porous inner portion of the wall will filter out the finer suspended particles. The porosity of the filter walls may thus be controlled as desired by using either fine or coarse inert material, or a mixture of both fine and coarse. Also the degree of filtering may be further controlled by accreting the walls thicker or thinner and with fine or coarse fibers either with or without the addition of inert material.

Examples of some of the inert materials that may be used in carrying out my invention are diatomaceous earth, vermiculite, kieselguhr, fuller's earth, and the like. Also it is to be understood that while my invention preferably contemplates the use of my novel filter members in filtering oil and the like, it is not to be limited thereto, but may be used for filtering any fluids to which my filter members may be adapted.

Another form of my invention is shown in Fig. 2 in which a suitable resin is added to the fibrous pulp bath, as a result of which I have discovered that the inert material is given uniform dispersion and distribution throughout the interstices of the fibers, instead of concentrating on the inner layer as in Fig. 1. In Fig. 2 the inner screen member 1 may be used or omitted as desired, and as shown in this view of the drawings the particles of inert material 2' are distributed uniformly throughout the fibrous wall. This phenomenon of the uniform distribution of the particles of inert material when resin is used in the bath is of great importance in that it enables close control of the porosity by controlling the kind and amount of inert material used. A water soluble resin is preferable but I do not wish the invention to be unnecessarily limited thereto.

Some of the resins that are suitable in carrying out my invention include phenol formaldehyde, cresylic acid formaldehyde, meta-para cresol, urea formaldehyde, thiourea formaldehyde, and the like, or the foregoing with furfural replacing the formaldehyde; these resins being in the "A" stage in which the condensation has been arrested before the resin has become hydrophobic. These resins may be dissolved in water so that the percentage of solids is from 3% to 7% by weight which amount of solids will be sufficient for the stiffening, water-proofing and giving of wet strength to the fibers of the filter members as more fully described later herein.

In Fig. 3 is shown a fragment of a portion of the fibrous filter member wall in which the surface first meeting the oil or other fluid being filtered is extremely rough, shaggy, indefinite, indeterminate or irregular as indicated at 4 so as to lessen the possibility of a coating or film being formed to close off the porosity, as a film forming substance would have the tendency to attach itself to the first part of the surface with which it comes in contact. The porosity away from the surface of the filter may be great or less as desired. A given amount of film forming material will have less tendency to form a continuous film—and thus close off or stop the effectiveness of the filtering area—where the indefinite or shaggy surface is present as in Fig. 3 to filter out the film forming material. This tendency to prevent the formation of a film on the filter surface may be better understood by likening it to the uneven, shaggy appearance of a lawn of more or less high grass in the spring when a light fall of snow falls on the same.

In Fig. 3 as in Fig. 2, resin is added to the pulp bath from which the filter member is accreted. As stated water-soluble resin is preferred. This resin is dissolved in the bath in desirable proportion. A suitable proportion is to dissolve 5% by weight of solid resins in the bath water in which the fibers to be accreted on the former are suspended. When accreted or felted and prior to drying a 30 gram filter carcass will have approximately 80 grams of water containing 5% solid resin. When the carcass is dried the 5% or 4 grams of resin remains in the carcass or filter shell, distributed uniformly throughout the fibers. The resin has also to a certain extent entered the fibers themselves as well as coating and joining the fibers. This method of treating the fibers as such in the bath waterproofs the fibers by using the proper resins and stiffens the fibers.

A further advantage in treating the fibers of the filter unit with resin is that the resin stabilizes the fibers and the structure, and prevents the fibers from softening or swelling in the presence of water, should some water pass through the interstices of the filter when filtering oil or other fluids. Should the fibers become soft or swell (as they will not do with the present invention) this would decrease the porosity of the structure which is undesirable, and might even lead to the rupture of the filter unit.

Referring back to Fig. 2, the incorporation of resin in the filter unit as described, will not only keep the inert material uniformly dispersed and distributed with relation to the fibers, but it will also allow a greater thickness of accretion with a given uniformity of porosity. The resin in the bath prevents the inert material from gathering in clusters or layers in the fibers and insures permanent uniform distribution. In other

words, it stabilizes the uniformity of distribution both during the making of a filter unit and in its use. The increasing of the wet strength of the fibers as described above will also render them water-proof as will be readily understood.

In Fig. 4 is shown a double shell single stage filter unit comprising an outer shell 5 and an inner shell 6 with the upper edges secured together by stitching, sewing, stapling or the like 7 to close that end of the filter unit. The base portions 8 and 9 of the outer and inner shells 5 and 6 respectively are formed with registering central openings around the edges of the material of which are secured the strengthening and supporting collars 10 and 11. These are secured together by a sleeve 12 formed with apertures 13 to permit the outflow of the filtered oil. As will be understood the accreted fibrous shells 5 and 6 may be of any of the various constructions described earlier herein, and of any desired shape. The filter unit of Fig. 4 will preferably be inserted in a filter casing 14 such as shown in Fig. 6, or of any other suitable shape and construction desired. In operation the oil or other fluid to be filtered will enter the filter casing 14 at 15, then pass through the shells 5 and 6 to the space 16 therebetween, then through the apertures 13 of sleeve 12 and out through any suitable outlet opening provided in the base of the filter and associated parts.

In Fig. 5 is shown a multiple stage filter unit comprising four shells 17, 18, 19 and 20 arranged in two pairs of which shells 17 and 18 form one pair having a reinforcing collar 21 in the openings of the base portions, and shells 19 and 20 form another pair having a reinforcing collar 22 in the openings of their base portions. These shells will be stitched, sewed, stapled or otherwise secured together at their upper edges as indicated at 23 for a purpose similar to that described above in connection with Fig. 4. The two stage filter unit of Fig. 5 will be inserted in filter casing 14 or other suitable casing in the manner suggested above in connection with Fig. 4. In the filter unit of Fig. 5 much greater efficiency in filtering may be achieved however because the outer and inner shells 17 and 20 may be of different construction from the intermediate shells 18 and 19 to give added filtering possibilities. For example, the outer and inner shells 17 and 20 may be of medium coarseness to filter out the sludge or heavier parts of the dirt in the oil or the like, and the two intermediate shells 18 and 19 may be of much finer porosity so as to filter out particles which color the oil black or gray, by having a combination of fibers and inert material, or fibers, resin and inert material in their composition as desired. The oil or other fluid being filtered would first flow inwardly through the shells 17 and 20 into spaces 23' and 24 to effect the first stage of filtering, and thence through shells 18 and 19 into space 25, and then through the outlet perforated spacer 21a to any desired receiving means to effect the final filtering and, if desired, a brightening of the oil. Also if desired, the first stage might be composed of coarse water-absorbing fibers to absorb water that may be entrained in the oil, so that water as such will not impair the efficiency of the later stage or stages.

My invention further contemplates the production of filters for oil and other fluids in which the filter unit is accreted onto a perforated hollow core or spool, the accreted filter portion having considerable mass and thickness. Such a

filter is shown in Fig. 6 in vertical cross section. The fibers used in accreting this type of filter are preferably rock wool, but other kinds of fibers may be used if desired. As seen in Fig. 6 the casing 14 is provided with an inlet 15 and an outlet 26, the cover 28 being removable by removing the hollow stud 31 to permit insertion into the casing and removal therefrom of the perforated spool or core 29 upon which the rock wool 30 or other fibers are accreted. As seen in Fig. 6 the thickness of the accreted fibers 30 is considerable. As shown the core 29 is perforated to permit the oil or other fluid to pass therethrough (after passing through the rock wool fibers) and thence out through the outlet 26, there being provided in the walls of the hollow stud 31 openings 32 to permit the passage of the filtrate. The hollow stud 31 is threaded into the base 27 at 33 to permit tightening and removal of the parts, and above the upper cover or hub cap 34 of the spool is a coil spring 35 to force the filter unit downwardly. The spring 35 is held under compression between the cap 34 and the shoulder 36 of the head 37, there being interposed a gasket 38 between the head 37 and the filter casing cover 28 to prevent leakage. A cloth covering is preferably applied over the outside of the core 29, to prevent the fibers from passing through holes $\frac{1}{2}$ in the core.

Fig. 7 shows how the accreted fibers 30 together with the core 29 may be made separate and installed in the spool when fresh and removed therefrom as a filter unit after use. Also the core 29 may have the rock wool fibers accreted thereon to any desired thickness by providing removable ends 39, 40 to the core 29 while in the accreting bath to define the shape of the ends of the accreted fibers, or other removable blank ends of the desired width may be applied to the core during accreting as desired to define the ends of the filter unit. The accreted fibers of the form of filter shown in Figs. 6 and 7 may have resin, or inert material or both in desired proportions incorporated therein during accretion, as set forth earlier herein in connection with the description of Figs. 1 to 3 inclusive, and for a similar purpose. A gasket 41 is provided between the outer edge of the casing cover 28 and the upper edge of the filter casing to prevent leakage. I may also provide three layers a, b and c (see Fig. 7) of different porosity, for example, these different layers may be of different fineness of fibers, and may have diatomaceous earth or the like in one or more but with resin in all of the layers. In other words, the layers will be so constructed in one or the other of the different ways heretofore described so as to have different porosity in the different layers as desired, with the coarser porosity in the outer layer, a finer porosity in the next layer and a still finer porosity in the inner layer so as to give different degrees of filtering in the different layers. Any greater or less number of layers may be used as desired.

My invention also contemplates the accreting of an article of fiber sheet or contoured form, in a fibrous pulp bath without resin, and then removing the article thus accreted from the first bath and immersing it into a second bath containing resin in solution in water and pulling or forcing by suction or pressure the resin solution through the said accreted article and supplanting the original water remaining in the interstices in the article, with the resin solution, and drying the article by removing the water and leaving the resin impregnation in and on the fibers.

In Fig. 8, I have shown a tank 50 containing a fiber-water bath 51, a porous felting former 52 being insertable into and removable from this bath. This felting former is hollow and has mounted in its base a hose, pipe or the like 53 communicating with the interior of the porous former so as to create a suction on the interior thereof for sucking the water through the openings in the former and depositing the fibers thereon to form a carcass or shell designated generally in Fig. 8 at 16'.

The hose 53 is formed with a coil 54 in order to permit the former 52 to be moved upwardly out of the bath, or downwardly thereinto as desired. Coil 54 passes through the wall of tank 50 and connects with the manifold 55, into which extend the air pressure pipe 56 and the suction pipe 57, which latter two pipes will be connected with any suitable means of air pressure and suction. Pipes 56 and 57 are controlled by valve 58 which may be operated to connect either the air pressure line or the suction line as desired to the hose 53 so as to create either a suction on the interior of the porous former or introduce air pressure thereinto selectively. The former and wet carcass are shown in dotted lines just above the tank 50.

Above the tank 50 is a transferrer 59 for receiving and transferring the wet carcass to the second tank 60 containing a fiber-water bath 61 having resin included therein. Transferrer 59 is formed on its interior with the porous shell 62 of substantially the same internal size as the exterior of the wet carcass 16', and into which hollow interior the wet carcass is introduced by moving the former 52 upwardly thereinto, after which the valve 63 will be operated to introduce from a suitable source of supply a suction in the space 64 so as to cause the wet carcass to adhere to the interior of the transferrer. If desired, this can be further facilitated by introducing air under pressure into the interior of the former to tend to force the wet carcass away from the exterior of the former 52, after which the former will be lowered again into bath 51, the air pressure cut off and suction introduced into the former to accrete another carcass thereon.

As soon as the former 52 has deposited its wet carcass on the interior of the transferrer and the former lowered away from the transferrer, the latter will be moved by any suitable means into the position shown in Fig. 9, after which the former 65 is introduced thereinto and suction created in the former 65 to suck the wet carcass thereagainst. At the same time, the suction in the space 64 of the transferrer will be cut off and any desired amount of air pressure introduced through pipe 66 into space 64 to further cause the wet carcass to grip the exterior of the upstanding porous portion of former 65, thus causing the carcass to adhere to the former. The former 65 with the wet carcass thereon is shown in Fig. 9 midway between the transferrer and tank 60. The former 65 together with the wet carcass 16' thereon will then be lowered into tank 60 into the position shown in Fig. 9, and the suction on the interior of former 65 continued so as to suck water from bath 61 through the pores of the former and through hose 54', manifold 55' and suction pipe 57' to pass liquid from bath 61 through carcass 16'. Included in bath 61 is resin similar to that previously described in connection with Figs. 1 to 7.

When the carcasses are formed solely in a single bath such as shown in Fig. 8, and the bath

shown in Fig. 9 not used, the resin will be added to bath 51. When, however, the resin is added to bath 61, there will be no resin added to bath 51 but the carcasses will be accreted without resin in bath 51 and then introduced as described above into bath 61 containing resin, which results in the suction in former 65 carrying the resin containing liquid through the carcass and incorporating resin into the carcass in the form shown in Fig. 9. In Fig. 9, the manifold 55', air pressure pipe 56', suction pipe 57' and valve 58' are similar to the corresponding parts described in connection with Fig. 8.

In Fig. 10 is shown a heating oven 70 through which the carcasses 16' may be passed for drying, hot air being introduced from any suitable source of supply through the pipe 71 and perforated discharge head 72, a chimney 73 or outlet pipe being provided as desired.

Having now described my invention,

1. A filter member comprising a body of accreted, interlaced fibers coated with resin, diatomaceous earth in the interstices of the body, the diatomaceous earth being uniformly distributed throughout the interstices of the fibrous body to control the degree of porosity of the filter member, the resin being of such character and so applied that it assists in effecting said uniform distribution.

2. A filter member comprising a body of accreted, interlaced fibers coated with resin, and having particles of inert material in the interstices of the fibrous body to control the degree of porosity of the filter, the resin being of such character and so applied that it assists in effecting uniform distribution of the inert material throughout the interstices of the fibrous body and to stabilize the fibers and prevent them from softening and swelling in the presence of water.

3. A filter member comprising a body of accreted, interlaced fibers, said fibrous body having incorporated therethrough resin and diatomaceous earth, the exterior surface of the filter member being irregular, indefinite and shaggy to prevent the formation of a film thereon that would tend to clog the interstices between the fibers, the presence of the resin on the fibers causing them to be rigid and maintain the irregular and shaggy condition, and the diatomaceous earth controlling the degree of porosity of the filter, the diatomaceous earth being uniformly distributed throughout the interstices of the fibers.

4. In a multiple stage filter, a plurality of pairs of accreted, fibrous pulp shells, said shells being in concentric relation and secured together around one edge, the two shells of each pair each having an opening in its central bottom portion and secured together around said opening but unattached with relation to each other from said opening to the opposite secured ends, perforate means for spacing the apertured central bottom of each pair, said pairs being positioned concentrically one pair within the other, whereby the fluid being filtered will pass first through one shell of each pair into the space between each pair of shells, and then through the other shell of each pair into the space between pairs, and then out through said perforate means.

5. In a multiple stage filter, a plurality of pairs of accreted, fibrous pulp shells concentrically positioned one within the other, the walls of each pair of shells and the walls of all pairs being secured together at one end, means securing the other ends of the walls of each pair together

with one pair in spaced relation to the other pair and for forming an outlet from the space between the pairs, whereby the fluid being filtered will pass inwardly through the exterior wall of each pair to the space within each pair, and then through the interior wall of each pair to the space between the pairs and out through said outlet from the space between the pairs.

6. In a multiple stage filter, a plurality of pairs of accreted, fibrous pulp shells concentrically positioned one within the other, the walls of each pair of shells and the walls of all pairs being secured together at one end, means securing the other ends of the walls of each pair together with one pair in spaced relation to the other pair and for forming an outlet from the space between the pairs, whereby the fluid being filtered will pass inwardly through the exterior wall of each pair to the space within each pair, and then through the interior wall of each pair to the space between the pairs, the exterior shell of each pair having greater porosity than the interior shell of each pair, and means for draining the filtered fluid out through said outlet from the space between the pairs.

7. In a multiple stage filter, an outer and an inner pair of accreted, fibrous pulp shells, the walls of the inner pair being spaced from each other and from the walls of the outer pair, said shells being concentric and secured together around one end, the two shells of each pair each having an opening in its central portion of the other end and secured together around said openings but unattached with relation to each other from the end having the opening to the opposite secured ends, perforate means for spacing apart the apertured central portions of the two pairs, said pairs being positioned so that the fluid being filtered will pass first through one shell of each pair into the space between each pair of shells, and then through the other shell of each pair into the space between pairs, and then out through said perforate means, the fibers of the shells of one of said pairs being coated with resin and having particles of inert material uniformly distributed in the interstices between the fibers thereof, the resin being of such character and so applied that it assists in effecting said uniform distribution.